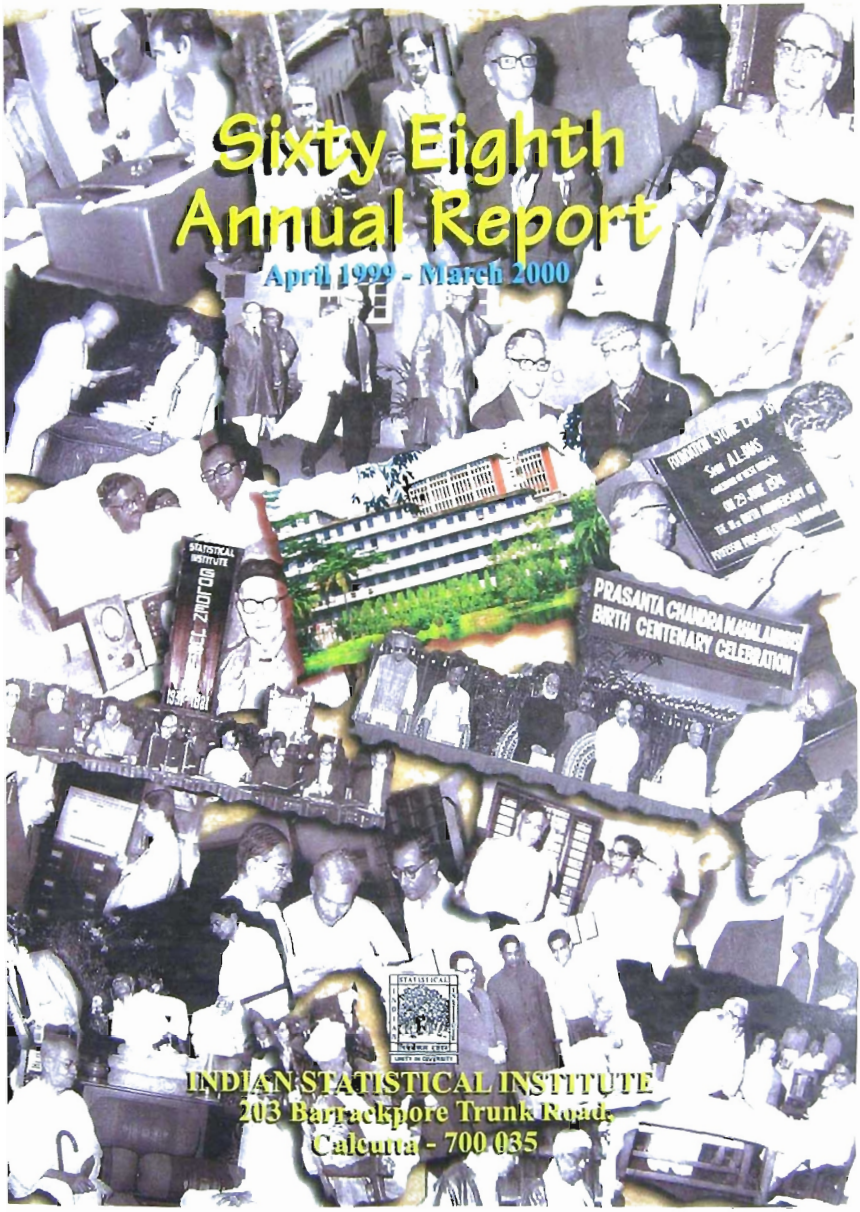
Sixty Eighth Annual Report

April 1999 - March 2000



INDIAN STATISTICAL INSTITUTE
203 Barrackpore Trunk Road,
Calcutta - 700 035

HAIRMAN AND OTHER MEMBERS OF THE COUNCIL ON MARCH 31, 2000

President Prof. M.G.K. Menon, FRS

1. Chairman : Dr. Bimal Jalan, Governor, Reserve Bank of India.
2. Director : Prof S.B. Rao.

Representatives of Government of India

3. Dr. N.S. Shastri, Director General & CEO, National Sample Survey Organisation
4. Shri T K. Das, Joint Secretary & Financial Adviser, (Statistics), Ministry of Statistics & Programme Implementation.
5. Dr R B. Burman, Officer-in-Charge, Deptt. of Statistical Analysis & Computer Services, Reserve Bank of India
6. Dr. Laxman Prasad, Adviser, Deptt. of Science & Technology, Ministry of Science & Technology

Scientists not employed in the Institute

Representative of ICSSR

7. Dr (Mrs.) R. Burman Chandra, Member Secretary (In Charge), Indian Council of Social Science Research

Representatives of INSA

8. Prof. S.K. Malik, Chairman, CAS in Mathematics, Punjab University, Chandigarh
9. Prof. R.K Varma, Emeritus Professor, Physical Research Laboratory, Ahmedabad
10. Prof N Appaji Rao, Emeritus Scientist (CSIR), Deptt. of Biochemistry, Indian Institute of Science, Bangalore
11. Prof V Kannan, Deptt. of Mathematics & Statistics, University of Hyderabad, Hyderabad

Representative of the Planning Commission

12. Dr. S P. Pal, Adviser (Evaluation), Planning Commission, New Delhi

Representative of the University Grants Commission

13. Prof G.K. Shukla, Deptt. of Mathematics, Indian Institute of Technology, Kanpur

Scientists Co-opted by the Council

14. Prof. M.G Nadkarni, Deptt. of Mathematics, University of Mumbai, Mumbai.
15. Dr. B.R. Nag, Institute of Radio Physics & Electronics, Calcutta University, Calcutta.

Elected representatives of members of the Institute not employed in the Institute

16. Prof. Deb Kumar Bose, Former Chairman, West Bengal Polution Control Board, Calcutta
17. Prof. Prabuddha Nath Roy, Former, Pro-Vice Chancellor (Academic), Calcutta University, Calcutta.
18. Shri B.K Pal, Former Head, SQC & OR Division, Indian Statistical Institute, Bangalore

Elected representatives of the employees of the Institute

19. Shri Ajoy Ghosh, Representative of the Scientific workers.
20. Shri Bhawani Sankar Chatterjee, Representative of the Non-Scientific workers.

Officers of the Institute

21. Prof. Somesh Bagchi, Professor-in-Charge, Theoretical Statistics & Mathematics Division
22. Prof K.S. Vijayan, Professor-in-Charge, Applied Statistics Division.
23. Prof. Atis Dasgupta, Professor-in-Charge, Social Sciences Division.
24. Dr. Dilip Saha, Professor-in-Charge, Physics & Earth Sciences Division
25. Prof Dipak Kr. Bagchi, Professor-in-Charge, Biological Sciences Division.
26. Prof. B P. Sinha, Professor-in-Charge, Computer & Communication Sciences Division.
27. Prof. B. Majumder, Head, Statistical Quality Control & Operations Research Division
28. Prof. Dipankar Dasgupta, Head, Delhi Centre
29. Prof. Gadadhar Misra, Head, Bangalore Centre.
30. Dr. P S.S.N.V.P. Rao, Dean of Studies.

Non-Member Secretary

Shri Anup Majumder, In-Charge (Administration & Finance) – Up to 30.11.1999 (AN)
Shri D.C. Bandyopadhyay, Chief Administrative Officer – From 01.12.1999 (FN)

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A BRIEF HISTORY OF THE INSTITUTE

Research in the theory and applications of Statistics as a new scientific discipline began in India in the early twenties through the pioneering initiative and efforts of Professor P.C. Mahalanobis. Soon after his return from England, Mahalanobis began to carry out statistical studies with the help of some part-time assistants. A chance meeting with Dr. Nelson Annandale (the then Director of the Zoological and Anthropological Survey of India) and subsequent interactions with him led to the first scientific paper by Mahalanobis on the statistical analysis of stature of Anglo-Indian males of Calcutta. This was followed by further research in anthropometry, in meteorology and in problems of flood control in North Bengal and Orissa. Gradually, a small group of young scientists were picked up by him in the Department of Physics, Presidency College, Calcutta, where he was a professor. This group formed the nucleus of a laboratory which later came to be known as the Statistical Laboratory.

In the early thirties, realising the necessity for a concerted effort for the advancement of theoretical and applied statistics in India, Professor Mahalanobis together with Professors P.N. Banerjee and N.R. Sen, both of Calcutta University, convened a meeting on 17 December, 1931, to consider various steps to be undertaken for the establishment of an association for the advancement of statistics in the country. It was unanimously resolved that the Indian Statistical Institute be established with Sir R.N. Mookerjee as President and Professor P.C. Mahalanobis as (Honorary) Secretary. The Indian Statistical Institute (ISI) was registered as a non-Government and non-profit distributing learned society on April 28, 1932, under the Societies' Registration Act No. XXI of 1860. The total expenditure in the first year was a meagre Rs. 238.00 and the number of workers was only two or three. From such a modest beginning, the Institute grew, under the remarkable leadership of Professor Mahalanobis, into an all-India organisation which now has around 1600 workers, including about 500 scientific workers. The Institute has its headquarters in Calcutta and two other Centres at Delhi and Bangalore and a branch at Giridih. In addition it has a network of service units of Statistical Quality Control and Operations Research Division at Baroda, Mumbai, Pune, Coimbatore, Chennai, Hyderabad, Calcutta, Delhi and Bangalore.

From the very beginning, Professor Mahalanobis and his associates who included Professors S.S. Bose, R.C. Bose, S.N. Roy, K.R. Nair, K. Kishen and H.C. Sinha worked with zeal and enthusiasm for the development of statistical theory and methods, and in promoting research and practical applications in different areas of natural and social sciences. *Sankhya*, the Indian Journal of Statistics, was started in 1933 with P.C. Mahalanobis as its Editor, and received instant international recognition which continues till today. Pioneering research activities were carried out in many areas of statistical theory, especially in the core areas of multivariate analysis, sample surveys and design of experiments. Such activities were strengthened and new directions were opened up by Professor C.R. Rao and many others who joined the Institute in the forties and the tradition continues. The Institute pioneered the development of statistical methods in agricultural research and in the conduct of large scale sample survey. This led to a large number of research publications and to the introduction of training activities offering short term courses in statistics for officers in government departments and scientific institutions. The scientists of ISI, led by Professor Mahalanobis, helped in introducing the first post-graduate degree course in statistics in India at the Calcutta University in 1941, and in securing a separate section for Statistics in the Indian Science Congress.

Activities of the Institute gained further momentum from 1938. Professor Mahalanobis started sample surveys to estimate the area under jute crop in Bengal in 1937 as an exploratory work, which later grew to a full-scale survey of the entire province in 1941. Gradually, sample surveys of agricultural crops and other socio-economic surveys became some of the most important activities of the Institute and earned the Institute and Professor Mahalanobis international reputation. After independence, Professor Mahalanobis was appointed Honorary Statistical Adviser to the Cabinet, Government of India, and in 1950, through his initiative, the National Sample Survey (NSS) was started for conducting socio-economic surveys of all-India coverage on a continuing basis. This was the first ever attempt in India to have a data base for various developmental programmes and the five year plans. The ISI group on sample surveys served as the Technical Wing of the NSS from 1950 till it was transferred to the Government of India in 1972.

The ISI was first again to play a pioneering role in starting the Statistical Quality Control (SQC) movement in India by organising a visit of Professor W.A. Shewhart, the father of SQC, to India in November, 1947 and later by inviting other experts like Dr. W.E. Deming, Dr. Ellis R. Ott, Dr. H. C. Tippet and Dr. Genichi Taguchi for the same purpose. SQC promotional work was gradually spread all over the industrial centres in India under a comprehensive programme covering education and training, applied research and consultancy services.

Research in economics was greatly stimulated when in 1954 Prime Minister Jawaharlal Nehru entrusted the preparation of the draft Second Five-Year Plan of the country to Professor Mahalanobis and the Institute. The "Draft" submitted by Professor Mahalanobis and the planning models formulated by him in that connection have since been regarded as major contributions to economic planning in India. Since then many economists of the Institute have worked in different centres of the Institute on various aspects of national planning and until 1970, were directly helping the Planning Commission in the preparation of the long term perspective plans for the country. Research in other disciplines of Social Sciences was also started in the Institute in the late fifties. Professor Mahalanobis' participation in 1946 in the annual scientific conferences of the Milbank Foundation led to the initiation of systematic studies in India on the growth of population. Earlier, the well known Y-sample estimates for 1941 Census population were also derived by the ISI. Theoretical and empirical research in sociology using statistical techniques was started in the Institute for the first time in south-east Asia. Similarly, the development and introduction of psychometric tests for selection processes in different organisations was first made by the ISI in India besides carrying out basic research in Psychometry. The studies of the phonetic structure of some major Indian languages have been made on a continuing basis in the Institute under the guidance and collaboration of the famous linguist Djordje Kostic.

The Institute, since its inception recognised the need for development and use of accurate and fast computing equipment for the processing and analysis of data. Professor Mahalanobis strongly believed that to be a good theoretical statistician one must also compute and must therefore have the best computing aids. The Institute has lived up to this tradition from the very beginning. In 1953, a small analog computer was designed and built in the Institute. In 1956, the Institute acquired a HEC-2M machine from the U.K, which was the first digital computer in India. In 1958, a digital computer URAL was received as a gift from U.S.S.R. Since 1956 till mid sixties, the Institute had been serving as a de facto national computer centre for the country. In early sixties, the Institute, in collaboration with the Jadavpur University, undertook the design, development and fabrication of a fully transistorised digital computer, called ISIJU-1 which was commissioned in 1966 by Shri M. C. Chagla, the then Minister of Education, Government of India.

Quantitative analysis in Physical and Earth Sciences was one of the novel ideas of Professor Mahalanobis pursued in the true spirit of the Institute. In addition to evolving some interesting techniques and obtaining some very interesting results from the analysis of directional geological data, the Institute also made a significant contribution by discovering the bones of a 16m (+) long sauropod dinosaur named, *Barapasaurus Tagoreii*, from the lower Jurassic Kota rocks near Sironcha, Gadchiroli district, Maharashtra, in the sixties. The discovery has helped in understanding the interesting problem about the origin and evolution of sauropod dinosaurs. It, in fact, represents the only intermediate form between the prosauropods and the sauropods, and is called a "missing link" in the evolution of the sauropod dinosaur.

The Institute expanded its research, teaching, training and project activities and earned national and international recognition over time. The substantial contributions of the Institute to theoretical and applied statistical work have culminated in the recognition of the Institute as an Institute of national importance by the Government of India through the Indian Statistical Institute Act, 1959. By the act the Institute was empowered to award degrees and diplomas. None other than Pandit Jawaharlal Nehru, the then Prime Minister of India, piloted the bill in the Parliament. With this recognition, the already existing teaching and training programmes were consolidated and expanded and courses for the degrees of Bachelor of Statistics [B.Stat. (Honours)] and Master of Statistics (M.Stat.) were started from June 1960. The Institute was also empowered to award Ph.D./D.Sc. degrees from the same time. Later on, courses leading to Master of Technology degrees were started in Computer Science and in Quality, Reliability and Operations Research which also received formal recognition from the All India Council for Technical Education (AICTE). Subsequently, a Master of Science programme in Quantitative Economics was also introduced. In recognition of the excellent research

work done by the scientists of the Institute in several areas related to statistics, the section 4 of the Indian Statistical Institute Act of 1959 was amended by the Parliament in September 1995 to empower the Institute to award Degrees/Diplomas not only in statistics but also in mathematics, quantitative economics, computer science and such other subjects related to statistics as may be determined by the Institute from time to time.

The role and importance of ISI in conducting and promoting teaching of statistics has been appreciated by international bodies as well. In 1950, the International Statistical Institute had initiated the International Statistical Education Centre (ISEC), Calcutta, jointly with ISI, to impart training in Theoretical and Applied Statistics to participants selected from developing countries. The centre is run by ISI jointly under the auspices of UNESCO, International Statistical Institute and the Government of India.

Recognition of the Institute by the Act of Parliament provided greater encouragement to research activities not only in statistics and mathematics but also in various branches of the natural and social sciences, without whose live contact, it was believed, the methodology of statistics could not grow to its current level. It is also due to this fact that "Unity in Diversity" is adopted as the motto of the Institute. In view of these, the Memorandum of Association of ISI was updated first in 1976 and subsequently in 1995. The objects of the Institute as laid down in the Memorandum of Association are :

i) to promote the study and dissemination of knowledge of statistics, to develop statistical theory and methods, and their use in research and practical applications generally, with special reference to problems of planning for national development and social welfare;

ii) to undertake research in various fields of natural and social sciences with a view to the mutual development of statistics and these sciences; and

iii) to provide for, and undertake, the collection of information, investigations, projects, and operational research for purposes of planning and the improvement of efficiency of management and production.

iv) to undertake any other ancillary activities in fulfilment of the objectives i), ii) and iii) above.

The units of academic, scientific, project and administrative service activities of the Institute were regrouped into eleven divisions under the new Memorandum of Association (MOA) of the Institute effective from 1996.

From the early days, the Institute has been in touch with many internationally famous scientists in different disciplines from the world over. Some of these scientists have worked in the Institute for several months or even longer. Sir Ronald A. Fisher, a pioneer of modern statistics, was a regular visitor to the Institute and lent it considerable support. Professor J.B.S. Haldane, a geneticist of international repute, was a member of the faculty for several years beginning from 1957. At the inspiration of these stalwarts and other renowned scientists, the Institute began to expand and/or undertake research activities in several areas of natural and social sciences with the hope that collaboration under the same roof would foster the mutual development of statistics and other disciplines. In fact, the Institute stood up to Sir Ronald Fisher who called Statistics a "Key Technology" of the century, in view of its intimate relevance to all scientific endeavours which involve experimentation, measurement and inference from sample to aggregate.

Coming to more recent times, the Institute has continued to pursue its goal of attainment of excellence in the various fields of science. Fundamental research in statistics with its roots in applications has been the bottom line ever since the inception of the Institute. The contributions from the Institute in multivariate analysis, design and analysis of experiments, sample surveys, statistical methods of data analysis and statistical inference have found their places in text books and monographs, and the tradition continues. In addition, probability theory and stochastic processes have also been major areas of research in the Institute. The theoretical mathematicians of the Institute, in addition to collaborating with the statisticians, are also making fundamental contributions in several fields - topology, functional analysis , harmonic analysis , algebra, combinatorics, quantum Mechanics, game Theory, to name some. The current trend of research in statistics not

only carries forward the traditions set up in the Institute, but is also setting new directions, both in theory and applications, in different disciplines.

The Institute has been maintaining its tradition of high quality research and development in the field of computer science. In 1979, a microprogrammed signal processing system using Fast Fourier Transform (FFT) was designed and developed. Keeping pace with the global advances in computer technology, the activities of the Institute in the field of computer science gathered a tremendous momentum in the late seventies, resulting in diversification of research in different areas including Algorithms and Complexity, Parallel and Distributed Processing, Fault-Tolerant Computing, VLSI, Computational Geometry, Fuzzy Sets and Systems, Cybernetics, Pattern Recognition, Neural Nets, Artificial Intelligence, Image Processing, Computer Vision, etc. In recognition of its contributions in the field of computer science, the Government of India established, in collaboration with the United Nations Development Programme (UNDP), one of the five national Nodal Centres for Knowledge Based Computing Systems (NCKBCS) at ISI in the year 1988. The Institute also has the infrastructure for providing the most modern computational environment with facilities for e-mail, internet connection, etc.

The different disciplines under the Social Sciences also continued to develop and flourish over time by carrying out basic research as well as inter and multi-disciplinary programmes. In economics, the Institute has come to be known as a specialized centre for its significant contributions in different branches of theory and also for studies on such areas as Demand Analysis, Poverty and Levels of Living, Measurement of Inequalities, Production and Prices, National Income and allied topics, Development and Planning etc. In Demography, Sociology, Psychometry and Linguistics also the Institute maintained its distinctive feature for the focus and emphasis on quantitative aspects. Mention may be made, in this context, about the pioneering theory for teaching and training for the hearing impaired children, developed by Prof. Kostic. Based on this theory the Electronics Unit of the Institute, in collaboration with the Linguistic Research Unit and the Government of Tripura, designed, developed and fabricated a set of instruments for the hard-of-hearing children of the Institute of Speech Rehabilitation, Government of Tripura, Agartala. This has come to be regarded as having a significant impact on social welfare.

Plant and human biology have been the major areas of research in biological sciences. Both basic and applied research are conducted, with emphasis on quantification, statistical design and analysis, and modelling. In the area of plant biology, research has included quantification of natural variability and modelling, animal behaviour, effect of interaction of rice varieties on yield, use of protein extracted from leaves to supplement human food, mathematical modelling of ecological and embryological phenomena, etc. In the area of human biology, researches have included anthropometric, genetic and biochemical studies on population affinities, micro-evolution, studies on utilising data on anthropometric variability in designing car seats, human adaptation to differing environments, human ecology and growth and genetic epidemiology.

With a view to developing innovative methodologies for collection and analysis of quality survey data, interacting and collaborating with organisations like NSSO, CSO, DoS, Planning Commission, RBI, etc., promoting the growth of inter-disciplinary research in statistics and data analysis in the Institute, and disseminating the methodologies (old and new) to the scientific, academic and research organisations, a Survey Research and Data Analysis Centre (SURDAC) has been established at the Institute in February 1997. Such a centre would benefit the planning processes and national development. In 1995, the Plan and Policy Research Unit (PPRU) was established under the Planning Unit at Delhi Centre which has already undertaken several projects of national and international importance.

Over the years, the SQC & OR Division has grown to the size of having ten operating units all over the country and have uniquely served for promotion, education and training and technical guidance in Total Quality Management Methodology, Quality Assurance Systems for the benefit of the manufacturing and service industry over the decades. It has thus, as was intended, played a leading role in dissemination of new concepts, methods and techniques in the areas of Quality and Productivity.

The Central Library of the Institute is located at Calcutta with a network extending to other locations of the Institute. Over the years, the library of the Institute has attained the distinction of being one of the richest libraries in the country, particularly in the fields of statistics and related disciplines. The library has developed a well-equipped Reprography and Photography Unit. The library's gift collections include the personal libraries of Professor P.C. Mahalanobis and Professor Walter A Shewhart. The library has been recognised as the Depository Library for World Bank publications. A separate collection of books and journals in Mathematics, Statistics etc., known as Eastern Regional Centre of National Board of Higher Mathematics(NBHM) has been developed out of the grants from the (NBHM) . Computerization of library facilities has been taken up which will certainly enhance the facilities for the users. Much more is on the anvil in this direction.

The Professor P. C. Mahalanobis Memorial Museum & Archives, which was inauguarated on June 29, 1993 by Shri P. V. Narasimha Rao, the then Prime Minister of India, has been established in *Amrapali* on the Institute campus in Calcutta.

The Documentation Research and Training Centre (DRTC) established at Bangalore in 1962 by the late Professor S.R. Ranganathan, a doyen in the field of library and information science, is engaged in research, teaching and training in documentation and information science. The Institute awards post-graduate diplomas in documentation sciences.

An index of the contributions of the Institute is the publication of many books and monographs, in addition to a large number of scientific papers in national and international journals, receipt of national and international recognitions of very high order by the scientists of the Institute in terms of awards, titles, and fellowships, and holding of prestigious positions in various scientific organisations of higher learning as well as in governmental organisations both in India and abroad. With a dynamic group pursuing and guiding research work in some of the most modern topics in statistics, mathematics, computer science, economics and in various fields of natural and social sciences, there exists a close interaction among the scientists from all over the world.

DIRECTOR'S REPORT

During the year under review, the scientific and technical workers kept a busy schedule with research activities, project works, case studies and professional activities both in Theoretical and Applied Statistics, Mathematics, Economics, Computer Sciences as well as in Social, Natural Sciences and in interdisciplinary research areas. The training in core areas of Statistics, Mathematics, Economics, Computer Sciences and other related areas was in full gear.

The Planning and Policy Research Unit (PPRU) at Delhi has undertaken several projects of national and international importance which include : Agricultural trade liberalization and spatial development; Exchange rate dynamics and its impact on trade balance; Incentive implications of alternative electoral rules; Commodity based targeting and PDS; Data collection for the Indian Sugar industry; Impact of agricultural innovation on household welfare in India; Welfare costs of trade protection in India; Ownership and performance in the Indian Sugar Industry; Promoting economic cooperation with ASEAN: Phase 2; Political economy of Center State resource transfers; Interregional disparities and growth; Restructuring and debt recovery procedures.

The Survey Research and Data Analysis Centre (SURDAC) has undertaken the following projects: Statistical analysis on modeling of bio-diversity using the data collection from the western ghats; Data base for the informal sector of Indian economy : an evaluation study; Statistical modeling and analysis of Psychological, Physiological and Ecological repeated measurement data; Psychological effects of PEMF therapy in diseases. In recognition of the global concern regarding the need to formulate and implement policies to protect the environment, a Workshop on "Statistical Science and Environmental Policy : Key issues and Possible Interactions" was held with the following major environmental themes :Environmental data bases, Environmental modeling, Environment and sustainability, Ecology, Society and Environment and Pollution. The stress was on Statistical models, methods and computational tools for design, collection, analysis and monitoring of environmental data. The technical talks explored economic issues, assessment of existing data bases, construction of models for further scenarios and examinations of statistical aspects of environmental monitoring. The workshop was conducted in collaboration with the Bernoulli Society for Mathematical Statistics and Probability, Ministry of Statistics and Programme Implementation; and others.

The Policy Planning and Evaluation Committee of the Institute was constituted for the first time as per the new MOA of the Institute to identify, from time to time, focal themes of research and to formulate new interdisciplinary proposals for major research projects, including project works with industrial applications pertaining to these, such as to bring out the full potential of the Institute existing in all or some of the disciplines in which the Institute is specially strong.

The use of Statistical Quality Control and Reliability techniques, in reducing loss and cost and for improving and augmenting productivity in industries, has generated great impetus to the quality movement in the country. Professor P. C. Mahalanobis was a messiah of the quality movement in India which was initiated at the Institute in 1948. The Institute with its expertise in the quality movement since the last 52 years is providing training, professional expertise and consultancy through its SQC & OR Units spread over the country in all areas of quality management and quality systems related to ISO-9001 series & QS 9000 quality management standards and ISO 14000 environmental management standards. The crash programme for 'Training of Trainers' undertaken as the Quality Mission Project during the 8th five year plan is continuing with some change in focus, on training programmes and systems implementation in industries such as Leather, Food Processing, Gems and Jewellery, Service Sector, Small Scale Industries, Environment and Quality Systems Implementation for financial services including Banks and Health Management etc. Recognizing these contributions of the Institute, the Government of India has nominated the Institute as a member of the Quality Council of India. The Institute is also represented on the National Accreditation Board for Auditing and Training (NABAT). The Institute has undertaken an important new project on developing a measure for overall performance Quality of a software industry. The SQC & OR Division extending consultancy services to some of the Industries abroad which include Mexico, Iran and Muscat. Efforts are being made by this division to export these consultancy services to Bangladesh, Srilanka and U.S.A.

The software SWORDS developed in Stat-Math. Unit at Calcutta for statistical exploration of features and patterns in DNA sequence data was used to analyze mitochondrial genomes of several vertebrates. The molecular data is available in the internet and SWORDS could expose some striking facts related to molecular evolution of vertebrates and transition of life from water to land. Estimation of incubation distribution for AIDS and estimation of AIDS related mortality in India were studied by Stat-Math. Unit and ASU. This seems to be the first attempt to estimate incubation period using data on Indian sero-converts. The findings show that by 6 years 50% of and by 17 years 99% of HIV sero-converts will develop clinical AIDS. These results are comparable with early HIV/AIDS epidemic data from the United States. Applications of Stochastic Processes and Martingale Theory to Option Pricing, Financial Mathematics and markets are being studied by Stat-Math. Unit at Delhi. Statistical methods are used to study the weakness of a commonly used cryptographic system and a more secured cryptographic system is proposed by ASU scientists.

The scientists of the ACM Unit have made several significant contributions in the areas of parallel algorithms, interconnection networks and mobile computing which have direct impact on various real life applications involving massive scientific computations, image and signal processing. An evolutionary modular Rough-fuzzy-network has been developed for rule generation with qualitative measures for cervical cancer management by MIU scientists. A new paradigm for cancer treatment has been developed by ECSU scientists. The Institute is happy to announce the pioneering development by CVPR Unit of a complete Devnagari (Hindi) Optical Character Recognition system that can now automatically read pages of Hindi books with 98% accuracy. It is the first system of its kind developed anywhere.

The Institute also undertook several externally funded projects of National and International importance from different government and non-government organisations including International organisations.

The Institute is undertaking mammoth Projects which include : Genomic Diversity in Indian Populations (DBT); Environmental management Capacity Building Technical Assistance Project : Environmental Economics Component (MOEF & IDA, World Bank); "Sustainable Development" (UNU/IAS, Tokyo); ISI-Hindusthan Lever Collaborative Project on Business Research, (funded by Hindusthan Lever Limited) and "Study on Taxable Capacity of Centre and States" (11th Finance Commission, Govt. of India) ; "Environment Conservation and Valuation of East Calcutta Wetlands", (World Bank) Health Sector Reforms : an Evaluation, Impact and Patterns of Utilisation among Valnerable Groups in the three Indian States (AP,TN,WB) (MOHFW & European Commission); New techniques of fast images compression based on Human Vision Systems and Geometric data structure (INTEL Corporation, USA); Compilation and Optimisation for Re-configurable Coprocessors, (IRISA, France); Software development for Cryptanalysis (DRDO); Regional Mathematical Olympiad(1999) and Indian National Methematical Olympiad (INMO) 2000 and Nurture Programme for INMO Students at Calcutta and Bangalore Centre (NBHM); Statistical Expert Opinion on Contractual Dispute between Gujrat Electricity Broad and South Eastern Coal Field Limited (ISEF); Eo-Semi-groups and dilation theory (INSA); Geometric Invariants of Quotients of Hilbert Modules (NBHM); Evaluation of Rainfed Frarming (HFCL,ODA,UK); Evaluation of base line study on district Primary education planning in five districts of West Bengal (Govt. of West Bengal); Guidance and Consultancy services in data-procession (ICSSR); Concurrent evaluation of TLC in the district of Uttar Dinajpur (Govt. of West Bengal); In-depth Studies on the levels development of SCs and STs (MOW, GOI); Interactions of water waves and structures (CSIR); Pattern forming Instabilities and Interface Waves (DST); Development of methodologies for self-organising fuzzy logic controllers with special emphasis on neuro-fuzzy techniques, genetics algorithms and stability analysis (DST); Development of a real time Intelligent decision making systems for range safety (DRDO); Application of fractal and multifractal technique in the processing of atmospheric data images (DST) ; Development of Image processing technique for improved wind estimations using INSAT cloud and water vapour imageries (ISRO); Bilingual (Bengal & Devnagari) OCR system development (DST); Development of a Spell Checker and morphological processor in an Indian language with speech output for the blind (DOE); Speech synthesis (Malayalam) application for the blind and speech output for the machine translation (ISDL, and DST); Cancer management in soft computing paradigm (CSIR); Khagen Babu-II (BITM); Development of software for creating Bibliographic records based on OCR technology (Nissat, DSIR); Strengthening local government ; The case of Madhya Pradesh (PWI, Govt. of MP); Risk analysis of a coal supply agreement (Coal India Ltd.); Development of Statistical tools as an aid to Geological mapping (CSIR); Estimation of Infant and Maternal Mortality Rates and Identification of their Determinants in North 24-Parganas, West Bengal

(UNICEF); Maternal (obstetric) Morbidity Study in Three Districts of West Bengal (DFID, U.K.); Glutathione-S-Transferase (GSTM1, GSTT1) "Null" Mutations and Incidence of Tobacco-Related Oral Cavity Precancer and Cancer in India (DST); Physical Stock Weight Assessment at FCI Godowns : Survey of Existing Practices (FCI); Resource Centre for Indian Language Technology Solutions (Ministry of Information Technology).

In appreciation and recognition of the high standards of research and Scientific excellence maintained by the researchers and the scientists of the Institute, several faculty and scientists of the Institute received laurels in the form of awards, prizes and fellowship from institutes and organisations of national and international importance.

Professor J. K. Ghosh, Jawaharlal Nehru Professor of the Institute has been selected for the First P.V. Sukhatme Memorial award by the Ministry of Statistics and Programme Implementation for his over all contributions to the development of theory and applications of statistics. Professor S. K. Pal, Distinguished scientist of the Institute has been elected as Fellow of the Third World Academy of Sciences and received the 1999 G. D. Birla award for Scientific research. Professor R. L. Karandikar was awarded the S. S. Bhatnagar Prize in Mathematical Sciences for 1999. Professor Arijit Chaudhuri was the Sectional President for Statistics at the Indian Science Congress 1999-2000. Professor P. P. Majumder was awarded the Millennium Science Medal of CSIR and the Indian Science Congress Association 2000. Professor S. B. Rao was Chief Guest at the Annual Convocation of the University of Calcutta 2000 and delivered the Convocation address. Several other colleagues and young faculty have received Young Scientist awards, and fellowship, membership, associateship, awards from scientific bodies such as INSA, Indian Academy of Sciences, Indian National Academy of Engineering etc.

It has been a practice of the Institute to share its expertise and its facilities with colleagues and scientists, researchers, teachers and students from other institutes, universities, colleges and research and scientific organisations. Following this tradition, various national and international conferences, summer/winter schools, workshops, symposia and seminars were held during the year to disseminate results obtained as well as to strengthen the research, project works, case studies, consultancy and professional work of the Institute and these organisations with fresh ideas and methods. Several international conferences, have been held during the year 1999-2000 particularly during the beginning of the new millennium in the current and future topics of research interests which emphasise the basic role of Statistics as a key technology.

The Stat-Math. Division organised international workshops on "Statisitics and Probability" and "Functional Analysis and Linear Algebra" at Delhi Centre to celebrate the Silver Jubilee of the formal inauguration of the New Delhi Campus of the Institute on 31 December 1974 by the then Prime Minister of India, Mrs. Indira Gandhi. The division also conducted three international conferences on "Quantum Probability and Infinite Dimensional Analysis" at Bangalore Centre, "Teaching and Research in Statistics" at Delhi Centre; and "Statistical Science and Environmental Policy : Possible Interactions" (jointly with Bernoulli Society for Probability and Mathematical Statistics, Ministry of Statistics and Programme Implementation) at Calcutta Centre. The Stat-Math division conducted Regional and National Mathematical Olympiads at Calcutta and the "Nurture" programmes of the NBHM for Indian National Mathematical Olympiad students at Calcutta and Bangalore Centres of the Institute.

The Applied Statistics Division conducted a national workshop on "Statistical exploration of patterns in spatial and other types of large data" at Calcutta. The Social Sciences Division conducted a national workshop on "Environmental Economics" at E.R.U., Calcutta, a national workshop on "Economic Theory and Policy" and a winter school in "Economics" at Planning Unit, Delhi, a symposium on "Methods in Quantitative Linguistics" at L.R.U., Calcutta and an international workshop on "Applied Bayesian Methods on Econometrics and Forecasting" at E.A.U., Bangalore.

The Computer and Communication Sciences Division organised three international conferences and one international workshop on "High Performance Computing" by A.C.M.U., "Advances in Pattern Recognition and Digital Techniques" by E.C.S.U., "VLSI design" by A.C.M.U. (organised jointly with several other organisations including the IEEE, ACM, IIT Kharagpur and Calcutta University), and "Document Analysis, Speech and Natural Language Processing" by C.V.P.R. Unit. The proceedings of these conferences have been published. The Biological Sciences Division conducted a national workshop on "Uterine Cancer Control :

Statistical Modelling : Data bases and other issues" by Bio-Chemistry Unit jointly with Stat-math Unit, A.H.G.U. and others.

The SQC & Or Division organised the "Third International Conference on Operations Research and Game Theory with Economic and Industrial Applications" at Chennai, a national workshop on "Design of Experiments" at Calcutta, and a Seminar on "Quality Management for Senior Executives" at Delhi, a one day workshop on "ISO/DIS 9001:2000 QMS" at Calcutta and several training programmes. The Physics and Earth Sciences Division organised a national workshop on "Geology of the Pranhita-Godavari Valley : Current Status and future directions" by G.S.U.

The Institute, based on the recommendations of the P.C.M. Centenary Celebrations Committee, instituted the P.C. Mahalanobis Chair/Fellowship with an endowment from the Government of India. Professor Ildar Ibragimov was the first distinguished professor to occupy this prestigious chair. Professor Ibragimov of the Mathematical Institute of the Russian Academy of Sciences visited the Institute from 24 January 2000 to 07 February 2000 and delivered special lectures/seminars at the headquarters of the Institute at Calcutta and also at Delhi and Bangalore Centres of the Institute. The topics of these special lectures included "Estimation of Analytic Functions", "On almost sure limits theorems" and "Statistical Curve Estimation". Several researchers from within and outside the Institute attended these thought-provoking lectures.

Regarding the teaching and training activities of the Institute, during the academic year 1999-2000, a total of 9952 candidates applied for admission to various courses conducted by the Institute including B. Stat.(Hons.), M.Stat. (M & S-Streams), Master of Science in Quantitative Economics (M.S.Q.E.), M. Tech. In computer Science, M. Tech. in Quality and Reliability and Operations Research, etc.. A total of 7157 candidates finally appeared at the admission tests conducted at 21 different centers all over the country. A total of 517 candidates who qualified in the written tests were called for interview for final selection. Based on the performance in the written tests and the interviews, a total of 199 candidates were offered admission to various courses leading to degrees and diplomas during the academic session 1999-2000. It may be mentioned here that encouraged by the recent amendment of the ISI Act of 1959, by the Parliament of India in 1995, which empowered the Institute to award degrees and diplomas not only in Statistics but also in Mathematics, Quantitative Economics, Computer Science and such other subjects related to Statistics, the M.S.Q.E. programme was introduced 1997 and the second batch of the students are graduating this year. The B.Math. (Hons.) programme is being introduced for the first time, in the academic year 2000-20001. This together with the M.Math. programme to be introduced soon is expected to produce excellent students, researchers and teachers in Mathematics, Statistics and Computer Sciences and to promote interactions for solving outstanding problems in these fields. The Teaching and Training Division has set up a multimedia laboratory as part of a project to develop multimedia courses of introductory nature in Statistics at Secondary/Higher Secondary levels. This laboratory also upgraded the ISI website during the year under review, by including up to date profile of ISI faculty, campus information, alumni, etc.

The International Statistical Education Centre (ISEC) is run by the Institute as an Associate Body/Institution under the Memorandum of Association of the Institute jointly with International Statistical Institute, the Netherlands, under the sponsorship of the UNESCO and the Government of India since 1950. During 1999-2000 the centre conducted its fifty third term of the General Course with 16 foreign trainees. One student from Mongolia has undergone the Special Course on Sample Surveys. The Annual Convocation of the ISEC for the 53rd term was held on 31 March 2000. Professor H. Morimoto, Emeritus Professor, Osaka City University, delivered the ISEC Convocation address. The ISEC will be completing 50 years on 13 October, 2000, and it is being planned to celebrate the Golden Jubilee of ISEC in a befitting manner by the Institute, International Statistical Institute, UNESCO and the Government of India jointly by conducting a Conference on Contemporary issues in Statistical education; Conference on Demography, Health & Education, and Economics.

Recruitment of faculty, essential scientific, technical and administrative staff based on the minimal needs of the Institute is in progress. New Academic leave rules have been formulated in the Institute. Further, the rules of the Institute as approved by the Council for Scientific works financed by bodies other than the Institute are being implemented. Several projects, works have been undertaken or being planned to be undertaken under these new rules. Certain medical benefits for retired colleagues of the Institute were introduced.

As far as the Non-plan grant for 1999-2000 is concerned, increase has been given by the Government for payment of revised salaries and arreass to the faculty workers of the Institute, subsequent upon the revision of the faculty pay scales based on the decision of the Government of India and the Council of the Institute in this regard. The plan budget for the year 1999-2000 was kept as Rs. 810 lakhs which is 10% lower than that of the year 1998-99. Due to the special efforts made by the Chairman of the Council of Institute and the Officials of the Institute, at the levels of the Ministry of Statistics and Programme Implementation & Planning Commission, the plan budget of the Institute for the year 2000-2001 is kept at Rs. 1191 lakhs (tentative) of which Rs. 810 lakhs is for the ongoing projects, Rs. 110 lakhs is for project concerning North-East region of India; and Rs. 271 lakhs is for new projects. In this connection the Director of the Institute and other senior colleagues are expediting the possibility of spending these amounts judiciously and negotiations have already been made with researchers, teachers, scientists, and academicians of the Institute, organisations in the N.E. region to do further collaborative research, training programmes, and project works, in this regard with them.

Construction of new Administrative block, a long felt need, at the Delhi Centre of the Institute has been completed in November 1999 with seminar halls and modern facilities, and several International, National conferences, Workshops were held already from November 1999 onwards at Delhi Centre using this facility extensively. A new hostel building is being constructed at Bangalore Centre of the Institute. Upgraded internet and e-mail connections for research work was installed at the Head Quarters at Calcutta and Delhi and Bangalore centres of the Institute. The Campus wide networking at Calcutta using optical fibre was completed and is in full use. The P.C.M. Museum & Archives is expected to be completed soon. Several new constructions including those of Faculty Quarters, Canteen Building, Post Office building at Calcutta have been started and substantial progress has been achieved. The Institute with its growing research and training programmes urgently needs the construction of an Academic building and Hostels within the next few years. These schemes have been approved by the ISI section 8 (1) committee and work is expected to start soon after appropriate approval by the Government for these New Constructions. Upgradations of the existing computers, purchase of new Computers for academic, scientific, technical and administrative work are urgently needed and some additional provision has been made in the plan budget of the year 2000-2001 for this purpose. Math. Sci. Net mathematical Reviews on the Web of the AMS is accessible on-line through any node connected to ISI campus networks and twenty other Institutes and organisations have been enlisted to avail this facilities with with minimal cost.

Passion for Quality should permeate all aspects of human life and organisations. In this new environment and in this new century and millennium, the Institute has a dynamic role to play for further excellence of the Institute, also in the emerging areas of research especially relating to the national development, social and human welfare. Our institute is nationally and internationally recognised as a centre of excellence both for its contributions to theoretical and applied statistics, mathematics, economics and computer sciences, and social and natural sciences and in interdisciplinary research areas as well as to their applications and several interfaces of Statistics : A key technology now known better as "Statistical Science". The statistical science has interactions and interfaces with industry, other sciences, interdisciplinary and multidisciplinary research, Planning and Governmental efforts for welfare of the Society, Computer Sciences and Information Technology, Environment and Public Health, Rural Development, Ecology & Bio-diversity, Statistical and Computational Genetics, Medical Sciences, Agricultural Sciences etc. We all pledge to uphold the standards and keep the banner of recognition of the research, training, project and professional work of the Institute high. "UNITY IN DIVERSITY" is our motto with the ideals "WORK IS WORSHIP" and "PASSION FOR QUALITY".

March 31, 2000 S. B. RAO

Part 1. Teaching and Training, Research and Publications

1.TEACHING AND TRAINING

Degrees and Other Courses

A brief account of teaching and training activities of the Teaching and Training Division during the academic session 1999- 2000 is given below:

During the academic session 1999-2000 a total of 9952 candidates applied for admission and were called for written selection tests for the various courses offered by the Institute, viz., B.Stat. (Hons.), M.Stat., (M-stream and S-stream), Master of Science (M.S.) in Quantitative Economics, M.Tech. in Computer Science, M.Tech. in Quality, Reliability and Operations Research, Two year Part-time Post-Graduate Diploma in SQC and OR (Chennai), Research fellowships in Statistics, Mathematics, Economics, Computer Science and Communication Sciences, Theoretical Computer Science, Theoretical Physics and Applied Mathematics, Anthropology, Bio-chemistry, Agricultural Science, Embryology, Psychology, Demography, Library and Information Science and One year part time course in Statistical Methods and Applications and the course on Operation and Programming of Automatic Data Processing Equipment. Admission tests were conducted at 21 different centres all over the country. A total of 7157 candidates finally appeared for admission tests and a total of 517 candidates who qualified in the written tests were called for interviews. Based on the performance in the written tests and interview, 199 candidates were offered admission to various courses during the academic session under review.

The annual/second semestral examinations for all the regular courses of 1998-99 were held in May-June, 1999. The 1999-2000 academic session commenced on 1st July 1999.

Forty one trainees in Engineering and Technology from various Universities (Indian Institute of Technology, Kharagpur, Indian Institute of Technology, Mumbai, Vallabhbhai Regional College of Engineering & Technology, Surat, Regional Engineering College, Rourkella, University College of Engineering Burla, Sambalpur, Indira Gandhi National Open University, Indian Institute of Science & Information Technology, Bhubaneswar, Assam Engineering College, Guwahati, Regional Engineering College, Sarojani Naidu College for Women, Durgapur, Jadavpur University, Utkal University, Jorhat Engineering College, Nagarjuna University, Indira Gandhi Institute of Technology, Sarong, PVR & JC College of Engineering, Guntur.) received a two weeks/six weeks/six months M.C.A./Engineering practical training in the different Computer Sciences Units of the Institute, viz., ECSU, CVPR, CSSC, MIU, ACMU and ASU.

Development of Teaching aid for Introductory Statistics in the Multimedia Laboratory

The division is undertaking a project to develop multimedia-based course material for introductory courses in Statistics at the 10 + 2 level. The Multimedia Laboratory was set up last year in room 526 of Library Building. Some new hardware and software were procured during this period. On the basis of the feedback on the pilot module produced last year, it has been planned that the presentation will consist of the following modules : Introduction, Summarization of data through tables and charts, Mean and median, Variability, and Introduction to more difficult problems. Out of these, the first module on the basis of an expanded script has been completed.

Apart from the above work, the Multimedia Lab provided training to several students from ISI and elsewhere. The Laboratory implemented the suggestions made by the Website Committee for the long overdue revision of the ISI website. The revised website contains a detailed clickable map of ISI Calcutta, an up-to-date database of ISI faculty, a database of ISI alumni, and links to the websites of ISI News, Sankhya and the various units of ISI, among others.

Indian Statistical Institute

The number of candidates admitted to the different degrees, diplomas and training courses in 1999-2000 and the number of students passed in the annual examinations in 1999 are given below :

Number of Students admitted and passed in different courses

Sl. No.	Course	Number of Students: Passed in the Annual Exam. In 1999	Number of Students: Enrolled in 1999-2000
	(1)	(2)	(3)
	Degree		
1.	Bachelor of Statistics with Hons. [(B.Stat.(Hons.)]		
	1st year	14	22
	2nd year	20	14
	3rd year	13	20
2.	Master of Statistics (M.Stat.)		
	1st year (M-Stream)	4	6
	1st year (S-Stream)	45	23
	2nd year	34	49
3.	Master of Science in Quantitative Economics (M.S.)		
	1st year	14	15
	2nd year	14	14
4.	M.Tech. in Computer Science		
	1st year	28	34
	2nd year	22	28
5.	M.Tech. in Quality, Reliability & Operations Research		
	1st year	18	17
	2nd year	7	18
	Certificate/Diploma:		
6.	Course on Operation and Programming of Automatic Data		
	1st year	9	14
	2nd year	13	9
7.	Part-time Certificate/Diploma Course in Statistical Quality and Operations Research (Chennai)		
	1st year	-	-
	2nd year	-	-
8.	Course in Documentation and Information Science (Bangalore)		
	1st year	-	6
	2nd year	6	6
9.	One year Part-time course in Statistical Methods and Applications		
	Calcutta	10	28
	Delhi	6	-
	Hyderabad	-	-

10.	Six-month part-time Course in Statistical Quality Control		
	Bangalore (July-December 1999)	9	15
	Bangalore (January-June 1998)	8	21
	Hyderabad (July-December 1997)	12	5
11.	(a) Junior Diploma in Statistics (June 1998)	1	
	(b) Junior Diploma in Statistics (November 1997)	2	40
	(c) Senior Diploma in Statistics (May 1999)		3
12.	Junior & Senior Research Fellows, and Research Associates in different disciplines	15	21*
	GRAND TOTAL :	324	428

* Number of scholars who joined in 1999.

International Statistical Education Centre (ISEC), Calcutta

The International Statistical Education Centre was established in 1950 and is operated jointly by the International Statistical Institute and the Indian Statistical Institute, under the auspices of UNESCO and the Government of India. The Centre functions under a Joint Board of Directors. Professor P.C. Mahalanobis was the Chairman of the Board since its inception until his death in 1972. Professor C.R. Rao has been serving as the Chairman since 1972.

The Centre provides training in Theoretical and Applied Statistics at various levels to selected participants from the countries in the Middle-East, South and South-East Asia., the Far East and the Commonwealth countries in Africa.

The Centre offers a ten-month (June to March) Regular Course of training every year. The Course is divided into two parts. The first eight months are devoted to training on general statistical methods including a six-week training in Official Statistical Systems conducted by the Central Statistical Organisation, Government of India, New Delhi. During the remaining two months, each trainee specializes in one selected branch of applied statistics, like Large Scale Surveys, Data Processing, Economic Planning, Statistical Quality Control and Operations Research and Vital Statistics and Demography. The course comprises lectures, practical work and assignments, field visits, and guided reading.

In addition to the Regular Course, a few persons are admitted on an individual basis, for Special Courses in various subject-fields.

The 53rd term of Regular Course has been completed on 31 March 2000. All the sixteen trainees comprising Cambodia (2), Ethiopia (1), LAO PDR (1), Maldives (4), Myanmar (1), Sri Lanka (3), Sudan (2), Uganda (1), and Zambia (1) have been awarded the "Statistical Training Diploma". A trainee from Mongolia has been awarded the certificate on successful completion of in the Special Course on 'Sample Survey'.

All the trainees actively participated in the International Students Day Celebration at Shantiniketan organized by Indian Council for Cultural Relations, on 28 November 1999. They also went on a study tour to Darjeeling during 14-20 January 2000.

The International Statistical Education Centre has completed its 50 years of inception. Preparations have begun for the celebration of the Golden Jubilee year through two conferences in Delhi and Calcutta.

Professional Examinations in Statistics

The Indian Statistical Institute holds Professional Examinations in Statistics in the theory and practice of analysis of statistical data for the external candidates on the basis of some model guidance for the award of following diplomas :

1. Junior Diploma in Statistics
2. Senior Diploma in Statistics

The examinations are separate form and independent of the examinations held for the award of degrees, diplomas and certificates on the basis of training given by the Institute.

The Government of India recognises the Junior diploma in Statistics as equivalent to Bachelor's degree in Statistics and the Senior Diploma in Statistics as equivalent to a Master's degree in Statistics.

These examinations are now held twice in a year, usually in the months of April/May and November/December at Bangalore, Calcutta, Chennai, Delhi, Hyderabad and Mumbai.

The total number of candidates and their results for May 1999 term and January 2000 term of the examinations are shown below. (The results of January 2000 term of examinations were not finalised by the end of March 2000. These are being processed.)

EXAMINATIONS	Registered		Appeared		Passed*
	May 1999	January 2000	May 1999	January 2000	May 1999
1. Junior Diploma in Statistics	80	52	40	36	10
2. Senior Diploma in Statistics	08	04	03	04	02

Preparation of the Model-answer booklets for the compulsory papers in Senior Diploma in Statistics and two papers of Junior Diploma in Statistics is also under way.

The cumulative total number of candidates who have qualified for the award of the Diploma in the Professional Examination in Statistics including the result of May 1999 term is 283.

Preparation of the Model Questions and Answers booklets for JDS and SDS examinations continued throughout the years. The booklets on JDS papers II and SDS papers I and IV are available in the final form.

2. RESEARCH AND OTHER SCIENTIFIC ACTIVITIES

The major thrust of the Institute is on research in various disciplines comprising Theoretical and Applied Statistics, Mathematics, Computer Sciences, Biological Sciences, Economics and other Social Sciences, Physical and Earth Sciences, Statistical Quality Control and Operations Research and Library, Documentation and Information Sciences. Scientists of the Institute carry out independent research in their own basic discipline and also undertake interdisciplinary research in collaboration with other units within the Institute and also with outside organisations. The Institute also takes up various internally and externally funded projects in diverse fields on challenging live problems of national and international importance. As a part of research activities, scientists of the Institute are involved in consultancy work as well. For academic and administrative convenience, a number of Divisions (each division having one or more units) have been formed which are listed below :

1) Theoretical Statistics and Mathematics

2) Applied Statistics

3) Computer and Communication Sciences

4) Physics and Earth Sciences

5) Biological Sciences

6) Social Sciences

7) Statistical Quality Control and Operations Research

8) Library, Documentation and Information Sciences

In addition, there is a well equipped Computer and Statistical Services Centre (CSSC) which manages the central computing system, e-mail and internet facilities and provides computing and statistical services to researchers.

Computer networking within the Institute at Calcutta has been completed and researchers, students, scholars and others can now access the computing facilities from any terminal. As a part of computer networking, all faculty members have been provided with individual PCs, connected to the network, in their offices. Delhi and Bangalore Centres of the Institute have also similar facilities.

A brief account of the research activities in different divisions and units during the year is given below.

Theoretical Statistics and Mathematics Division

The faculty of the Division took a major part of the teaching of Mathematics, Probability, Statistics and Theoretical Computer Sciece to the B. Stat., M. Stat. and M. Tech. students of the Institute. Apart from these, courses are run for research fellows and there are regular seminar activities all round the year. The faculty of the unit also take part in the JCCS course for Government Personnel and the UGC refresher course for college/university teachers. The unit has also taken the responsibility of the Nntional Board for Higher Mathematics Nurture - Programme for the 1998 - 2002 batch. A number of faculty members of the unit are engaged in the editorial functions of journals like Sankhya, - The Indian Journal of Statistics, Proceedings of the Indian Academy of Sciences (Mathematical Sciences) and Resonance-

Journal of Science Education and in the administration of the Mathematics Olympiad Project of the NBHM at the regional and national level.

Stat-Math Unit, Calcutta

The unit is actively engaged in research in many areas of Statistics, Probability, Mathematics and Theoretical Computer Science. A list of the active areas of research and some of the major contributions of the unit are given below.

Research Activities

Theoretical Statistics

The main areas of research included Asymptotic theory in Statistics, Sequential Analysis, Bayesian Inference, Ranking and Selection, Cramer-Rao type Integral Inequalities, Multivariate Analysis, *M*-estimation, Asymptotic Inference (specially in dependent models), Non-parametric Inference, Inference in Stochastic Processes, Directional Data Analysis, Optimal Designs and other aspects of experimental designs, Survey Sampling, Survival Analysis, Time Series Analysis, Bootstrap, Jackknife and other resampling techniques, Central Limit Theorem, Edgeworth expansions, Strong Law of Large Numbers, Sequential Estimation (especially second order properties of estimates), Parametric and Nonparametric Regression Techniques and related topics, Bayesian Nonparametric Statistics and Estimation, Bayesian Semiparametric Inference and inference with many nuisance parameters, Robust Bayesian Analysis, Reliability theory, Applications of Statistical and Graph Theoretic techniques to Social and Biological Sciences, Biostatistics and AIDS epidemiology.

Theoretical research on the rates of convergence in CLT and some quality control problems were continued.

Application of Distance Optimality criterion in the set up of one-way *ANOVA* model for optimal allocation of observations with a given total was studied. In the context of pairwise comparison of treatment effects *DS* optimal designs for small values of v (number of treatments) were obtained. The problem is under investigation for general values of v. In the context of Fractional Factorial Designs, some linear arrays for three level experiments and some series of Mixed Orthogonal Arrays were obtained. Construction of some Nearly Strong Balanced Uniform RMDs and Balanced Near Uniform Repeated Measurement Designs were also undertaken.

Work on allocation and related problems in Sample Surveys was continued. Search for optimum probabilities of selection of sampling units was made. Application of complex sampling designs to population studies in general and generational mobility in particular was made.

Research on flexible and adaptive discriminant analysis is continuing. Asymptotics of weighted likelihood equation in the regression setup was studied.

In the area of Neural Networks and Statistics, an automatic procedure was developed to find the right architecture of a multilayer perceptron for regression or classification problems and the method seems to work quite well. Some encouraging results were obtained when trying to replace the popular sigmoidal transformation functions in a multilayer perceptron by an appropriately chosen function.

Various aspects of bootstrap in linear models were studied, including the situation where the dimension of the parameter space increases to infinity with the sample size. Generalised bootstrap schemes in martingale estimating equations were introduced and their first and second order behaviour were studied. New as well as

unifying results on resampling plans in a large class of M_m estimators were obtained which include all standard resampling schemes and a huge class of common estimators used in statistics.

Statistical estimation in diffusions was studied. Asymptotic properties of U-statistics based on the Kaplan-Meier estimate in right censored data were investigated..

A detailed comparative study for various resampling techniques (the bootstrap, the jackknife and the subset sampling) applicable to phylogenetic and taxonomic trees constructed using word-frequency based cluster analysis of DNA sequences was carried out. The most striking discovery was the superior performance of the jackknife compared to the bootstrap, which implies that the more popular bootstrap approach is statistically less effective than less popular jackknife approach for analyzing molecular data. An X-WINDOWS version of the software SWORDS, which can run on UNIX platforms, was developed for such computer intensive investigations. The earlier 16-bit WINDOWS-95/98/NT version of SWORDS was also upgraded to a 32-bit version to enhance its performance.

Estimation of Incubation Distribution for AIDS in India are studied (jointly with AIDS Research and Control Centre, Mumbai).

The West Bengal Board of Primary Education (WBBPE) conducted External Evaluation, '99 of class II students covering about 52,000 schools which are directly managed by the Board. Preliminary Summary reports came in various newspapers. The purpose of this massive effort was to create an online database for Primary Education in the state. This database should enable the authorities to identify educationally weak circles and districts in the state (even information at the school level should be retrievable). The first phase of the total scheme itself was quite pioneering in the whole country. To complement this study, a small survey was conducted that should help the Board in preparing a practical workbook for the weaker sections of the students. The design of the survey was based on item response theory (identifying specific areas of weakness in the curriculum). This research has been solely conducted by the ISI. This report has been published by the WBBPE. The analysis of this survey gave rise to new statistical techniques which will be published later on as research papers. (This is a work undertaken jointly by the Stat. Math. Unit, Sociological Research Unit, and the Psychometry Research Unit.)

Probability Theory and Stochastic Processes

The main areas of research included Limit Theorems, Rates of Convergence and Expansions, Markov Processes and Dynamical Systems, Polynomial Martingales, Random Walks, Percolation Theory, Probability Inequalities, Martingale Theory and Stochastic Calculus and Markov Chain simulation.

A regular weekly seminar in probability theory was started and is expected to continue. The idea is to acquaint with areas of current research interests in probability theory and stochastic processes.

An *RSW*-theorem for the Voronoi Tessellation model was proved. Conditions for the convergence of convolution powers of probabilities on the space of $d \times d$ Stochastic matrices were obtained. Random continued fractions were studied. A boundary crossing problem of maxima of i.i.d. random variables was investigated and was applied to problems in sequential estimation.

Mathematics and Theoretical Computer Science

The main areas of research included Commutative Algebra, Geometry of Banach Spaces, General Topology, Algebraic and Differential Topology, Topology with emphasis on Function Spaces, Equivariant Plus Construction and Acyclic Maps, Gromov Theory on Partial Differential Relations, Quantum groups, Uncertainty principles on Nilpotent and Solvable Lie groups, Wiener Tauberian Theorems in Semisimple Lie groups, Equivariant Cobordism, Stochastic Differential Geometry, Descriptive Set Theory, Automata Theory,

Harmonic Analysis, Ergodic Theory, Functional Analysis, Operator Algebras, Differential Geometry, Spectra of Laplacians, Sediment Transport, Graph Theory, Combinatorics and Construction of Designs.

A result on separable A^I – forms over arbitrary commutative algebras over any field was proved. A result was obtained on the embedding of certain planes in the affine three-space over arbitrary commutative rings containing a field of characteristic zero.

The forms of diameter-preserving linear bijections in various function spaces and function algebras were investigated. A very general result was proved characterizing when a linear functional, dominated by a sublinear functional p, on a subspace of a real vector space has unique extension to the whole space in terms of nested sequences of "p-balls". This potentially useful result was then specialized to Banach Spaces to connect uniqueness of Hahn Banach extensions and the Vlasov Property and W^*-asymptotic norming properties.

It was observed that characterizations of strict convexity of the dual X^* of a Banach Space X like Vlasov's Theorem or Taylor-Foguel Theorem are local consequences of the fact that if X^* is strictly convex, then every point of $S(X^*)$ is a *rotund point* of $B(X^*)$. It was also observed that rotund points are special kinds of exposed points. Characterizations of smooth, very smooth and Frechet smooth points in terms of straight unbounded nested sequences of balls were given. The structure of the union of unbounded nested sequences of balls were studied and it was shown that the union of an unbounded nested sequence of balls whose centres lie on a straight line through the origin is always a cone. In general, such a union need not be a cone and examples can be constructed, upto renorming, in any non-reflexive Banach space.

In Topology, Function Space Topologies and related problems were studied and some problems in Set Topology were investigated.

A weekly seminar on "Toric Manifolds" is being conducted. A categorical description of equivariant cohomology with local coefficients was given. A study of residual finiteness of G-spaces was undertaken. This involves the generalisation of the notion of completion to G-spaces. Work is also being done on Equivariant Morse Theory.

Work on some problems in Descriptive Set Theory, particularly related to Polish Group Actions, counting the number of equivalence classes etc., is going on. The characterization of "good" Borel was investigated. The technique of forcing was studied and its application in results in Descriptive Set Theory is being looked into.

For specification of real-time systems, Neighbourhood Logic *(NL)* was proposed by Hansen and Zhou. An extension of *NL* to two-dimension, called NL^2 was proposed (jointly with Zhou) and its completeness was proved. Continuing the work in Cellular Automata, Kauffman's random Boolean network was studied and a formula for the evolution of overlaps between configurations was obtained.

Work on approximation algorithms and hardness of approximation is being continued. Several results about hardness of approximating some *NP*-optimization graph problems related to linear ordering problem were established.

Work on harmonic analysis centred around some questions on a topic of current interest, the so-called Uncertainty Principles in the setting of Nilpotent and Semisimple Lie groups. In particular, it was shown that the heat kernel on a Riemannian symmetric space of noncompact type can be characterized in terms of its decay and that of its Fourier transforms.

Projects Undertaken

Robust Discriminant Analysis

Discriminant analysis is a technique which is widely used by practitioners from all branches of the scientific community. In the year 1999-2000, robust discriminant analysis procedures based on the minimum disparity estimators were studied and followed up with a study of the existing robust estimators, and finally a comparison -- theoretical as well as numerical -- of the proposed estimators with the existing ones was provided. The entire exercise required a very heavy computational effort.

Uterine Cervical Cancer: Database, Statistical Modeling and Other Issues

The Stat-Math division has been involved in Multi-disciplinary research during the past several years under "SURDAC". As a result of joint collaborative research with scientists of sociology and biochemistry units significant demographical, cytological and clinical information have been collected, which can be very useful in studying epidemiology and cost-effective management of uterine cervical cancer among lower socio-economic strata of female population in India. The main source of patients has been government medical colleges, non-government organizations and independently organized camps in rural areas. The collected data have been analyzed using modern statistical techniques.

With data generated out of the current program, Stat-Math unit, jointly with the Biochemistry unit organized a two-day workshop on **Uterine Cervical Cancer: Database, Statistical Modeling and Other Issues** during March 23-24, 2000 in the Institute. The theme of the workshop has been control and prevention of uterine cervical cancer in India. Specific attention was given to understanding the database issues: both methodological and biological. Several scientists of the institute actively participated in the workshop. Invited participants included eminent gynecologists, health professionals, pathologists and other experts in the field.

Selected Papers of C.R. Rao

Volume IV of the Selected Papers was published in 1999. It is hoped that the last of the volumes planned so far, namely Volume V, will be published before the Conference planned at the Institute in celebration of the eightieth birthday of Professor C.R. Rao which will be held during 29-31 December, 2000.

Regional Math Olympiad

The Regional Mathematical Olympiad 1999 for West Bengal, sponsored by National Board for Higher Mathematics, for class 9, 10 and 11 students was organized on 5 December 1999 at various centres including Berhampore, Burdwan, Calcutta, Kalyani, Kharagpur, New Jalpaiguri, Purulia and Santiniketan. The Indian National Mathematical Olympiad 2000 for West Bengal was held at I.S.I., Calcutta on 6 February 2000. Over the years, these events have led to a great interest and enthusiasm in Mathematics in the region.

Stat-Math Unit, Delhi

Research Activities

Statistics

The main areas of research included Estimation of a common mean, Associated random vaiables, General methods of density estimation, Strong Law of Large Numbers and Central Limit Theorem for U-statistics, Wavelets : estimation of integral of a square of a density and integral of a square of a derivative a density, Distributions with periodic failure rate, Cramer-Rao inequalities in Banach spaces, Semi-matingales and statistical inference, Stochastic orders and Concomitants of order statistics.

Bayesian and nonparametric inference for parameters involved in stochastic partial differential equations were investigated. Approximation of maximum likelihood estimator and asymptotic minimax estimation in nonlinear stochastic differential equations were studied. Nonparametric estimation of partial derivaties of a multivariate probability density by the method of wavelets was obtained. Cramer-Rao type integral inequalities for general loss functions were derived. Explicit bounds on the Levy-Prohorov distance for a class of multidimensional distribution functions were obtained.

It was shown that for symmetric games, stability of the core is equivalent to largeness of the core. For nonsymmetric games, this result is valid under a slightly stronger condition when the number of players is less than six.

Work in the area of inference under order restrictions, competing risks, reliability theory and stochastic orders for order statistics, spacings and concomitants of order statistics was carried out.

A new method of construction was obtained which leads to highly efficient BTIB designs. These designs are used in control-test comparisons. The orthogonal arrays were generalized to a new class of arrays called quasi-orthogonal arrays. These arrays lead to optimal fractional factorial plans for arbitrary factorials under suitable models. A general procedure of constructing asymmetric orthogonal arrays of arbitrary strength was discovered for the situation where each column of the array has prime power number of symbols. Most of the arrays of strength three, obtained via the proposed method are tight.

Investigations were carried out to obtain A-optimal designs for parallel line and slope ratio bioassays. A large number of A-optimal designs, both for symmetric and asymmetric parallel line assays was obtained.

Probability and Mathematics

The main areas of research included Characterisation of stochastic processes, Multivariance and multicorrelation, Covariance identities, r-th order strong mixing, Uniform approximations for families of stochastic integrals, Directed spanning trees, Backbends on the 2-dimensional planar lattice, Exit times for triangular simplices, Martingale problems, Stochastic control, Filtering Theory, Fieldler's results on eigen spaces of second eigenvalue of the Laplacian matrix of graph, Matrix and Operator Theory, Noncommutative differentiation in Operator Theory and Numerical Analysis and Quantum Theory.

Filtering theory was looked into using Martingale problem techniques. It was shown that the filter is a Feller Markov process. While this result is known in the special case when the filter is the unique solution to the Zakai/FKK equations of filtering, the approach taken up shows that this result is true in a wider framework and is deduced without any reference to the equations of filtering. The Markov property enables one to take recourse to the semigroup theory and its interplay with ergodic theory. Using these techniques, it was possible to deduce that the filter as well as the observation along with the filter (with a wrong) initial condition are Ergodic Markov process. This observation is important from the point of view of robustness of the filter.

Recently, there has been a lot of interest in the field of Mathematical finance. Investigations were carried out on the relationship between absence of Arbitrage and existence of equivalent martingale measures. The equivalence of the two was shown using Orlicz space techniques.

The characterisation problem of Levy processes was also considered. Two classes of Levy processes were described - one containing homogeneous Levy processes and the other consisting of more general processes where the process can be determined by a finite family of polynomial martingale functions of the process. The exact number of polynomials required for determining a given Levy process was obtained.

The asymptotic properties of a minimal spanning tree formed by n points uniformly distributed in the unit square, where the weight function is such that the minimal spanning tree has a "direction" growth. It was shown that the number of branches from the root of this tree, the total length of these branches and the length of the longest branch each converge weakly. This model is related to the study of record values in the theory of extreme value statistics and this relation is used to obtain the results. The results also hold when the tree is formed from a Poisson point process of intensity n in the unit square.

Two dependent models of percolation, - the random stick model and the Voronoi percolation model were investigated. In the first model, the geometric structure of the finite clusters was studied, while in the latter, it was shown that if the Voronoi percolation model arises from a Poisson point process conditioned to have a point in every unit square, then in two dimensions the criticality of the model is ½.

Research was carried out in the broad area of 'Estimation of a Common Mean'. Explicit expression and properties of the unique unbiased estimator of the optimal weight for combining two normal means based on sample variances of independent samples of possibly unequal sample sizes were obtained in the more general set up of two independent observations from Gamma populations with possibly unequal scale parameters for wider applications which include extension of Olkin-Pratt results on unbiased estimation of intra-class correlation besides the common mean problem and the related problem of recovery of inter-block information. The most significant application of the results is to the normal common mean problem where it provides simultaneous improvement over both means under mildest condition on sample sizes known so far. Techniques employed involve inequalities concerning Hypergeometric function which are of independent interest.

The classical Matrix-Tree Theorem due to Kirchhoff asserts that the number of spanning trees in a graph equals any cofactor of its Laplacian matrix. This theorem has been generalized by several authors. Mixed graphs, i.e. graphs in which some of the edges may be oriented, was considered and a combinatorial description of all the minors of the Laplacian matrix was obtained. The work implies a result of Chaiken describing all minors of the Laplacian matrix of an undirected graph. Work on non-commutative stochastic process and geometry was carried out.

Stat-Math Unit, Bangalore

Research Activities

Apart from continuing research activity in various areas of Mathematics and Statistics, the unit is actively involved in the efforts to promote quality teaching at the undergraduate level Mathematics. These include involvement in the "Nurture" programme of the N.B.H.M. and the Mathematical Olympiad.

A Brief resume of Research carried out during the year is given below:

Mathematics

The main areas of research included Groups of exceptional Lie type, Coxeter groups and the Monster group, Combinatorics (Bruck-Ryser type theorems for quasi-symmetric designs and strongly regular graphs), Functional Analysis, Geometry of Banach space, Ergodic theory, Operator algebras and Operator theory, Harmonic analysis, Differential Geometry and Topology, Spectra of Laplacians (especially on Vector bundles), Spectral theory for partial differential operators, Non linear partial differential equations & Geometry, Finitely additive measures, G-inverses, Algebraic groups, Number theory and Algebraic geometry. Research in the following areas of mathematics is also being carried-out : Algebraic groups, Number theory, Algebraic geometry, Non linear partial differential equations and geometry.

It was proved that the code given by hypersurfaces of degree r in the n- dimensional projective space over a finite field is the same as the code given by the $(n\text{-}r)$ planes in the projective space; this significantly simplifies the well-known Hamada's formula for the dimension of the code given by $(n\text{-}r)$ flats. It was also shown that a projective plane of prime order is 'tame'. This result provides strong evidence towards the validity of the Hamada-Sachar Conjecture in the prime order case. Optimal bounds for the minimum weights of the codes given by a projective plane of order n were obtained using novel methods, sharply improving the earlier known results.

Certain representations of automorphism groups of free groups were studied and a generalisation of the classical Burnside problem was proved confirming a conjecture of V.Platonov. A novel and elementary way to solve a certain Diophantine equation was obtained which avoids some deep work on quadratic forms that Mahler used to prove it first.

Symmetry and uniqueness of solutions to an elliptic equation in $\mathbf{R}^2$ with singular nonlinearity was proved. Complete analysis of solutions was done and it is shown that except for the example of nonradial solutions given by Chanillo-Kiessling, all other solutions are radial. A one-dimensional symmetry result for solutions of semilinear equations in Heisenberg group was established.

It was proved that the question of points of weak-norm continuity, and hence questions about the existence of strongly extreme or denting points, can be decided based on the 'position' of an M-ideal; this result is expected to have wide implications in function theory and the theory of operators. Motivated by some recent work of Molnar and Zalar, the question of 'local surjective isometries' on function spaces is being studied. A result in this direction is that 'any local surjective isometry of the space of affine continuous functions on a metrizable compact Choquet simplex, whose adjoint preserves extreme points, is surjective'.

The Canonical model corresponding to a characteristic function of the form $\lambda\theta$, where λ is a positive scalar was obtained. New geometric invariants for quotients of Hilbert modules werefound.

Ongoing work on problems on a) integral geometry and b) Uncertainty principles, both in the context of $\mathbf{R}^n$ and symmetric spaces / Lie groups was continued.

Some questions related to the wave and heat equation associated to the sublaplacian on the Heisenberg group were investigated. L^p estimates for solutions of the wave equation and for the heat equation were proved and the impossibility of certain exponential decay of solutions was established. It was also shown that when the initial condition f is in $L^p(H^n)$, $1 \le p \le 2$ the solution of the heat equation cannot vanish on any cylinder for all time $t > 0$. This leads to the interesting fact that cylinders are sets of injectivity for the spherical mean value operator on the Heisenberg group.

The notion of "Chaotic dynamical systems" was under study. Though there are several different definitions of "Chaos", for one-dimensional systems, "sensitive dependence on initial conditions" seems to be the most appropriate one. As the available results are scattered in different books and research papers, a beginning was made to write an elementary but rigorous book on dynamical systems generated by unimodal maps on an interval of the real line.

Statistics & Probability

The main areas of research in Probability Theory included Quantum Probability, Diffusion processes and Skorohod problem, semi-stable measures and processes and Chaotic dynamics on the real line. Research in Statistics was conducted in Sample surveys, Large sample theory, Bayesian Inference, Bayesian non-parametric statistics, Bayesian non-parametric estimation, Robust Bayesian Analysis, Reliability theory and Optimality and construction of experimental designs;

Ongoing work on quantum dynamical semigroups and their dilations was continued. A proof of existence and uniqueness of such dilations in the context of general C* algebras was obtained. The approach of Hilbert C*-modules for this dilation theory is being explored. A model theory for q-commuting contractive tuples was also worked out; most of the theory developed by W. Arveson for commuting tuples generalizes to this context. Work on minimal dilations for operator cocycles of semigroups of endomorphisms of type I factors is under progress.

A general time and space dependent Skorokhod problem in an orthant was formulated in which the coefficients depend on the "pushing" variables as well; a subsidy – surplus model for a multisectoral economy was presented in terms of such a Skorokhod problem; comparison results and minimality of solutions were also studied.

Sufficient conditions to prove general optimality of an infinite class of linked block designs(LBDs) and A-optimality of an even bigger class of LBDs in the general class were derived; this solves partially a problem which has been open for a long time. The same conditions were also applied to prove new optimality properties of some classes of GD designs as well as certain other partial geometric designs in the binary class.

Viewing the Pearson correlation coefficient in a radically different light, it was presented as a binding theme to connect together various approaches to statistical inference. This was achieved using the marginal correlation between a parametric function and an estimate or more generally the marginal correlation between two functions of both the parameter and the data. Closed form expressions for these marginal correlations were used to derive various connections to other criteria of inference and decision theory such as maximum likelihood, admissibility, and unbiasedness. Following these a new method for construction of proper default priors and a method to select one Bayes estimate from a family for actual use was explored. The default prior methodology finally amounts to minimization of Fisher information. As a consequence, for any bounded location parameter problem, the Bickel prior works out as the default prior. The selected Bayes estimate, on the other hand, corresponds to "Gaussian tilting" of an initial reference prior.

Applied Statistics Division

The Applied Statistics Division came into being from September 1996 in place of Applied Statistics, Surveys and Computing Division. The Computer Science Unit was renamed as the Applied Statistics Unit and the Biometry Unit was transferred to the Biological Sciences Division. Thus at present, the Applied Statistics Division consist of only one unit viz. the Applied Statistics Unit.

The following are the research and other activities of the Applied Statistics Unit of the Applied Statistics Division during the year.

Applied Statistics Unit

Scientists of the Applied Statistics Unit (ASU) are involved in various teaching, training, research and development activities. ASU is fully responsible for conducting the short-term course "Intensive Course on Programming and application of Electronic computers". This unit also regularly conducts teaching/training programmes like winter/summer schools and workshops. The members of the faculty conduct research in various areas of statistics, mathematics and computer science, with special emphasis on applications. Some members collaborate with other units of ISI on joint projects. Currently, there are collaborative on-going projects with the Theoretical Statistics and Mathematics Division and the Social Sciences Division. The scientists of the unit are also actively involved in the activities of the Survey Research & Data Analysis Centre (SURDAC).

Research Activities

Sample Surveys

In estimating a finite population total, the two alternative versions of circular systematic sampling (CSS) with probability proportional to sizes (PPS) were compared through a simulation-based numerical exercise. Warner's (1965) randomized response technique was revisited when the samples are drawn by a complex survey design involving unequal selection probabilities with or without replacement. The efficacies of the testimators were numerically evaluated through a simulation study in the context of estimating total, multiple and partial correlation coefficients for small domains of a finite population.

A few alternative variance and mean square error estimators were derived when the condition of homogeneity or unbiasedness in the original estimator of a survey population total is relaxed and the variance of the original estimator is not expressed as a quardratic form.

General MSE estimators in multi-stage sampling were derived. For dichotomous populations RR-based estimators for complex surveys were derived.

Design of Experiments, Combinatorial Methods and Their Applications

Adaptive designs for continuous responses, which use all the information from previous responses for the next allocation, were developed and their performance studied through numerical studies. Robust estimates were proposed (and modifications suggested for delayed response). The optimal choice of design parameter for adaptive designs using the randomised play-the-winner rule was calculated (with reference to the Michigan ECMO trial and a Bayesian approach suggested for the general case).

An efficient design was obtained which selects the true model from a given family of nested linear models (with probability tending to one as the number of trials grows to infinity). A nonparametric test procedure for testing the absence of the random term in a two-way nested design with mixed effects model was proposed.

Construction methods for some classes of cross-over designs were developed (for models where second and higher order carry-over effects are assumed negligible). A class of designs were shown to be optimal for carry-overs and efficient for direct treatment effects while being much smaller in size than the available optimal designs under the same model. When carry-overs may persist for several periods, some designs were shown to be optimal under a random-subject-effect model with a non-iid error-structure.

Multivariate Analysis

Some classification rules for data with incomplete features from two normal populations were studied. Multivariate multiparameter generalizations of the P^2-test which encompass possibly non-normal populations were obtained and applied to outlier and mixture problems. Performances of some tests for the change-point problem in the multivariate case were studied. Some new multivariate circular distributions with conditional specifications were obtained and their properties are being studied.

Inference

Procedures for testing a normal mean for costly trials were proposed. Nonparametric tests were proposed for the two-sample location problem where samples are drawn sequentially by adopting an adaptive design. A test for Bernoulli success probability in inverse sampling based on an adaptive sampling scheme was proposed. Inverse sampling procedure was studied for the problem of multinomial subset selection in its most general form and was found to be often more efficient than the usual fixed sampling procedure. An optimal estimating equation approach was proposed for estimating regression parameters achieving asymptotic efficiency.

Optimal tests for isotropy against the wrapped stable mixture family in circular data were derived and their asymptotic distributions were obtained. A modification and generalization of Neyman's C_α test was enhanced to derive optimal tests for the change-point problem with circular data in the presence of multiple nuisance parameters. Optimal inference procedures for a new class of multivariate von Mises conditions distribution exploiting a recent generalization of Stein's result on computing expectations are being investigated. Various approaches for construction of asymmetric families of circular distributions were developed and some such new distributions were studied.

Reliability, Life Testing and Survival Analysis

In a first-of-its-kind analysis of fatal accidents in Indian coal mines, rates of accidents were compared with those in other countries. It was found that contrary to the worldwide pattern, Indian open cast mines are not safer than underground mines. On the theoretical front, reliability of coherent systems of dependent components was studied under various stress-strength scenarios. Availability of systems under imperfect repair was studied in three situations: (i) when a perfect repair/replacement is made after a few imperfect repairs, (ii) when there is a single spare, and (iii) when the system is periodically inspected and a replacement is made after a few imperfect repairs. The difficult problems of designing optimal examination times during the span of a study involving simple illness-death model was investigated in the light of some new criteria.

Biostatistics

A Bayesian formulation for analyzing bivariate ordinal data was made using latent variables and Markov Chain Monte Carlo techniques. The method was extended to include (i) truncated data (in the form of empty cells) and (ii) random effects. The effect of forcing imbalance in sequential allocation of treatments in clinical trial was studied. Such imbalance may be necessary to introduce in view of the prognostic factors.

Cryptology

The research in cryptology was conducted in two directions. The first direction involved construction of highly non-linear balanced Boolean functions with important cryptographic properties. A variety of new techniques were introduced which are powerful enough to solve several open problems and to improve significantly upon previous research. Also an efficient hardware implementation strategy for a class of such Boolean functions of a large number of input variables was presented. The implementations are through low cost pipelined architecture

which is programmable. The second direction was in the cryptanalysis of LFSR based cryptosystems. The attack assumes no knowledge of the combining function and is also faster than the existing ones. The attack was also generalized for the situation when the combining function is correlation immune of any particular order.

Projects Undertaken

A. Internally Funded Project

A Statistical Projection of HIV Incidence in Calcutta

A preliminary projection of HIV incidence in Calcutta was obtained on the basis of pooled information from various sources. Work on bootstrap confidence intervals as well as sensitivity analysis is also complete. Construction of the incubation distribution for the Indian scenario is ongoing.

Robust and Efficient Testing of Hypothesis

Work is going on for the construction of tests of hypothesis based on new classes of disparities, as well as the development of new classes of divergences outside the scope of "disparities" and related inference. Other work includes new weighted likelihood procedures based on minimum distance estimating equations and robust hypothesis testing based on that.

Analysis of Incomplete Life Time Data

A nonparametric estimator of cause specific hazard rates in competing risks with missing failure types had been developed. The properties of estimator were studied theoretically as well as through computer simulations. A nonparametric estimator of the number of component processes in a system of superimposed iid renewal processes had been obtained earlier. Some sensitivity analysis was carried out in this regard. As expected, this estimator was found to work better than conventional model-based estimators.

Work was also done on finding a randomized-play-the-winner-type rule for allocating entering patients in one of two treatment groups being compared in longitudinal studies with binary outcome. A draft is being written up.

Regression Models for Survival Data

The purpose of this project is to make a systematic study of the available diagnostics for some regression models for survival data. During the first year, the various residuals in Cox's Proportional Hazards (PH) model were examined. Departure from the PH model due to unequal scales of various observations was studied specifically. The possible methods of estimating the scale from the data and adopting it into the regression model are being investigated.

Telugu Language Processing

Corpus enrichment, which is a continuous and time intensive process, was continued during the year. Parallel corpus cleaning, editing, separation of work and alphabet bytes were carried on about 20,000 words. The nature of statistical relations between the combination of Vowels-Consonents, Consonents-Consonents etc. interms of frequencies are being studied on the ever increasing corpus. This study is necessary to formulate the rules of the script which help in the recognition strategy. Special programs are being developed for all these studies, which is a heavy task.

Text digitisation, threshold determination for image conversion of 2-tone image, line, word and character separation are being attempted in the OCR work. The character separation shows a success rate of 65% on an average. More trials and experiments are planned to improve the success rate. Attempts are made in the character recognition also. Here. There is need for more work. The work will continue.

Theory and Applications of Two-Dimensional Cellular Automata

This project has been undertaken in order to study the mathematical properties of nearest neighborhood 2D CA transformations. A number of interesting mathematical results were obtained. However all the results for 511 linear transformations are yet to be complete. Investigation are going on.

Winter School on Applied Statistics

The Applied Statistics Unit organizes Summer/Winter School every year. This year (1999-2000), the Unit organized a Winter School on 'Statistical exploration of Patterns in Spatial and other Types of Large Data' during 8-25 February 2000 in Calcutta. The objective of the School was to generate research/teaching interest among the faculty and scholars on Spatial Statistics and to emphasise, to the scientists and officers, the vast potential for applications in the use of Remote Sensing data with ground truth and modelling of large data sets.

The lecture topics included Spatial Process, Statistical Image Processing and Image Display, Models for large data and their applications in DNA mapping, Human Growth, Geological Mapping and Crop Forecasting, and some Research Topics aimed at applications, in addition to hands-on training on GIS.

The participating scientists and officers from NSSO, DST, ICMR and IASRI, faculty and scholars from universities were from 11 states. Other than the faculty of the Institute, resource persons were drawn from CRSE, IIT Bombay and the National Crop Forecasting Centre, Ministry of Agriculture, Govt. of India.

The Winter School was partially funded by DST, Govt. of India.

B. Externally Funded Project

Software Development for Cryptanalysis

This project, funded by the Defence Research & Development Organisation (DRDO), was taken up by ISI jointly with the Bengal Engineering College. The aim of the project is to develop, implement and evaluate cryptanalysis of LFSR-based encryption schemes. The model considered for cryptanalysis is the usual LFSR-based stream-cipher. When the feedback polynomials are known and a sufficiently long cipher is available, algorithms have been developed to estimate the initial conditions of each LFSR as well as the non-linear boolean combining function. A software based on these algorithms has been developed which may be useful for practitioners. The software seems to be working very efficiently if the length of each LFSR is less than 32 and working good with some constraints when the lengths are more than 32.

Audit Sampling Project

This project sponsored by the Govt. of W.B. was undertaken by ISI and was implemented during 1.4.99-30.4.2000 to complete its first phase covering the health sector only. The hospitals with attached medical colleges attached to them and certain health related offices in Calcutta and 5 districts outside Calcutta in W.B. were covered. The field work was done by W.B. Govt. officials, who were trained, and supervised by ISI. The sampling design was devised by ISI; the preparation of questionnaires, computer-based data processing, tabulation, graphical representation and report writing were accomplished by Project Team of ISI. Quality in the maintenance of official

health-related records in respect of both quantitative and categorical data was examined through this sample survey and estimates of various characteristics were prepared and included in a report which was submitted to the Govt. of W.B. for their evaluation.

Computer and Communication Sciences Division

The Division comprises Advanced Computing and Microelectronics Unit, Computer Vision and Pattern Recognition Unit, Electronics and Communication Sciences Unit, and Machine Intelligence Unit. Faculty members of the Division are engaged in teaching and training related to M. Stat., M. Tech. (CS), and M.Tech. (QROR) programs, in addition to their research and project works. Many undergraduate and postgraduate engineering students of Computer Science, Electronics and Telecommunication, Electrical Engineering, and students of MCA courses from several universities and institutes undergo their vocational/semestral training under supervisions of the faculty members of this division. Research works carried out in these units are summarized below.

Advanced Computing and Microelectronics Unit

During the period 1999-2000, the faculty members of the Unit were engaged in doing research in various fields of Computer Science and Engineering, including Heterogeneous Computing, Logic Synthesis and Design for Testability, Multi-Mesh Architecture, Electronic Design Automation, Applications of Computational Geometry to VLSI Layout, Mobile Computing, Microelectronic System Design using FPGA's and Discrete Event Simulation.

Research Activities

Electronic Design Automation (EDA)

During the past 10 years, the scientists of ACMU have done extensive research in the area of VLSI design including synthesis, testing, and physical design. New techniques of testable design, partitioning, floorplanning and routing in microchips have been developed. With the advent of high-performance VLSI and ULSI (Ultra Large Scale Integration) chips, FPGA (Field Programmable Gate Array), and MCM (Multi-Chip Modules), efficient EDA tools targeted to achieve high speed and low power design, are now in great demand. During the year under review, the scientists began to explore the following emerging areas of research.

A. Design for testability and built-in self-test (BIST);
B. Floorplanning, and routing in VLSI chips to enhance performance, and to reduce cost;
C. Test response compression in a system-on-a-chip (SoC).

New design-for-testability techniques for symmetric Boolean functions, non-scan sequential circuits, and BIST for CMOS circuits were developed.

Floorplan partitioning targeted to achieve better routability has been studied and algorithms based on network flow, have been developed and tested on benchmarks. Next, a novel topological router has been developed using techniques of computational geometry. The performance of this router has been found to be superior to the earlier methods.

Response compression in a system-on-a-chip has emerged out as a new problem in VLSI system design. A system consists of several intellectual property (IP) cores, the internal structure of which may not be known. Since the designer has no information about the structure of the circuit, conventional methods of compressing test response data are not applicable. To overcome this, a new technique has been developed that uses information of the test set and fault-free responses only. The response is compressed to a periodic string of 0's and 1's. Further, we have overcome an earlier lower bound on the number of outputs of the compactor for zero-aliasing, by proposing a new

generic scheme of compactor design. Algorithms for compactor synthesis for both combinational and scan-based sequential IP cores have been developed.

Parallel Architecture for Image Pattern Recognition

Identification of objects from the digitized black and white image pixels constitutes important problem in image processing. The computational time involved in the recognition algorithms, reported so far, is usually very large.

In an attempt to simulate the fast, but approximate, and adaptive pattern matching characteristics of human brain, we plan to introduce a novel parallel architecture using content-addressable memory for fast recognition of simple geometric patterns in an image. The underlying idea is based on a model for neuro-computing, which describes the human brain basically as a pattern recognizer with adaptive pattern learning feature. In this model, any computation, be it a number crunching operation, or the recognition of a geometric or complex figure, is performed by matching the given image with a given small domain of fixed patterns. Each pattern is characterized by a set of attribute values. However, the set of values may change with time depending on the maturity of the brain. Matching of patterns is performed in several steps with a hierarchical structuring of the attribute sets. For implementation, patterns can be stored conveniently in associative memories, and the matching process can be effectively simulated by threshold circuitry.

This matching process is very fast, though may be approximate. By gradual adaptive learning, the domain of the fixed patterns, as well as the set of values for an attribute can be increased, resulting in an overall increase in the accuracy of matching. Once a recognition algorithm for simple primitive patterns is developed, this algorithm will be used to develop other algorithms for more complex patterns which can be constructed from the primitive patterns. The notion of adaptability here refers to this aspect of developing complex algorithms from the simpler ones.

Given a 2D image consisting of straight-line segments, a novel parallel algorithm on 2D-mesh architecture has been proposed for identifying all straight-line segments present in the image. Unlike the Hough transform, our approach detects the broken lines, which would help in a more accurate recognition of these boundaries.

For a 2D image consisting of N straight line segments, we use a $p \times p$ *mesh* architecture with a shared RAM working under CREW model. The algorithm needs $O(N \log N + \log p)$ time to identify all straight line segments, and the computation time does not depend on the size, location and orientation of the component straight lines, nor on the total number of pixels in the image plane.

Performance Analysis of Multiprocessor Systems

An $N \times M$ shared – memory multiprocessor architecture consists of a set of N processors and a set of M memory modules, In such a system, contentions occur when more than one processor in the same memory cycle generate requestes for a common memory module. By some arbitrary policy (usually random), one of the conflicting requests is granted, while others are either rejected (non-buffered system), or queued up for future processing (buffered system). Contentions degrade the acceptance rate of memory requests and hence the overall system performance. One measures of the performance is the effective memory bandwidth (BW), i.e., the number of modules that are busy during the same cycle. Other performance measures include mean waiting time for a memory request and expected queue length.

The memory access pattern of the processors can be uniform or non-uniform. A uniform reference model is one in which all the processors have the same probability of accessing any memory module. However, many practical applications exhibit non-uniform memory accesses due to, for example, the locality or reference in the computation requirements, or the need for accessing shared variables and codes.

The non-uniform memory access patterns can be either intra-cycle or inter-cycle. There are different types of intra-cycle non-uniformity. A processor may have a favorite memory module(s) which it accesses more often than the other modules. On the other hand, all the processors may access a particular module or a class of modules more often than the others. These module (s) is (are) called hot spot (s). If we classify each memory module as one of the types – H (Hot), F (Favorite), NH (Non-hot), and NF (Non-favorite) – then a shared memory environment can have any one of the following four combinations of memory modules : {(NH, NF), (H,NF), (NH,F), (H,F)}.

The purpose of this project is to find a unified approach to deal with the problem of memory access contentions for a buffered, multiprocessor system in which all the four types of memory modules are possible. We assume that the processor-memory interconnection mechanism does not create any bottleneck, i.e., a request has successfully passed through it.

We have studied some aspects of the problem starting from a combinatoial viewpoint, and arrived at closed-form solutions for memory bandwidth for a general NxM system. For evaluating the average delay for all the memory requests made by each processor in the absence as well as in the presence of hot spots (but with no favorite memory), we use an approximate queuing model which gives another closed-form expression for bandwidth for the NxM system.

We have shown through our analysis that the presence of multiple hot spots in the system leads to an improvement in the overall system performance in the (H,NF) environment. The analytical expressions show that the bandwidth increases with the increase in the number, K, of hot spots upto a certain value, beyond which the bandwidth either drops or saturates. This behavior is in close agreement with the simulation results. The corresponding results for (NH,F) and (H,F) environments from the combinatorial view point also closely resemble the simulation values.

Efficient Utilization of Caches in Designing Algorithms

In order to speed up memory accesses, small high speed memories called caches are placed between the processor and the main memory. Accessing the cache is much faster than accessing main memory. From the time of introduction of caches, main memory has continued to grow slower relative to processor cycle time. Unfortunately, caches are much smaller than main memory. As a result, it can hold only a subset of the contents of the main memory. Memory access first consults the cache to see if it contains the desired data. If the data is found in the cache, the main memory need not be consulted. On the other hand, if the required data is not present in the cache, it is considered as miss, and the data must be loaded from the main memory. The time to service a cache miss to memory has grown from 6 cycles for the Vax 11/780 to 120 cycles for the Alpha server 8400. Cache miss penalties have also grown to the point where good overall performance cannot be achieved without good cache performance. But, in most of the cases, in the literature we observe that algorithms are designed and optimized in terms of only instruction count without any concern about cache performance. As consequence, these algorithms which have been designed to minimize instruction count, may not achieve the performance of those algorithms which take into account both instruction count and cache utilization.

The aim of this project is to investigate, both experimentally and analytically, the influence of cache management on the overall execution time of different most commonly used algorithms.

Mobile Computing

Mobile computing refers to the use of portable computers interconnected through wireless networking. It allows the mobile users to effect versatile communication with other people along with continuous access to the services and resources of the land based computer network. Designing softwares for a mobile computing system is different from that involved in case of a stationary networked system in certain aspects, as mobility induces several new problems.

A mobile computer's net-address changes dynamically. This dynamic feature in mobile wireless networks leads to a problem of keeping track of the topology connectivity. This problem, also known as the location management problem, becomes too complex when the rate of change of location is high and the network size is large. Thus an important issue in mobile computation is the design and analysis of the location management schemes.

We have proposed some new schemes of location management, with the concept of dynamic location areas, and transmission of polling messages at a higher transmission power than the normal. The simulation results show that this technique reduces the number of updation messages, and the poll messages, at the expense of increased complexity of location updation. Moreover, depending on the call-to-mobility ratio, we may select optimal size of the location area for minimizing the total cost per call.

Whatever be the location management technique, so far we can locate a mobile within a location area, or at most within a single cell, extended over an area of a few Km^2 But in some emergency needs, like fire, accident, medical help etc., the exact location of a mobile can be determined within a radius of about 10 meters only. The process is simple, and produces the result within a constant time of about a few miliseconds.

Wireless communication used for mobile computing system is characterized by low bandwidth channels with high error rates and more frequent disconnections. Adjacent cells in a mobile computing environment may interfere with each other. Assuming a k-band buffering system where the interference does not extend beyond k-cellsway from the originating cell, we have provided two different formulations of the channel assignment problem – distance-k chromatic number problem, and k-band chromatic bandwidth problem. Existing algorithms on the first problem are non-optimal, while we have developed a new algorithm for this problem that is optimal. Further, a near-optimal algorithm for channel assignment corresponding to a 2-band chromatic bandwidth problem has also been developed by us which has a performance bound of only 4/3 relative to the optimal solution. The complexity of this algorithm is only O (p), where p is the number of cells in the network. In addition, the application of genetic algorithms to the channel assignment problem is presently under study.

The design of 'Advanced Traveler Information systems' (ATIS), is becoming an important application area of mobile computing. ATIS are being developed to facilitate various kinds of travel, to assist travelers with planning, perception, analysis and decision-making to improve the convenience, safety and efficiency of travel. The travelers can use personal communication devices including pagers and laptops to avail of the ATIS services. We are developing an ATIS for traveling within Calcutta. It will include different information like shortest route, expected time of journey, bus-routes, approximate fare etc.

Interconnection Networks

Since multistage interconnection networks can have dead-lock free routing and equal communication latency between any network input and output, they receive more and more attention as interconnection for parallel computers and ATM switch architectures in broadband networks. Multicast, or one-to-many, is a fundamental communication pattern that is highly demanded in parallel computing and telecommunication applications, e.g., FFT, barrier synchronization, write update/invalidate in directory-based cache-coherence protocols, teleconferencing, video broadcasting. Thus supporting multicast in parallel computers has become an increasingly important issue. In direct networks, the routing algorithms adopted may cause deadlock due to cyclic dependency between channels. The situation becomes worse in multicast communication. On the other hand, some parallel computers with multistage networks, e.g., IBM GF11, NEC Cenju-3, support some forms of restricted multicast in hardware. Due to the complex communication patterns in multicast networks, there is still a considerably large gap in network cost between the currently best known multicast networks and permutation networks. Our objective is to propose a class of interconnection networks which can realize a substantial amount of well-defind multicaste and yet have a comparable cost to permutation networks.

So far, we have studied the permutation routing problems on shuffle-exchange networks. A necessary condition for routing a given permutation in a minimum number of hops (m) has been found out. For some special classes of permutations, namely the BPC class, LC class etc., we have found the necessary and sufficient condition, but the problem is still open in general.

Computer Vision and Pattern Recognition Unit

Research Activities

Document Analysis

The performance of the bi-lingual OCR system was improved to read real-world books, in general, printed materials, in Bangla and Devnagari scripts with 98% accuracy. It is currently able to handle style and size variations of the characters. A system was developed for automatic identification of most of the popular South Asian language scripts like Bangla, Hindi, Urdu/Arabic, Chinese, English (Roman) etc. Some techniques were developed for Information Retrieval (IR) from paper documents. These are based on automatic detection of bold, italic, and all-capital words from a document. In case of IR from paper documents, such words are treated separately as the information content of such words is generally higher than that of the words printed in normal style. A system for recognition of handwritten Bangla numerals was developed. The work on automatic processing of Mathematical Expressions (ME) in printed documents produced interesting outputs. For an input document automatic detection of MEs was achieved. The work on recognition and interpretation of MEs also progressed satisfactorily. Work on recognition of such degraded documents progressed. Work is going on for developing document data compression techniques for Indian language documents.

Biomedical Image Analysis

Algorithms are being developed and improved for segmentation of various histo-pathological images, detection of cyto- and histological features of cells, and automatic cancer grading. methods for quantitative evaluation of filamentous bacteria in industrial sludge, using 3-D images are also being investigated.

Neural Networks

In pattern recognition problems, the convergence of back-propagation training algorithm of a multilayer perceptron is slow if the concerned classes have complex decision boundary. To improve the convergence performance of back-propagation algorithm, a technique was proposed. This technique at first cleverly picks up samples near the decision boundary without actually knowing the position of decision boundary. To choose the training samples, a larger set of data with known class label is considered. For each datum, its k-neighbors are found. If the datum is near the decision boundary, then all of these k-neighbors would not come from the same class. A training set, generated using this idea, results in quick and better convergence of the training algorithm. To get more symmetric neighbors, the nearest centroid neighborhood is used. The performance of the technique was tested on synthetic data as well as speech vowel data in two Indian languages.

The study of the filamentous objects in waste water has recently gained momentum due to its significant effect in environmental pollution. A neural network based skeleton extraction technique for volumetric images of these bio-film objects was studied. These objects require huge computer storage space. One way to economize the storage space is to represent such images in the form of a vector skeleton (a piecewise linear approximation). Such a skeleton preserves the essential structure of the object. The proposed neural network does not start with a predefined net topology. The topology evolves during the learning process on the basis of the input. The present

technique has certain advantages over the conventional 3-D thinning techniques. It achieves data reduction at a higher rate. Also, the proposed technique is highly robust to noise and arbitrary rotations of an image.

Natural Language Processing

A corpus of 30,00,000 printed wordforms is ready for analysis. Different types of statistics are taken from this corpus which are used for Spell Checker design and OCR development. An electronic dictionary of 60,000 wordforms is ready for various kinds of CL and NLP research. A tagged sentence corpus of about 20,000 sentence is almost ready. Additionally, a tagged corpus with all grammatical information for 20,000 most frequent wordforms is near completion. An exhaustive list of multiple spellings of the wordforms is studied and types of spelling changes are defined which can be used for a robust Spell Checker design as well as for a spelling dictionary development. The total set of Bangla grapheme clusters were analyzed to define their articulator peculiarities which can be used for synthetic speech development as well as for preparing primers for language learners. A comprehensive verb parser with all grammatical information is complete. Linguistic analysis for a comprehensive pronoun word forms parser is also complete and ready for computer implementation. Spelling error statistics was taken from a 10 million word corpus which is collected manually from answer scripts of different school and college examinations. A Bangla word processor with spelling check/correction is ready. A set of rules covering almost the entire gamut of Bangla text to speech rules was proposed and is being tested. A sample software for Machine Translation from Hindi to Bangla in a highly specific domain (broadcasting weather reports) was developed and thoroughly tested. An exhaustive linguistic study on Bangla onomatopoeic word forms and negative particles is now ready for computer implementation for morphological, semantic and syntactic processing. Work has started on computational stylistics.

Speech and Signal Processing

A comprehensive set of grapheme-to-phoneme rules for Bangla was developed. These rules are being incorporated in the prototype speech synthesis system. A voice and pitch detection program is also being implemented. Study on intonation, amplitude, and prosodic patterns in Bangla speech is going on.

Methodology Development

Some studies in fuzzy set geometry were made. New definitions of fuzzy geometric were provided. A fuzzy correlation measure was been proposed. A split and merge approach was proposed for finding a polygonal border on a shape of dot patterns. A new cascaded genetic algorithm was proposed for accurate and fast convergence.

Information Retrieval

The Smart search engine was installed and tested. Some preliminary modifications to the system were made in order to use it to search Indian language (specifically Bangla) document collections. A small test collection consisting of about 2000 Bangla documents and 50 queries (along with relevance judgments) was set up. A simple Webcrawler was written and used to collect about 5000 Web documents. This document set is being used to investigate automatic hypertext markup methods. Large-scale experiments will be possible only after the TREC collections have been acquired. These collections are expected to be available during 2000-2001.

Research Activities

The major research in the year 1999-2000 includes the following areas: Theoretical and Experimental Investigations in Computer Vision, Biomedical Imaging and Image Analysis, Artificial Intelligence, Approximate Reasoning and Neuro-Fuzzy Computing; Remote Sensing and Data Analysis in Atmospheric Science and Wave Propagation; Acoustic Phonetic Studies on Indian Speech and Musical Sounds Leading to Automated Speech Recognition.

The highlights of the major research works are as follows.

Computer vision/Biomedical Imaging/Image analysis/artificial intelligence/neuro-fuzzy computing

Document Image Analysis

A fast algorithm for correcting skew in document page image was developed. The method was found to be more efficient than existing skew detection techniques. Document image segmentation algorithm developed earlier was refined using this skew correction method. Performance evaluation technique was also modified accordingly. Image data corresponding to different image region are being treated differently to suit the purpose like L_AT_EX format for math equations, CAD format for line drawing, GIS format to convert maps and others.

Mathematical Morphology

Algorithm for local contrast enhancement was developed using multiscale morphological techniques. Result of proposed method was compared with that of conventional methods, and the former was found superior. This concept was used to develop an algorithm for noise cleaning in gray-level images and is being applied to satellite images too. The shape-size distribution of objects can be represented by pattern spectrum also known as size distribution. A fast algorithm for computing size distribution using city-block distance is developed.

Multisource Data Integration

Work on integration of multisource data continued. A new concept called morphological tower had been employed for integrating MRI and CT images (i.e., to bring together information collected through different modalities). A method of unbiased symmetric image registration technique was developed for the purpose of image fusion.

Pattern Recognition

A new scheme was developed for generation of decision trees for pattern classification. The decision tree was then used to generate fuzzy rules for classification. A fuzzy rule generation scheme was also developed with the help of Kohonen's self-organizing maps and successfully applied to various problems including analysis of satellite images.

Fuzzy Control

A self-organized fuzzy rule generation scheme was developed for control application. The system uses an evolutionary algorithm and does not require any expert's knowledge to start with. It is a multi-stage algorithm with different stages using different genetic operators consistent with the goal of respective stages.

Neural/Neuro-Fuzzy Computation

A novel fuzzy-neural system was developed which can simultaneously do feature selection and fuzzy rule extraction. The initial system had been for function approximation which was then modified to deal with classification problem. A neural scheme was developed for detection of targets of defence interest from LADAR images. Earlier a Neural-fuzzy system had been developed to realize the compositional rule of inference with better properties. The system was extended to deal with antecedents having multiple clauses-it is a multi-layered network.

Soft computing tools have been successfully used to characterize the hydrogenation and de-hydrogenation characteristics of hydrogen storage composite materials. This can result in a drastic reduction in time, cost and research effort to characterize new composite materials without doing the actual experiment.

Qualitative Physics

The aim of this work is to extend the existing method of Qualitative Simulation (QSIM) with qualitative curvature. A new definition of the reasonable function was considered, by introducing the concept of the point of inflection. The new tables for P-transitions and I-transitions were generated and the need of the new definition of the reasonable function was ultimately justified. It was demonstrated that the new definition of the reasonable function produces qualitatively accurate curvature profile of the response which is absent in the existing QSIM.

Remote Sensing and Data Analysis in Atmospheric Science and Wave Propagation

Analysis of Satellite Image

An area morphology based image segmentation algorithm was developed to segment cloud images of geostationary satellites. The segmented cloud region was tracked in a sequence of satellite images to estimate the direction of cloud motion and its shape deformation. A hybrid technique was developed for estimating Cloud Motion Vector (CMV). From a satellite image sequence consisting of two images (source image and target image) taken at half hourly interval, first, a tracer cloud (a cloud patch having considerable shape stability) was chosen on the source image. Next, an active contour, commonly known as snake, was initialized around the tracer cloud patch. The active contour was allowed to evolve on the basis of Gradient Vector Flow (GVF) method. After the evolution, the snake took the outer shape of tracer cloud patch. There were two distinct regions on the source image -- one region was inside the snake i.e., the inside of tracer cloud patch, and the other region was the immediate outer zone of the active contour i.e., neighborhood of tracer cloud. In the next step based on information or features computed from the previously mentioned two regions on the source image, the target image was classified into two classes. This is done by multi layer perceptron technique that leads to a binary image showing two classes, one was the tracer like region and the other was outside tracer zone. The contour of the tracer like region was found on this binary image and was initialized on the target image as the initial contour for snake. This snake was allowed to evolve on target image. The tracer, which had possibly been shifted, was captured by the active contour on the target image. Finally the two contours (one on source and the other on target) were matched by Hopfield network model, after finding out significant curvature points on the two contours. This optimal matching technique gave the CMV subject to expert validation. This work was conducted jointly with Oklahoma Imaging Lab at Oklahoma State University, USA.

Analysis of SODAR Images

Elementary sodar patterns were identified using neural networks (perceptrons) and rules were developed for identification for basic sodar patterns which were successfully tested on number of sodar images.

Modelling of Transport Phenomena in ABL

A model for scalar transport in turbulent flows was developed. It was found that this model may satisfactorily explain vertical transport of concentration in a turbulent flow.

Fractal algorithm for study of ABL dynamics

Fractal and multifractal dimensions had been used to characterize turbulent convection in the surface layer. One multifractal dimension i.e. correlation dimension had been calculated and it was observed that where intermittency is visually located deviation of correlation dimension from fractal dimension is large. In addition to the study of a sodogram with the help of fractal dimension, multifractal dimension may render some more information. Side by side with the study of convection through fractal dimension, inhomogenous turbulent convection was also studied by other methods. A satisfactory model has been developed.

Multifractal dimensions may have their own interpretation and is expected to obtain interesting results of far reaching consequences. A detailed study had been taken up for implementing the findings of fractal and multifractal dimension of wind directions so as to understand different microclimate. The concept of fractal and chemical dimension may be utilized in characterizing cloud from IR images. An attempt was made to apply technique of physical erosion process on cloud IR image to identify clusters formed by pixels with gray values above a certain levels. A Critical point was conjectured from the development of clusters.

Acoustic Phonetic Studies on Indian Speech for Automated Speech Recognition

Acoustic Phonetic Study

Acoustic phonetic studies of Assamese fricative consonants had been reported. The study revealed the existence of four groups of fricative consonants. In general, four spectral bands were noted for these fricative consonants. The spectral bands were found to be influenced by the category of following vowels. In another work the investigation on Bengali glides were conducted on 25 of possible vowel-vowel (V-V) combination. Bengali common words were selected for most of the cases.

For other combination word junctures were used. All such utterances can be grouped under four categories according to their spectral structure. Among 25 combinations, 7 were not perceived as glides or diphthongs, 18 combinations were perceived as glides. In the next phase the effect of transitional duration as well as duration of steady states on perception of glides will be studied.

Stress and intonation pattern in Bengali text reading

In spoken language processing (SLP), stress and intonation patterns play a very important role. For automatic computer processing of speech it is necessary to have comprehensive knowledge about acoustic correlates of stress and intonation and their perceptual significance. With this objective stress and intonation patterns in Bengali were examined for 10 minutes long news broadcast from All India Radio, Calcutta by a female newsreader. The analysis data indicate that Bengali is a language with bound stress, the stress being at first syllable. In a recent investigation intonation patterns of sentences in Bengali text reading was investigated. Intonation pattern was determined from observing movement of pitch contour in sentences. The result of investigation showed that in Bengali text reading characteristic phenomena is rising intonation at the beginning of a word. The intonation patterns were also found to indicate word boundaries to a certain extent. Directly 72% correct word boundary segmentation rates seemed available. In the next phase, the work will be carried out to frame rules for intonation and stress in standard colloquial Bengali (SCB).

The objective of the Machine Intelligence Unit (MIU) is to carry out basic research concerning certain aspects of machine intelligence. Machine intelligence signifies the work associated with attempting to make a machine behave like a human being. In other words, it conveys the core concept of pattern recognition and machine learning with the advanced technologies like fuzzy logic, artificial neural networks, genetic algorithms, fractals, wavelets and rough sets.

The investigation that is currently being done in MIU comprises both the development of these technologies individually and in an integrated (hybridization) manner, and demonstrating their effectiveness in solving various problems of pattern recognition, machine learning, image processing, brain modeling, expert systems, vision, data mining, etc. related to the design of intelligent systems. Hybridization such as neuro-fuzzy, neuro-rough, neuro-fuzzy-genetic helps in making such systems artificially more intelligent.

These tools collectively constitute what is known as soft computing paradigm. They provide the theory of flexible information processing, which can deal with real life ambiguous situations in an efficient manner like human beings, and therefore form the basis of future generation computing systems.

Research work carried out in the aforesaid line is categorized and described as follows.

Research Activities

Pattern Recognition

A clustering technique that utilizes the searching capability of genetic algorithms for determining the appropriate cluster centers has been developed, and its superiority to the k-means algorithm demonstrated for several artificial and real-life data sets.

The concepts of variable string lengths in genetic algorithms (VGA) and chromosome differentiation (GACD) were integrated for the development of an improved *VGACD-classifier*. Its significant superiority over the asexual version was demonstrated for several artificial and real life data sets.

Use of a quantitative measure called ``kappa'', instead of the number of misclassified points, as the optimizing criterion in the non-parametric genetic classifier is being studied. Floating point representation is being used for this purpose. Results of preliminary investigation are encouraging.

Use of a hyperplane-based method for automatically clustering a data set is currently being studied. Hyperplanes were used to partition the data set, and a fuzzy measure based on entropy and π-ness was optimized for evolving the appropriate clustering. The developed system was proposed to be used for object-background classification.

A method has been developed for fitting straight lines to data sets using GA's. Its superiority over the spline-based methods was established. The problem of outliers was tackled effectively.

Analysis of large data sets for data representation and condensation is being attempted here. A nearest neighbour based method for multi scale representation of data was proposed. Its theoretical properties from the point of view of density estimation and its utility on large data sets like KDD archive data, census data and image data was established. This method was found to perform better than other technique s such as LVQ, clustering, CNN, LASM, etc.

Image Analysis/Processing and Computer Vision

Standard wavelets are not suitable for high frequency analysis. To overcome this problem M-band wavelets were used to develop an algorithm for two class texture segmentation. A modification of the algorithm for multitexture segmentation is in progress. A scheme for image denoising using spatial adaptive wavelet thresholding is currently under investigation.

An adaptive and unsupervised technique for rotation and translation invariant two class textured image segmentation was developed using wavelet coefficients. Noise immunities of these techniques were also shown. This approach was applied to real life data like document images. An effective representation of the document is to separate out the text from the graphics part and store the text as ASCII (character) set and the graphics part as bit-maps. An unsupervised approach to segment out the text part from the non-text part in document images was developed. The approach assumes no *a priori* information regarding the font size, scanning resolution, type layout, orientation and even skewness.

Contour images and their coding techniques play an important and significant role in segmentation based gray level image data compression algorithm. One of our recently developed methods decomposes a contour image into line and arc segments through an extraction of dominant pixels. Each arc is then approximated by suitably stretching a locally defined discrete circular arc. The stretching is based on affine transformation(s) and the approximation is an iterative process. The coding method provides good compression ratio.

A new methodology for segmentation of gray-level images into homogeneous sub-images was also developed. The method uses the Bezier-Bernstein polynomial for its number of advantages in image data compression. The method was also found superior to many other existing methods.

Digital watermarking is another research problem of MIU. Attempt is made to hide useful information in other information. Methods are being developed for hiding the binary images of "logos" in given gray-level/colored images. A new method of digital watermarking technique based on minimum variance of block was developed. This technique is robust and is able to withstand the deliberate outside attack like multiple mean and median filtering. The investigation is going on to make this technique tolerant against lossy compression like JPEG.

Data Mining and Knowledge Discovery

Data mining is the nontrivial process of identifying valid, novel, potentially useful and ultimately understandable patterns within huge data from heterogeneous data sets. There are two aspects which make this endeavor challenging - the problem of scaling up learning and pattern recognition algorithms to huge data sets, and the problem of knowledge representation, interpretation and evaluation.

For the purpose of developing scalable algorithms - the following two approaches were studied: (i) Multiscale condensation of data sets and their underlying distributions, and (ii) sequential and active learning to reduce computational complexity. Also learning algorithms having low sample complexity like the Support Vector Machine were used.

In the knowledge discovery aspect, algorithms were developed for constrained training of a Modular Rough Fuzzy MLP using GA, which obtains a network suitable for extracting logical rules in human interpretable form. Rule extraction algorithms were developed. Quantitative indices for evaluating the extracted rule (knowledge) were proposed and compared.

Artificial Neural Networks

Image features (e.g., corners) were detected in a neural network framework from binary and gray images. Investigations are being made to suitably represent and learn visual information in neural network, fuzzy set theoretic and neuro-fuzzy frameworks.

Genetic Algorithms (GAs)

GAs were made efficient by introducing better individuals in terms of fitness function from outside the population or preserving and reintroducing individuals which were dropped out at earlier generations. This promises to increase the general degree of exploration of the search space, thereby improving the performance.

Multi-parent recombination, instead of two-parent recombination, is becoming popular in genetic algorithms due to some of its advantages. One such technique is *gene pool recombination*. In this technique, allele-wise genes of all selected parents are used to create an offspring. A simplified version of it is called *univariate marginal distribution algorithm* (UMDA) where allele-wise probability distribution of genes is used to generate a new offspring. Studies are going on to apply this technique for non-stationary environments where the optimizing function is changed with time.

Fractals and Wavelets

Fractals are successfully used for solve image analysis problems. A genetic algorithm based method for image compression is developed using partitioned iterative function systems. For the purpose of medical diagnosis EEG signal compression using fractals was successfully developed. Another technique for edge extraction for compressed domain processing of images was also developed. It uses the fractal code of the given image as input and generates the edge map doing the reconstruction process.

An online image compression technique using probabilistic iterative function system, was developed. This technique uses the principles of probability for obtaining the code of an image. A patent application has been filed in the US patent office in this regard.

Due to the separable nature of implementation of the two dimensional discrete wavelet transform, it is strongly oriented in the horizontal and vertical directions. Such a decomposition cannot efficiently characterize directions other than 0^0 and 90^0. Another important drawback of the DWT is that, a simple integer shift of the input signal will yield a completely different wavelet transform. A redundant discrete wavelet frames (DWF) representation was developed as a possible solution to this problem.

Yet another drawback of standard wavelets is that they are not suitable for the analysis of high frequency signals with relatively narrow bandwidth. The use of M-band wavelets for segmentation was proposed as an alternative. Unlike the standard wavelet decomposition which give a logarithmic frequency resolution, the M-band decomposition gives a mixture of a logarithmic and linear frequency resolution. Additionally, M-band wavelet decompositions yield a larger number of subbands which is required for good quality segmentation. M-band wavelets were used for the purpose of two class as well as multiclass texture image segmentation. These wavelets were found to give much improved results

The capability of wavelet analysis, from perfect reconstruction to imperfect reconstruction of different degrees, is currently under investigation. Use of orthogonal as well as non-orthogonal wavelets in image compression was studied. Frequency decomposition using such wavelets is also under examination.

Neuro-Fuzzy Computing

Concept of fuzzy sets was incorporated at various stages (e.g., input, output, learning and neuronal level) of Kohonen's network and multi-layered perceptron to handle imprecise, incomplete or linguistic input data and intractable pattern classes for recognition. Its extension to expert system for rule generation and inference was made along with applications to real life data. This shows how pattern description in terms of linguistic properties and membership values can be processed by a neural net for fuzzy and crisp classification. A generalized framework for integration of multilayer perceptron and fuzziness measures had been developed earlier to design an unsupervised system for object extraction. Implementation of fuzzy set theoretic operators using neural networks and the utility of these networks in pattern classification and rule generation had also been demonstrated. During the year under review, various ways of integrating fuzzy set theory and connectionist systems for feature evaluation under both supervised and unsupervised modes were formulated together with the theoretical analysis.

Case-based Reasoning

Case-based reasoning may be defined as a model of reasoning that incorporates problem solving, understanding, and learning, and integrates all of them with memory processes. These tasks are performed using some typical situations, called *cases*, already experienced by the system. Systems based on this concept are finding widespread applications in various decision making processes e.g., medical diagnosis, law interpretation where the knowledge available is incomplete and/or evidence is sparse. A method of selecting cases in neuro-fuzzy framework was developed. Incorporation of fuzzy set theory helps in selecting the *cases* from ambiguous/overlapping regions. Cases are represented as hidden nodes of a network, the architecture of which is determined adaptively through growing and pruning of hidden nodes under supervised mode of training.

Fuzzy Sets, Rough Sets and Applications

A modular rough-fuzzy-neuro-genetic system was developed for classification and rule generation. The novelty of the method lies in applying rough set theory for extracting dependency rules directly from real-valued attribute table consisting of fuzzy membership values. This helps in preserving all the class representative points in the dependency rules by adaptively applying a threshold that automatically takes care of the shape of membership functions. The GA tunes the fuzzification parameters, and network weight and structure simultaneously by optimizing a single fitness function. This methodology helps in imposing a structure on the weights, which results in a network more suitable for rule generation. This sort of divide-and-conquer strategy was found to improve speed of convergence. The extracted rules were quantitatively evaluated by developing new performance indices.

Projects Undertaken

The Institute has an international collaborative project with the College of Engineering, Osaka Prefecture University, Osaka, Japan which was initiated and is being coordinated by MIU. Members of MIU are also involved as co-investigators in the Indo-Polish collaborative project titled "Reasoning under uncertainty about complex objects/rough set theory and fuzzy set theory". This is coordinated by the Dept. of Science & Technology (DST), India and the Polish State Committee for Scientific Research (KBN), Poland. Recently, some members have started collaborative project with Hongkong Poly University, Hong Kong, on Soft Computing in Case-based Reasoning.

Physics and Earth Sciences Division

The division comprises Geological Studies Unit and Physics and Applied Mathematics Unit. Faculty members of the division are engaged in teaching and training in B. Stat., M.Tech. (CS) and M. Tech. (QROR), besides their research and project work. Research carried out in these units are described below.

Geological Studies Unit

The Geological Studies Unit has been conducting a number of thematically integrated research programmes centered around the Proterozoic geology and Gondwana geology of several basins in peninsular India. Empirical statistical analysis of naturally arising field and laboratory data has been an important aspect of research of the Unit. The Unit has also been supporting research programmes on Colloid, Surface and Environmental Science.

Research Activity / Projects Undertaken

Proterozoic Geology

Chattisgarh Basin

Detailed facies analysis of the siliciclastic sequence in the eastern Chattisgarh basin revealed the existence of a storm and tide dominated wide shelf comparable to the modern day continental shelves. Two prograding shelf sequences were identified. The lower sequence is storm dominated, whereas the upper one bears the signature of deposition in macrotidal regimes. The evidence of macrotidal fluctuations and storms of hurricane proportion also speak for the presence of a major marine basin which was situated to the north-northwest of the study area around Sarangarh in Chattisgrah Dt.

Petrographic analysis of the felsic pyroclastics intercalated with the Chattisgarh sedimentaries was carried out, and the garnets in the pyroclastics were analyzed by electron microprobe. The composition as well as textural character of garnets indicate their possible derivation as primary magmatic mineral. The estimated pressure of crystalization of garnet indicates that the parent magma was generated at a depth of about 40 km., through extensive partial melting at the lower crust. The partial melting induced crustal stretching, consequent rifting and basin opening.

Eastern Ghats

An important finding relates to the synkinematic intrusion of the Rairakhol alkaline rocks, which display an array of deformation structures developed by progressive deformation during intrusion. Petrological investigations on Paderu Sector, A.P., revealed a retrograde P-T-t path starting with a high temperature decompression followed by isobaric cooling; the prograde reaction history can be assigned to dehydration melting in different pelitic precursors, generating different granitic plutons and migmatites. Detail field-studies, complemented by structural analysis and microscopic fabric analysis led to an important inference relating to Granulite-Greenstone relations around Paikmal, Orissa: oblique collision of the Granulite belt on the irregular continental margin (comprising Singhbhum and Bastar cratons). New geochronological findings relate to (a) 3.0 Ga Granulite facies metamorphism in the northeastern sector of EG and (b) Mid-Proterozoic secretion of the Chilka Lake Granulite terrain.

Cuddapah Basin

Pre-Grenvillian deformation in the Nallamalai: Multiple episodes of deformation were recorded from the Nallamalai fold belt along the eastern half of the Cuddapah basin in south India. The early deformation is restricted to the Cumbum Formation and older horizons of the Nallamalai Group and does not affect the Neoproterozoic Kurnool Group. This episode of deformation is pre-Grenvillian as indicated by the occurrence of 1.6 Ga old late-tectonic granites intrusive into the Nallamalai Group. The later phase of deformation affecting the Kurnool Group is probably linked with the main deformation (Grenvillian) in the Eastern Ghats.

Nallamalai sedimentation: The Bairenkonda (Nagari) Formation outcropped around Guvvalcheruvu, Cuddapah district is represented mainly by shelfal sandstone showing storm influence. The Nagari quartzites non-conformably overlie the granite gneisses at Sanipai; further north at Guvvalcheruvu, stratigraphically equivalent Bairenkonda rocks unconformably overlie near-shore, mixed siliciclast-carbonate facies of the Vempalle Formation, or the Gulcheru Quartzite dominated by fluvial sandstones. Apparently the Bairenkonda/Nagari quartzites represent a major transgressive event over a tilted and partly exhumed basement. The tilting is accompanied by major steep E-W faults with northerly down throw. Northeasterly paleocurrent prevail in the Guvvalcheruvu section and is comparable to those in the Sanipai section.

Vindhyan Basin

A brief field work in parts of the Vindhyan basin led to discovery of a coastal aeolian sandsheet deposit and revealed the dynamics of sand sheet formation during Proterozoic. The effort was a follow up of the work in the Pranhita-Godavari Valley, for understanding the roles of fluvial and aeolian processes in spreading out large sand sheets in the unvegetated Proterozoic landscape. It was inferred that periodic wetting due to aqueous flooding inhibited the formation of large bedforms and favoured development of the sandsheet.

Gondwana Geology

Satpura Basin

Geological mapping in the central area of Satpura basin mainly around Jhirpa and Paraspani covering Pachmarhi, Denwa and part of Bagra Formations were completed. A complete skull with lower jaw of a brachyopid was collected from the Denwa Formation. An exceptionally rich graveyard of capitosaurid amphibians from the Triassic Denwa Formation was uncovered. The capitosaurid skulls are stacked within a small area (about 2m x 6m) indicating an interesting taphonomic history of these fossils. Some archosaurian remains were also collected from the Bagra Formation.

On-going work in the Satpura basin reveals that contrary to the existing notion of fluvial origin, the Bijori Formation probably indicates existence of a large siliciclastic lake. It was also established that the Denwa formation can be subdivided into two units based on their lithologic and sedimentologic attributes. Both these observations have important tectonic, climatic and paleogeographic implications in reconstructing the evolutionary history of the Satpura Gondwana basin. There is strike-parallel lithofacies variation of the units and a major erosional surface between the Pachmarhi and Bijori Formations was identified. The nature of the lithofacies variation in several stratigraphic units and understanding of their implications are in progress. Development of a useful systematics of sequence stratigraphy applicable to the alluvial succession of the Satpura basin is in progress.

It was noted that the current notion of interpreting Barakar sandstone bodies of the Satpura basin as braided channel deposits and associated coal-carbonaceous shale as contemporaneous floodplain of the same braided fluvial system does not explain the disposition of the lithofacies. An alternative explanation was put forward which proposes that the fluvial and coal-forming mire depositional systems alternatively occupied the depositional site in consequence to episodic tectonic pulses.

Deatailed paleocurrent analysis of the Satpura succession was undertaken to resolve the roles of transverse and axial fluvial systems in spreading out sediments.

Veevers & Tewari (1996) had postulated that the Gondwana basins of Peninsular India developed as a part of the mega-inland drainage basin in Pangean supercontinent originating from East Antarctic highlands and were dismembered into disparate grabens and half-grabens during Middle to Late Triassic time. A test of this generalised reconstruction from detailed stratigraphy and sedimentology of the Satpura basin is in progress.

Pranhita-Godavari Valley

Study of the Permian dicynodonts from the Pranhita-Godavari valley was completed. A new species of endothiodont was identified along with another endothiodont species. The new species was named after the founder, Prof. P.C. Mahalanobis -- *Endothiodon mahalanobisi*. Apart from endothiodonts, there are pristerodont, cistecephalid dicynodontid and carnivorous therapsids. Biostratigraphy of the fauna indicate that this horizon is coeval with the *Cistecephalus* and/or *Tropidostoma* Assemblage Zone of the Beaufort Group of South Africa and Rio do Rasto Formation of Brazil. A detailed palaeobiological study of the endothiodonts was carried out. A new evidence of the presence of masseter muscle in the endothiodonts indicates that these animals could perform slightly orthal transverse jaw action along with the typical dicynodont propaliny.

Quantitative Analysis of Geological Data

Quartz C-Axis Fabric and Fluid Activity

The influence of high fluid activity under greenschist facies condition may lead to concentration near Y-axis of finite strain ellipsoid in asymmetric type-I cross-girdle or asymmetric kinked, single-girdle quartz c-axis fabric, as borne out by measurements on a large sample of quartz tectonites from the Singhbhum shear zone, Eastern India.

Colloid, Surface & Environmental Sciences

Micellar and Microemulsion Systems

Systematic investigation on microemulsions was taken up for the better understanding of phenomena of solubilization of water, oil and other ingredients in single surfactant and mixed surfactant systems to improve both the competitiveness and the performance of their products. Physicochemical studies with special emphasis to its applications in tertiary oil recovery, agrochemicals and pharmaceutical use are in progress. In selecting microemulsion suitable for pharmaceutical use, the toxicity and biocompatibility of the ingredients were considered.

A series of phase diagrams are being constructed in three or four dimensions to establish different microemulsion zones with single and mixed surfactants, alcohols of different molecular weights and structures and oils (aliphatic, aromatic, alicyclic, polar and vegetable). The role of the ingredients and their compositions in order to achieve a large single phase zone, were established. The effect of environment i.e. temperature and additives (sodium chloride, urea, glucose, sodium cholate) were undertaken to evaluate the stability of the systems under investigations.

Environmental Pollution

Investigation on the interaction of selective heavy metals with clay minerals (montomorillonite and kaolinite), and the effects of solution pH, proportion of clay size fraction, organic matter, iron oxides, detergents of different charge types on metal removal were taken up to understand the nature of the chemical interaction of these pollutions (specially heavy metals at initial stage) with soil /soil clays under natural conditions for preventing the contamination and for cleaning up the environment.

Workshop on the Geology of the Pranhita-Godavari Valley

The Geological Studies Unit organized a three day workshop, between 16-18 November 1999 on the geology of the Pranhita-Godavari Valley which had been the main area of integrated research activity of the Unit

since its inception. The workshop was organized to evaluate the progress made by the Unit as well as by geoscientists from other parts of the country in reconstructing various aspects of the geology of the valley, and also to define the future directions of research in the valley. The workshop was attended by geoscientists from different organizations of India, as well as from abroad. Presentations and discussions in the workshop brought into focus several problems that require resolution to achieve complete analysis of the basin. Several possible areas of collaboration between important geological organizations of the country were also highlighted.

Physics and Applied Mathematics Unit

The faculty members of PAMU carry out research in diverse areas of current interest in Theoretical Physics and Applied Mathematics. Most of the Applied Mathematicians of the Unit are engaged in experimental studies as well. Apart from problems of theoretical nature, real life problems are also taken up by the scientists in the Unit. These include collaborative research work with other Units of ISI and with different Institutions in India and abroad.

Apart from research activities in Physics and Applied Mathematics faculty members of this Unit are engaged in teaching various courses like B.Stat. (Hons). M. Tech (CS), M.Tech (QROR) and Regular Courses of ISEC. The Scientists also guide and assist research students (towards the Ph.D degree) and research associates. Scientist in PAMU also conduct advanced courses to research students.

Research Activities

Physics

Condensed Matter Physics

Quantum field theoretical analysis is very helpful to study the condensed matter systems like Quantum Hall Effect and High Temperature Superconductivity. A new unified approach, the chiral anomaly and Berry Phase approach, was proposed to study these systems in which the main problem of the pairing mechanism of high temperature superconductors is also investigated. In Anyon Physics a spinning particle model of Anyon has been constructed.

CP (1) – Model with Hopf Interaction

CP (1) or 0 (3) non-linear sigma model with Hopf self interaction in 2+1- dimensions has soliton solutions. The issue of their having fractional spin is still being debated. An attempt is being made to quanitize the above model in the Batalin-Tyutin formalism to obtain the quantum corrections of the soliton parameters, such as mass, spin etc.

Extended Electrodynamics and Non-Zero Mass of Photon

Within the framework of extended electromagnetic theory and B(3) field, a non-Abelian Electrodynamics was developed rigorously where it is possible to explain Sagnac effect, the inverse Faraday effect, the Michelson effect etc. in a consistent way. A new gauge condition known as Evans-Roy gauge condition was proposed.

Foundations of Quantum Mechanics and Quantum Information

The violation of Bell inequalities was studied within the framework of unsharp observables. Bell-type correlations were shown to be responsible for explaining the homogeneity of the universe. Other ongoing work includes study of state estimation, quantum teleportation and further probe in the problem of quantum cloning and its relation with quantum teleportation.

Theoretical Plasma Physics

Solitary waves and double layers in relativistic multi-component plasma are the most important area of research in plasma physics. After derivation of the exact pseudo-potential for a relativistic plasma and plasma in magnetic field, work is going on on some current topics like Alfven waves, double layers in magnetised plasma with a view to application in astrophysical plasma.

Supersymmetric Quantum Mechanics

Q-deformation of quantum mechanics, conservative quantum dynamical semigroup, P–T symmetry in quantum mechanics are the topics of current research. A novel way of supersymmetry breaking had earlier been proposed. A connection between partial algebraization and supersymmetry had also been developed for determining energy eigenvalues of confined quantum mechanical systems. Research on P–T symmetry quantum mechanics, complex potentials were taken up recently.

Conformal Field Theory, Quantum Group and Berry Phase

The relationship between conformal field theory in 1+1 dimension, Chern-Simons theory in 2+1 dimension and chiral anomaly in 3+1 dimension was investigated. This suggests a relationship between the central charge C and Berry phase factor μ which is associated with the chiral anomaly. This study also relates the quantum group parameter q with these parameters.

Non-commutative Geometry

The role of non-commutative geometry in the quantization of a Fermion was investigated and topological features of a Fermion from this viewpoint were studied. Also the relationship between non commutative geometry and quantum group were studied with reference to their association with the Berry phase.

High and Ultrahigh Energy Physics

Experiments on the latest heavy ion collisions at highest CERN energies provide very important data for understanding the nature of high energy interactions. One very important observable is the nature of the Average Phase Space Density (APSD) which is under study. The 'universality' behaviour was established with great emphasis. Behaviours of some ratios on particle production were also analyzed and are being analyzed. A new pathway was built to link up the nucleon-nucleon with heavy ion collision.

'Soft' (non-perturbative) collisions constitute roughly 90% of the natural events. A recent attempt at providing some understanding of the phenomenon of soft collision at high energies met with a modest degree of success.

Theoretical Astrophysics

Within the framework of dynamic multiple scattering theory, a new effect called screening effect was proposed to explain the redshift controversy at cosmological scale. This effect can be verified not only at the cosmological scale but also at laboratory experiments.

Plank Scale Physics

The recent developments in Quantum Gravity raise a certain suspicion among the scientific community that nature may be discrete or rather behaves discretely on the Plank Scale. Based on the working philosophy that the macroscopic space-time (or rather, its underlying macroscopic or microscopic substratum) is supposed to emerge as a superstructure of a web of lumps in a dynamical cellular network, it was argued that the so called physical point, are on a timer scale actually entangled subclusters of nodes & bonds of the underlying network or graph at pregeometric stage. It may be possible to show that both Quantum gravity and Quantum mechanics are derived theories from the more fundamental principles at pregeometric stage.

Applied Mathematics

Basic Fluid Flows

Industrial Fluid Mechanical problems are modelled with a view to understand the physical processes involved in their industrial applications. On thin film development on a rotating disk, it was found that at the initial stage the rate of fluid depletion is more for slower rotation of the disk. But at large time fluid is depleted more for faster rotation. This anomaly is due to the fluid viscosity.

On this film flow on an inclined plane, it was found that different types of waves develop on the surface of a power-law fluid depending on the order of flow rate, angle of inclination with the horizon and surface tensions. This finding may be useful in spin coating process.

Hydrodynamic Stability and Wave

In view of designing heat exchangers and condensers, flow instability and formation of waves on thin film of both Newtonian and non-Newtonian fluids are of current interest. A possibility of solitons in thin film of non-Newtonian liquid flowing down an inclined plane was predicted. It was observed that the power-law index n plays a vital role in stabilizing the waves developed on/under this inclined plane. Deformation of free surface in thermal convection is being studied.

Integral Expansions, Integral Equations and Applications

Integral expansions involving associated Legendre functions and other special functions are being developed and applied to handle problems on continuum mechanics. Two research monographs have been published recently based on the research work in the above area.

Queuing and Inventory Models in OR

Some new models in the area of inventory and queuing were constructed.

Turbulence

Turbulence problems are presumably difficult to solve due to inherent closure problems in them. Several models had been developed within the framework "Statistical Approaches to Turbulence" and applied to stratified flows, rotating flows, flows with suspended particles, bubble plumes etc. Currently, a model on a two-phase flow problem is under construction.

Water Wave

Research work involves problems on source potentials, wavemaker problems, water wave scattering and radiation problems, interface wave scattering problems, problems on wave generation due to initial disturbances, problems of incoming waves against a cliff and problems in stratified fluid. Linear theory is assumed and the emphasis is on analytical and numerical techniques. These problems have applications in ocean related industries such as modelling of breakwaters, docks, ships, offshore structures, submersibles supporting oil drilling rigs in high sea, etc. One research monograph highlighting mathematical techniques for water wave problems had been published earlier, and another monograph involving water scattering problems is under publication. These monographs are based on the research work in this area.

Interdisciplinary Research

Brain Function and Cognition Process

The orientation selectivity of neurons leads to the formulation of a distance function in the cortical areas like visual or cerebral cortex of the brain. Based on a study of the characteristics of the oriented neurons, a statistical distance function was proposed. It is expected to play a significant role in formulating the geometric structures of the cortical areas.

Dynamical Systems & Chaos

Modelling various physical problems by dynamical systems are of considerable interest. They are very useful in the understanding of unfolding of bifurcation mechanisms as a function of an externally controlled parameter of the physical systems in consideration. A model of thermal convection in the form of assymmetric squares in high Prandtl number fluids was studied. Models for competing instabilities are of current interest.

Hydraulic Flume Laboratory

The Institute has a Flume laboratory attached to the Physics & Applied Mathematics Unit. This laboratory was set up in 1978 with an aim to generate multifaceted data on sediment transport. The work under this project is interdisciplinary in nature involving a fluid dynamist, a statistician and a geologist. Mathematical models were developed to estimate the bed load, suspended load, deposited grain size distributions etc. A model is being investigated using the combination of reflecting and jump boundary conditions to the suspension equation to estimate the grain-size distributions in suspension at different heights.

Multivariable System and Control Theory

Current area of interest is to develop Numerical Methods for analysis, design and development of Multivariable Control Systems. Recent work was conducted in the area of Robust Control, Numerical Methods and Adaptive control.

Pattern-Forming Instabilities

Instabilities in physical systems driven far from thermodynamic equilibrium often show transition from isotropic state to anisotropic one varying in space or in time. Selection of various spatio-temporal patterns and other nonlinear phenomena in soft condensed matter are of current interest. Some of the predictions from the theory of instability of the free-surface of visous fluids in Faraday experiment, proposed earlier, were experimentally verified. The study of granular materials under vertical vibration addressed some basic issues in the area of physics of granular materials.

Biological Sciences Division

The Biological Sciences Division is engaged in studying the varied biological processes covering plant and animal kingdoms, including humans. It comprises the following units : Agricultural Science Unit, Anthropology and Human Genetics Unit, Biochemistry Unit, Biometry Unit, Chemistry Unit, Embryology Unit and Plant Chemistry Unit. Faculty members of all units participated in teaching various courses of the Institute and of other organizations. They were also actively engaged in guiding research of Ph. D. students. Research activities carried out in these units in the form of various projects are described below.

Agricultural Science Unit

Research Activities / Projects Undertaken

Research studies in Agricultural Science Unit are mainly conducted in two distinctly different ecological regions, namely Giridih region of Bihar Plateau and Sundarbans coastal region of South Bengal.

Crop-Soil-Weather Relationship

Different weather parameters are being collected and analyzed to identify suitable rice cultivars for Giridih region.

Water harvesting structure was constructed last year to harvest rainwater and studies were made to increase the productivity of the area by introducing the second crop after rice with the harvested rainwater.

Technology Performance Studies

Integrated nutrient management experiments where vermicompost as a major component of the experiment were conducted in lowland rainfed situation of Giridih, Bihar and Shekampur, West Bengal. Results indicated that 25% chemical fertilizer could be saved with the incorporation of vermicompost in the sequence.

During the year under review, attempts were made to develop the vermicomposting methodology in the field condition. Cost effectiveness of vermicompost in conjunction with fertilizer or as sole source is being analyzed.

Subsistence Farming Studies of Bihar Plateau Region

In order to gain intimate knowledge of technology adoption, a complete household survey of three villages in the 'Usri' watershed of Giridih area had been done in the watershed area with varying socio-economic systems, productivity, ecology and technology adoption rate. Examination of field level constraints of adoption in rice and maize revealed that socio-economic and infrastructure, environmental and situational and technological parameters account for 49-57%, 26-34% and 13-16% respectively in villages having different agro-ecosystems in Bihar plateau. During the year under review an attempt was also made to analyse the resource data through GIS tools.

Work on Palmae

In phase III, the work dealt with the ecology, germplasm collection, conservation, and propagation of economically important palms. The three economically important semi-xerophytic palms, *Borassus flabellifer*, *Phoenix sylvestris* and *P. dactylifera* were selected for cultivation at the ISI Giridih Farm of the Bihar plateau.

A total of 63 seedlings of *Borassus*, 16 of *P. dactylifera* and 332 of *P. sylvestris* were transplanted during the year under review.

Introduction of Oil Palm and High Yielding Coconut Cultivars in the Sundarbans Area of West Bengal

The objectives of this project are: (i) to evaluate the possibility of introduction of oil palm and (ii) to select the most high yielding coconut palms among the well known high yielding varieties of coconut, suitable in the Sundarbans area.

On the basis of stabilized yield data, selection could be made for high yielding coconut and oil palm cultivars.

Regular data were collected in respect of number of leaves, height of the plant, girth at the base of the stem, flowering time, number of male and female bunch (for oil palm) and number of nuts produced per coconut plant per year. These data are under analysis.

Eco-Floristic and Anatomical Investigations on Mangroves of Sundarbans

In Phase II work, it has been decided to study community structure, zonation pattern and eco-physiological aspects of the mangroves of the Sundarbans.

Eco-floristic and anatomical investigations on mangroves of Sundarbans

In Phase II work, it has been decided to study community structure, zonation pattern and eco-physiological aspects of the mangroves of Sundarbans.

In the study of community structure, data were collected from two quadrants (4m x 16m) each of five different sites of Lothian Island. The data included number of plants per species, plant height and dbh. The analysis of data indicated that total biomass per hectare was maximum towards tidal coast whereas species diversity increased landward.

In ecophysiological work, proline from leaves, and osmotic potential from both roots and leaves of 13 species of mangroves were estimated following volumetric methods. The data are now under analysis.

Biodiversity of Horse Gram

This project concerns upgrading the genetic potentiality of this crop as well as standardizing the agro-techniques.

Germplasm were extensively collected from different parts of Bihar plateau area and other parts of India. NBPGR, Akola Centre also supplied many germplasms in this regard. The field studies were carried out in Giridih experimental farm with collected germplasms and selections were made through examination of yield attributing characteristics.

Anthropology and Human Genetics Unit

Apart from carrying out research work in different areas of Biological Anthropology and Human Genetics, faculty members of the AHGU regularly participated in teaching in various courses offered by the Institute and Calcutta University. Some of the faculty members were also engaged in Supervision of Ph.D theses.

Research Activities / Projects Undertaken

Genomic Diversity in Indian Populations

Significant findings were: (a) there was a major demographic expansion of modern humans in India in prehistoric times, as inferred from statistical analyses of data on autosomal and mitochondrial DNA markers, (b) there was prehistoric migration of modern humans from India to southeast Asia, (c) female genomic lineages of Indian ethnic groups are strikingly similar, as evidenced by statistical analyses of mitochondrial haplotypes, (d) male genomic lineages of Indian ethnic groups are strikingly dissimilar and there is very little sharing of Y-chromosomal haplotypes across ethnic groups.

Genetics of Complex Disorders

Two statistical methodologies for mapping quantitative trait loci were proposed. The first methodology is based on an iterative procedure, EM algorithm and Bayesian classification, and uses data on nuclear families. The

second methodology, which uses genomewide-scan data on sib pairs, is a semi-parametric procedure. The statistical efficiencies of both methods were shown, using simulated data, to be high.

Epidemiological Investigations on Genetics and Environmental Factors Related to Diabetes

The aims of the project are in estimating prevalence, monitoring long-term complications and management of the disorder - diabetes mellitus. Preliminary analysis of the data is in progress.

Genetical Survey of Some Endogamous Groups of North India

A genetical survey of different endogamous groups of Uttar Pradesh was carried out at the 2nd phase of this Population Variation Programme.

Determinants of Health Among Some Populations of Eastern India

The objective of the study is to know how the Tibetans are coping with the new and alien milieu as well as their survival strategy (ies) in a changing clime (as a result of downward migration to a coastal area from a high altitude econiche). It is also interesting to know how the genetically different groups (e.g. Kora and Mahali tribes) adapt to a similar habitat. Whether they respond similarly or differentially to the ecological stress and their survival strategies to cope with the environmental insult.

The basic aim is to develop an objective measure of health, in addition to the perceived wellbeing (i.e. subjective measure of health) as the health status of a community is an indicator of adaptation to an environment.

The study revealed that there are more than 590 Tibetan households (comprising approximately 3000 individuals of both sexes) in Chandragiri (altitude : 600-830 metres) in Gajapati district (erstwhile Ganjam district) Orissa who migrated from North India in 1962. They are, at present, exposed to a totally alien habitat from their ancestral place as the physical as well as cultural environmental conditions of Orissa are totally different from their original homeland. They are also exposed to a completely different and new disease ecology as well as cultural milieu. Their food habit has been drastically changed.

The preliminary analysis of the data showed that Malaria (both benign and malignant) and Tuberculosis are highly prevalent among them which were quite uncommon in their original homeland. Cervical cancer among the females were also found to occur among them.

Another study among the Kora and Mahali tribes of Midnapore showed that gastrointestinal problems are quite common among them. The infant mortality rate is higher among the Mahalis compared to the Koras.

Gene Environment Interaction

It was observed that young people, aged 50 years or below, carrying the glutathione-s-transferase (GSTM1) homozygous "null" mutation, are more susceptible to tobacco induced oral cancer compared to controls carrying at least one copy wild type GSTM1 gene.

Preliminary work, on antituberculosis drug-induced hepatotoxicity, showed that tuberculosis patients carrying homozygous "null" mutation at GSTM1 locus are more susceptible to hepatotoxicity compared to patient controls who have at least one copy of wild type GSTM1 gene in their genes.

Women's Studies: Health & Well-being

This study emphasizes the dynamics operating in dual-earner families. Study is being conducted among a cross-section of employees in one private and one public sector organisation in the city of Calcutta.

Modernization and Health in the Sikkim Himalaya

Data on self-reported morbidities and socioeconomic characteristics including social support were collected from about 200 Bhutia households inhabiting both urban (Gangtok and its neighbourhood) and rural (Ralong and its neighbouring villages) settings. Data on blood pressures from about 100 young urban Bhutia adults were collected.

DNA Based Studies in the Populations of Southern Andhra Pradesh and Meghalaya

Genomic diversity based on 13 STR loci among the subcastes of the pastoral caste Golla in southern Andhra Pradesh suggested that these hypervariable DNA loci are useful in reconstructing the history of population subdivision even at the local level. A comparative analysis based on a subset of these loci among 23 Indian populations, both castes and tribes, from different regions further suggested phylogenetic relationships that are consistent with ethnohistorical, linguistic and geogrpahical backgrounds.

Blood samples from 36 more endogamous castes and tribes were collected, covering the entire gamut of socioeconomic variation. DNA extraction and typing of these material for certain loci in near future is likely to unfold the total range of genomic diversity in Andhra Pradesh and may help test certain anthropological hypotheses hitherto unresolved, in a suitable study frame.

Collection of relevant anthropological information and blood samples from the tribes of Meghalaya were completed. The typing of these samples for Y-based, mt DNA and autosomal markers is in progress. After this material is analysed, it will be possible to examine certain evolutionary processes, including the origin of one of the Khasi tribes.

Health Productivity Relationship

The brickfield labour group consists of mainly three ethnic groups, e.g. Santal, Mech and Oraon. The following were collected from from about 130 brickfield labourers of both sexes: (i) anthropometric measurements (ii) blood samples for hematological parameters, (iii) blood pressure, physical fitness and lung function data (iv) food intake, energy expenditure and work output data. Preliminary step-wise regression analysis of the data shown that out of 45 variables, 6 variables significantly determine the productivity in males. In the case of females only two variables significantly determine the productivity. In males, the more the back strength, calf girth and energy expenditure the more the productivity, provided the minimum values of skinfold thickness (triceps), age and grip strength (left). In females, the more the energy expenditure the more the productivity.

Secular Trends in Growth

A repetitive growth survey after 10 years of the initial, was started. So far, 471 boys aged 6.0 to 16.0 years were measured for 21 body measurements in one occasion only (on and around birth dates of the subjects) following the protocol of the International Biological Programme (1969).

Genetics of Dermal Ridges

Homogeneity of sex dimorphism among 5 endogamous populations of West Bengal suggested a common characteristic within the same geographic area for qualitative and quantitative dermatoglyphic traits. But differen

features were displayed in diverse populations, perhaps due to the role of environmental prenatal factors in the realisation of the level of dermatoglyphic sex-difference.

Biochemistry Unit

Research Activities / Projects Undertaken

Natural History of Human Papilloma Virus (HPV)

This work is being done at the Child In Need Institute (CINI) - RCH clinic, Pailan, 24-Pargonas (S), with the objective of developing a molecular/ epidemiological data base on the natural history of HPV. For each subject, a pap smear, a smear for Gram-test (mainly for diplococci infection) and a cervical scrape for HPV-assay were collected. Also recorded were several demographic variables, life style-variables, marital/extra-marital history, contraception history, past medical history (if any), clinical, cytological, any STD- related information and HPV-indicators. Eight hundred women have so far enrolled.

Common clinical problems included unusual cervical/vaginal discharge, cervical erosion (various degrees) with contact bleeding. Prevalence of HPV 16/18 infection in various cytopathology groups were as follows: normal (49 out of 554), inflammatory smear (0 of 21), abnormal squamous cell of undetermined significance [ASCUS] (1 of 17), and low squamous intraepithelial lesion [LSIL] (0 of 20).

Results of the follow up study were as follows. Of HPV 16/18 positive subjects but cytologically normal (n=26), 7 showed persistent infection. One subject having HPV infection and ASCUS at the base line showed no infection (transient) at the follow up. Four LSIL subjects (with no HPV infection at the base line) showed HPV 16/18 infection at the follow up, two with persistent LSIL and two changed to normal. Among other molecular markers, determination of telomerase activity is ongoing. The data is currently in the process of analysis. Bcl-2 marker was standardized.

Development of in Vitro Model for Carcinogenesis/Tumorigenesis

There has been a need for a model system for the study of carcinogenesis/ tumorigenesis. The immediate objective is to establish a lymphocyte culture system and to explore the possibility of using it for developing aids/markers (through apoptotic mechanism) for tumorigenesis. The long-term goal is to establish tumor cell line(s) and to use them in biomedical application (raising antibody etc).

The action of various (mutagenic/ carcinogenic) drugs on the apoptotic principles is being studied using lymphocytes in culture. In view of the association of reactive oxygen species (ROS) with cancer, the effect of such species by treatment of proliferating lymphocytes with H_2O_2, which is known to produce ROS, was analyzed. A dose dependant induction of apoptosis, in response to oxidative stress in PHA stimulated peripheral blood lymphocytes of normal humans, was observed. This was coupled with a decrease in proliferation of the cells. However, pretreatment of these proliferating lymphocytes with a non-toxic concentration of the oxidizing agent H_2O_2, resulted in an inhibition of the induction of apoptosis along with improvement in the proliferative capacity of these cells.

Cellular Factor(s) Associated with Resistance to Oxidative Stress in M5 Cells, Derived from V79 Cells

The objective of this study is to identify cellular factors responsible for the resistance to oxidative stress in a cell strain, M5 with genetic instability, derived from V79 cells. The M5 cells were found to be resistant to the induction of apoptosis by H_2O_2 treatment in a dose dependent manner, compared to the parental V79 cells after 48 h of post treatment. The induction of apoptosis in both the V79 and M5 cells appeared to be independent of p53, since V79 cells are p53-/- and M5 are derived from V79 cells. Elevated glutathione levels in the M5 cells were found to be involved in the altered apoptotic response of the M5 cells to oxidative stress.

The role of the antiapoptotic protein, Bcl-2, in response to oxidative stress in the rodent cell system, was investigated. Some bcl-2 transfectants were isolated using V79 cells and these were used for the standardization of immunocytochemical detection of Bcl-2 gene product. Using two such transfectant clones (which appeared to be positive for the detection of Bcl-2 gene product) as positive controls, it was observed that the M5 cells were positive for the presence of Bcl-2 protein. This finding indicated the involvement of this protein in resistance to oxidative stress by way of reduced induction of apoptosis in contrast to the V79 cells, which did not appear to be positive for Bcl-2. Also, the Bcl-2 transfectant clones showed up with higher levels of GSH compared to the V79 cells probably indicating an interactive role of GSH and Bcl-2 in resistance to oxidative stress in the M5 cells.

Biometry Unit

Research Activities/Projects Undertaken

Fishery Science

The Unit is engaged in applying conventional statistical methodologies to live data generated in the field. Some work reported earlier needs further attention. For example, the problem area of growth as reported earlier is reviewed from the point of 'lag phase' of growth of Indian major carps. Attempts are beig made to minimize this problem area of growth as evidenced from the negative velocity and acceleration by applying suitable high quality nutrients. In this area we are collaborating Institute of Freshwater Aquaculture (CIFA) of Bhubeneswar. Results so far obtained from the Directional Data Analysis of fish growth indicate the predominance of 'between direction' variation over 'within direction' variation of the dissolved oxygen contest of pond which contributes largely to the growth of the carps.

Biomedical Science

Juvenile MRDM with Dietary Error

The aim was to find out how and why diabetes (especially type II or NIDDM) develop in patients suffering from malnutrition and undernutrition.

It was planned to (i) make a dietary survey to find out the prevalence of these dietary errors in different communities, (ii) detect dyslipidaemia, atherosclerotic disease or type II diabetes among those survived and (iii) correlate dietary errors with atherosclerotic disease, dislipidenemia and type II diabetes.

The project revealed some interesting results which are different from those of other works of the world. A particular HLA-class II antigenic association in the patients was observed. This led to the extension of these findings to other types of diabetes such as IDDM , NIDDM and also MRDM with a special emphasis on Fibrocalculous Pancreatic Diabetes or FCPD. Beside this, during the period a comperative study of the genetic resemblence between Type I, Type II and MRDM patience in the eastern part in India was continued and the work is in progress.

Studies of Gymnema Sylvestre Leaves in Controlling Diabetes

In order to know the effect of water soluble alcoholic extract of Gymnema leaves on blood glucose level, after determining the LD_{50} and working dose of the leaf extract, its role on blood glucose level of (i) Normal (ii) glucose fed hyperglycemic (iii) adrenaline-induced hyperglycemic and (iv) streptozotocin induced diabetic rats was studied.

Further studies on some other parameters for its blood glucose lowering action, with a special emphasis of its role on the β-cells of the pancreas are in progress.

Beside this, studies of the effect of Interleukin-8 (IL-8) on some infectious diseases, specially diabetes and cancer are being carried out in collaboration with the immunology department of Indian Institute of Chemical Biology, Jadavpur during this year separation of the alcoholic and non-alcoholic portion of the extract was done and the experiment started afresh in order to see which portion possess the active principle for flood lowering activities.

Efficacy of Azadirachtya Indica (Neem) as a Drug

Preliminary studies on water soluble portion of alcoholic extract of Azadirachta indica leaves revealed that the *A. Indica* leaf extract possesses significant antihyperglycemic, hepatoprotective, antiinflammatory, antiserotonin, hypotensive, antifertility and hypoloipidemic activity.

Detailed study regarding possible mechanism of antihyperglycemic activity of *A. indica* leaves revealed that the *A. indica* leaf extract blocks significantly the inhibitory effect of serotonin on insulin release mediated by glucose.

Chemical analysis revealed that the A. indica leaf extract contains the following six compounds (i) Quercetin-3-O-βD-glucoside, (ii) Myricetin-3-O-rutinoside, (iii) Quercetin-3-O-rutinoside, (iv) Kaemferol-3-O-rutinoside, (v) Kaemferol-3-O-βD-glucoside and (vi) Quercetin-3-O-αL-rhamnoside. These compounds are collectively known to be responsible for blood sugar lowering activity.

Physiological Effects of Pulsed Electromagnetic Field Therapy in Bony and Rheumatological Diseases

Pulsed Electro Magnetic Field Therapy (PEMF) has recently gained a lot of attention. It can accelerate fracture healing, and can be applied through casts, making it a powerful utility in sports medicine. It also can greatly help conditions such as Osteoporosis.

In the pilot study, 24 patients were subjected to PEMF therapy, thrice in a week for 16 weeks. Their blood samples for haematological, serological and biochemical analysis were taken at 0 day (immediately before PEMF therapy) and during PEMF therapy upto 16 weeks.

It was observed that the treated patients are better of than the placebo patients at least during 16 weeks period.

Chemistry Unit

Investigation on the level and state of existence of Heavy metals and some relalted micronutrient elements in soil was carried out.

The study dealt with heavy metals in presence of various soil components. The heavy metals are often beneficial when present in small amount in soils and highly toxic above a certain level. It was found that Iron content in soils were adequate, but manganese deficiency is more in soils with high organic matter content, generally in hill and feet hill soils. Copper and Zinc were present in small amount and the Boron availability in those soils were less which may cause deficiency.

Spectral investigations of the interactions of fluerescein dyes with surfactants.

The spectrophotometric investigation of the interaction of two structurally resembling halogen-substituted flourescein dyes, Eosin Blue (EB) and Rose Bengal (RB), with surfactants of different charge type were undertaken.

Research Activities/Projects Undertaken

Biomathematics of Morphogenesis and Carcinogenesis

Non-linear mathematical and discrete stochastic models of cellular growth, differentiation and morphogenesis were further improved and investigated. Diversity of species specific pattern formation influenced by different genotypes were considered. The dynamics of these models were thoroughly investigated using advanced mathematical tools of nonlinear analysis, such as bifurcation and catastrophe theories, global stability and control theories, system analysis etc. The spatio-temporal nonlinear mathematical models were studied on different geometries and their global behaviour was investigated. The idea of activator and inhibitor, their self- and cross-diffusion and contact cell inhibition of mitosis was further developed and investigated by spatio-temporal mathematical models.

Agricultural Ecology

Intervarietal and intercrop allelopathic interaction as well as weed-crop ineteraction were futher investigated and chemical properties of the allelochemics were determined. Allelopathic activity of the weed *Chrozophora* and *Leonurus*, was investigated. In the weed *Chrozophora*, sinapic acid acts as one of the allelopathic agent. In the case of *Leonurus*, caffeic acid was identified as the main allelopathic agent. The study was continued to examine the allelopathic interaction between rice and *Laudougia* weed (rice specific weed).

Mathematical Epidemiology

Mathematical and stochastic models on Japanese encephalitis (JE) were further investigated by incorporating the seasonal fluctuation in the density of mosquito population. The spatial spread of a disease in an SIRS epidemic model with immunity imparted by subclinical infection on a population was considered and the dynamics of the infectious disease as well as its endemicity in local and global sense were studied.

Mathematical Ecology

A mathematical model of phytoplanton-zooplanton system, in which the grazing pressure of zooplanton is decreased due to toxic substances produced by phytoplanton population at the time of red tide, was proposed and analysed. Conditions for the coexistence of both the species were obtained in local and global sense. The parameter dependency of the outbreaks and crashes of the pattern of blooms, excitable situations, triggering mechanism of the blooms were observed. To validate analytical findings, numerical solutions of the system were performed using available real live data.

Real live data were collected on the abundance and fluctuation in the density of the marine plankton communities from the off-shore region of some parts of the Bay of Bengal in the Digha-Talsari-Sankarpur belt. Bloom, pulses and succesion were investigated with the help of these data and mathematical as well as stochastic modellings.

Research Activities/Projects Undertaken

Screening and Local Vegetation

In this project physico-chemical status as well as microbiological profiles are being studied consecutively for three years. Microflora of the various zones of soil samples were isolated through enrichment culture and preserved for identification. Some fungi were identified as Aspergillus, Rhizopus, Fusarium, Cladosporium and Paecilomyces.

Microbiology & Technology

Particle boards were prepared from Anthocephalus kadamba pressed fibre residue with 15% urea formaldehyde resin. Physical properties of the prepared board were assessed. Mechanical properties such as density, moisture content, swelling value, tensile strength were investigated. The data expresses on volume and mass basis was found to be comparable to those of the Bureau of Indian Standards (BIS).

Nutritional and Biochemical Studies

A study was conducted on the utilization of pressed fibre residue left after extraction of leaf protein from Dalbergia sisoo, Cassia bicapsularis, Cassia siamea and Limnophila heterophylla. Although the nutritive value of pressed fibre residues were almost comparable to that of the original plants, but to improve the feeding value some chemicals like urea & NaOH, were added. Optimization of cone of urea and NaOH was studied in details to establish the role of the chemicals in the clarification of the pressed fibre residues.

Aquatic weeds and Water Relationship

Monthly variations of important physico-chemical parameters of a pond were studied for a period of one year to assess its water quality and macrophyte abundance data. To document aquatic macrophytes, their identification, abundance ranking and the vegetation map of different species were recorded. Statistical analysis (correlation, ANOVA) of the data was made in order to determine variations and associations between the variables.

Yield Performance

Sugarbeet varietal trial was undertaken on four varieties namely, Raspoly, Solid, Virtus & Mezzanopoly, to study their yield performance in comparison to Ramnaskaya 06, the popular variety. Root yield, shoot yield, dry matter, protein nitrogen extractability and leaf protein yield and sugar yield of the varieties were studied at every 20 days interval starting from 80 days after sowing. All the four varieties were found to be highly comparable with Ramanskaya – 06.

Enzymes from Soil Microbes

During extensive screening of different bacteria along the alluvial soil tract of West Bengal, a number of exocellular protease producing pseudomonas spp were isolated. Biosynthesis of enzyme was detected in a number of media varying the nutritional parameters. A medium consisting of glucose (5%), asparagine (0.4%), yeast extract (0.4%), K2HPO4 (0.15%), MgSO4. 7H2O (0.05%) was the best medium at pH 7 for the biosynthesis of enzyme (10.75 units/ml and 7.87 units/ml) for Pseudomonas aeruginosa and P. fluorescens respectively.

Social Sciences Division

The Social Sciences Division includes the following units : Economic Research Unit, Economic Analysis Unit, Linguistic Research Unit, Planning Unit, Population Studies Unit, Psychology Research Unit and Sociological Research Unit. Economic Analysis Unit is located at Bangalore, Planning Unit is located at Delhi, while the remaining five units are located at Calcutta. Faculty members of this Division participate in teaching and training activities at various levels, including Ph.D. supervision. The research work done in these units during the year under review is described below.

Economic Research Unit

The faculty of Economic Research Unit was actively involved in research, training, project work and supervision of Ph.D. students.

The faculty members and scientific workers of the Unit undertook research in a wide range of topics in Economic Theory, Applied Economics and Econometrics. Areas of research included Industrial Economics, Welfare Economics, International Economics, Development Economics, Problems related to the Indian Economy, Macroeconomics, Analysis of Consumer Behaviour, Level of Living, Regional Disparities, Studies on Quality of Life, Environmental Economics, Econometric Theory and Applications, Agricultural Economics and Sampling Techniques. These researches have been published/accepted for publication in international journals like Theory and Decision, Review of Development Economics, Keio Economic Studies, Journal of International Trade and Economic Development, International Review of Economics and Finance, Journal of Economics, European Journal of Political Economy, and Statistics and Probability.

The teaching and training activities included both Ph.D. research supervision and teaching in various academic programmes of the Institute. Thus all the courses on economics and econometrics of the B. Stat. (Hons.), M.Stat., M.Tech. (QROR), ISEC (regular and specialization) and MS(QE) programmes were taught by the faculty of the Unit.

The Unit conducted a Four-Week Faculty Upgradation Programme on Environmental Economics for college teachers during 1 to 26 November 1999. The programme was organized under the ongoing World Bank Aided Environmental Management Capacity Building Technical Assistance Project : Environmental Economics Component. It was attended by 21 candidates of whom 11 were outstation participants. There was a total of 32 resource persons drawn from all over the country and also from abroad.

The programme provided the participants with a discussion and review of the relevant economic theory along with the basic principles and tools needed for economic analysis and then to expose them to the various environmental problems including the important areas of research on these problems. Attempt was made to treat them as not only prospective trainees but also to motivate them to undertake research on environmental problems requiring application of economic tools and principles. The participants were also exposed to some software developed specifically for tackling environmental problems.

Plan Projects

Price Seasonality, Storage and Speculation

The broad purpose of the project is to understand the process of agricultural price formation. Unlike industrial goods, the production of agricultural goods is seasonal. Hence to meet a continuous demand these goods have to be stored. Storage, in turn, gives rise to speculation.

The project focuses on the problems of storage, speculation and other aspects of intertemporal trade by studying selected potato markets in West Bengal. Potato markets in West Bengal were chosen as the object of the

study firstly because potato is a highly storage dependent product and secondly because West Bengal is a large producer of potato. The village markets of the Hooghly District in West Bengal that are being studied are revealing interesting aspects of intertemporal trade and speculation.

Identification of the Causes of Sickness of Small Industrial Units

The purpose of the project was to find out the causes of sickness of small scale industrial units. The existing method of defining sickness is primarily concerned with "net worth". The approach taken in this project was to define sickness by considering not only financial factors but also economic factors. The field areas were chosen from the industrial belts of West Bengal. For comparison, the industrial agglomeration of Delhi was considered.

Economic Analysis Unit

Research Activities

The department is active in the areas of applied econometrics and quantitative methods with a few thrust areas that were pursued with vigour in the recent past. Bayesian methods of data analysis are in the forefront of research world wide but in India there are only a few individuals and a selected few centers of excellence that have been able to push this line of research. At the Economic Analysis Unit this is one of the thrust areas. The research in application of Bayesian methods to Social Science helped solve one of the long-standing problems of empirical verification of Inventory investment behaviour. The problem of low power of classical tests of non-nested hypothesis that used to cast shadow on the appropriate model for the size distribution of incomes was also successfully resolved by the use of Bayesian method of model comparison. This approach is also being applied in Financial Economics for examining the volatility of stock prices to the rate of information arrival.

Another area of interest is Statistical Forecasting. Useful insight into the movement of Euro versus US Dollar was gained. Several lectures at ISI and other Postgraduate departments lectures were delivered to enthuse young researchers into this fold.

The Unit was also involved with several important issues confronting Indian economy. The question of Indian Agricultural scenario in the light of WTO was looked into. Other investigations touched almost all areas of Indian economy including trade, employment, pricing and distribution of resources. Interdisciplinary research in Bibliometrics was also conducted.

The Unit has been working in Information Economics that is currently an area of great importance in Economics and contributed enormously by research in the telecommunication regulations and pricing of telecommunication products.

The Visitors provided added stimulus by discussions and interaction into diverse areas such as Environment Economics and Cost and Production Efficiency and Non-conventional sources of energy. A whole gamut of issues related to environment and some fundamental questions of international price comparisons were discussed by Professor D.S. Prasada Rao.

Linguistic Research Unit

During the period April 1999 to March 2000, the Linguistic Research Unit continued its programme of research in the areas of Quantitative Linguistics and Computational Linguistics with special emphasis on speech psycholinguistics, sociolinguistics, syntax and text analysis.

Research Activities

During the period April 1999 to March 2000, the Linguistic Research Unit continued its programme of research in Applied Linguistics. The major thrust areas were: (i) Computational Linguistics, (ii) Methods in Quantitative Linguistics, (iii) Studies on the Phonetic and Phonological Structures of Major Indian Languages and Application, (iv) Language movements in India, (v) Clinical Linguistics, (vi) Psycholinguistics, (vii) Post-Structuralism and (viii) Syntactic Theory.

Projects Undertaken

Linguistics, Statistics and Cybernetics-An Integrated Approach to Quantitative Linguistics

This project aims at developing the methodology for the quantification of Micro- and Macro-linguistic data by using Statistical and Computational techniques. In spite of substantial application of Statistics in the realm of linguistic research, there is no indegeneous and integrated method for Statistical-Linguistic analysis appropriate to the Indian situation. Quantification of (i) texts of Bankimchandra and Rabindranath, (ii) Bilingualism, (iii) Language learning, (iv) Fuzzy expressions in Bangla has been made. The attention of academic institutions where specialisation in linguistics is offered was drawn to incorporate methods in quantitative linguistics as an integral part of linguistics and applied linguistic methodology. Simultaneously, a manual on methodology applicable in the Indian context was brought out.

Using Computational Language Processing Methods in planning Language in Plural Society

The project was devoted to the problems of computational parsing of Bangla sentences with a view to planning language in the Indian plurilingual milieu. The aim was to deal with the problem in four phases. Phase I was on the order of the Bangla verb in sentences. In phase II, verb projected on the structure of Bangla sentences. The last two phases were completed during the year under review. In phase III different possibilities of Bangla verb-combinations were explored. Phase IV supplied the rules for combinations (particularly Compound Verbs) and exceptions to these rules. The linguistic clarifications for Aspectual use of vectors was also investigated. Though the syntactic analysis of Bangla sentences (after the completion of phase III) was done on the basis of valency, the crucial area of semantico-pragmatics faced many problems as this area includes the non-algorithmic character of the human cognitive domain. The analysis of fuzzy expressions in Bangla proved the mismatch between human cognitive domain and the algorithmic structures of the computers. This project highlighted the fact that it is merely impossible to deploy the algorithmic structure in human language ignoring the semantico-pragmatic problems. Moreover, in a plurilingual country like India, grass-root multilingualism suggests its preference towards shadow economics to manage numerous languages by means of large scale convergence rather than any costly enterprise. This suggestion betrays the centralist politics of homogenisation by means of electronic capitalism.

Interference of L1 (Bangla) in the Learning of L2 (English) : An Item Response Theoretic Approach

The earlier method of teaching English in West Bengal was indirect access to Universal Grammar (Anglo-Vernacular or Grammar-Translation method). Instead of this the Monolingual Functional-Communicative method was introduced from Class V. This project seeks the result of the impact of this method on class V to class X students , who have little or no access to L2 in their environment. Firstly, the mismatch between L1 and L2 was explored from the standpoints of markedness hypothesis. The items like passivization, wh- and yes-no questions, word order, tense, etc., were arranged to understand interference of L1 in L2. Apart from this syntactic investigation, the lexically marked derivational and inflectional affixes were also arranged to meet the same goal. Thus almost eight parametric differences were arranged in fifty questions according to the supposed English knowledge-base of students from each class. The responses of about 800 students were analysed using the discrete point system. Then the achievement level of L2 was investigated by using Item Response Theory (IRT) and the Linear Logistic Test Model (LLTM). The choice of this particular model is due to the fact that particular cognitive tasks or items are

functionally related to learning achievement levels which can be explicitly expressed mathematically. The consequences of this L2 policy was investigated on the basis of the first hand experience gathered during the field work done for the Ashok Mitra Commission's Report (W.B. Government, 1992).

The Glottopolitics of Linguistic Subalternity in Multilingual India

The project is devoted to the problems of heterogenous linguistic attitudes of Superordinates and subalterns' collaboration and non-collaboration regarding superordinates' imposition of a single prestigious linguistic variety in the Indian plurilingual milieu with a view to understand the inner domain of the subalterns. We have already covered the following movement-prone linguistic zones: (i) Rajbansi, (ii) Pahari, (iii) Gorkhali, (iv) Santali. The survey of aforementioned languages reveal the nature of the language movements as either cohesive or divisive forces, or as self-deterministic forces aiming at socio-economic decentralization. It also reveals the characteristics of movement-prone zones and linguistically deprived areas.

Development of an Integrated Programme Using Audio-Visual Aids for Teaching Language to Hearing Impaired Children

This project aims at the development of audiovisual tools and teaching materials using special animation techniques, for the habilitation of hearing impaired children. The most unfortunate deprivation in Hearing Impaired (HI) children is the total/partial absence of the auditory channel for learning language. There is thus a need to teach them language systematically by making use of other channels of communication. The basic objective of this project is to develop language learning and language teaching aids using the visual display channel. The work was done on Bengali by preparing a list of Bengali words and concepts where we made use of the text analysis of the curricula language. A pilot video was produced with the help of the Audio-Visual Unit.

Second National Symposium on the "Methods of Quantitative Linguistics", February 28-29, 2000

Researchers from twelve institutions participated in this symposium organised by the Linguistic Research Unit. Apart from panel discussions on "Application of quantification at various levels of linguistic analysis" and "Prospects of Quantitative Linguistics in the Indian perspective", ten papers were presented. The papers were on the application of quantitative methods in the field of Computational Linguistics, Psycholinguistics, Sociolinguistics, Corpus Linguistics, Network analysis and also in the area of Theoretical Quantitative Linguistics.

Planning Unit

The Planning Unit's research activities can be divided into three broad categories: Applied Economics / Econometrics, Applied Theory and Advanced Economic Theory.

Research Activities

Applied Economics and Econometrics

This category can be further divided into India-specific (developmental) issues and international issues. More specifically, in the field of Indian agriculture, recent and continuing work includes risk and uncertainty issues: (i) the impact of off-farm income on the viability of part-time farming and (ii) the design of area-yield crop insurance schemes. Work is also being done on issues relating to food policy and agricultural Markets: (i) impacts of increase in PDS prices (ii) reforming the PDS for better targeting and (iii) working of agricultural markets for semi-perishables are also examined. A third related area of the work is the supply of agricultural technology; recent work consists of (i) evaluating economic reforms of the seed industry and the impacts of private research and (ii) investigating role of spatial clusters in providing services and inputs.

Various issues relating to the Indian Sugar industry are being studied. Another continuing study looks into the relationship between forest degradation, poverty and local governance. An econometric study of interaction between pedestrians and vehicles in Delhi traffic situations was also undertaken.

Some earlier studies showed that regional growth rates vary considerably in India. A further study aims to find causes underlying the discrepancies and specifically link the growth performance of various states to their social indicators.

As is well-known, India's trade liberalization program is underway since 1991. Unfortunately, no quantitative study exists on welfare cost of trade protection in India. Just as import restriction and substitution policies were a matter of faith since Independence till 1991, so are the virtues of liberalized trade in 1991. A recently completed study has attempted to estimate the welfare losses associated with trade protection given to certain industries like petroleum, cement and iron and steel.

There have been some studies on Indian fiscal issues. Work on issues such as economic cooperation with ASEAN states and technology and research and development in India have also been done. A few papers in these areas have been prepared and communicated to different journals for publication.

An econometric work on the impact of technological innovation on consumption in India has been initiated. In the international context, an antipoverty program in Argentina was evaluated by estimating the distribution of gains by propensity score matching.

Applied Theory

This spans industrial organization, international trade and economic growth. A study on leasing of durable goods and market segmentation asked why sellers of durable goods like automobiles might want to sell as well as lease such goods. Another study analyzed how home-ownership affects households' behaviour in making social investments in their neighbourhoods. A unique auction mechanism used by traders' guilds in Surat in the 19th century to collect funds for charity was also studied, and the equity and efficiency properties of this auction were compared to "standard" taxation schemes.

Work in international trade continued to focus on links between trade and investment policy on one hand and personal distribution of wealth and income on the other. Research was initiated into the Political–economy aspects of trade policy when distribution of wealth and income in a trading economy endogenously evolves over time. In another work, it was found that foreign direct investment into skilled-labour intensive sectors may actually lower the skilled-unskilled wage ratio.

In the context of endogenous growth, a model of a developing economy was developed with three factors of production, one of which is a public good. The model facilitated investigation of the possibility of failure of well-known results on growth rates characterizing command and market economies.

Another theoretical research has focused on various issues in finance such as the possibility of bank runs.

Advanced Economic Theory

An important area of research for the members of this Unit is the theory of mechanism design. For instance, studies on various issues in the design of networks both from a strategic and axiomatic viewpoint, the structure of incentive-compatible random allocation mechanisms, incentive-compatible allocation mechanisms with special reference to designing revenue-maximizing multi-unit auctions, problem of making strategy-proof selections

from the core correspondence and structure of domains on which incentive-compatible allocations satisfy specific properties such as dictatorship and "tops-onliness" were undertaken.

Population Studies Unit

Research Activities

Interpolation for Population Data : An Emperical Study

Many econo-demographic and other secondary data may need interpolation. Many interpolation formula which are available suitably used according to need. The present study was restricted to some specific interpolation methods empirically applied to many types of data. As for example. Aitken's iterative method was used for interpolation from unequal grouped data to point data. Such examples are available in Social Development volumes of United Nations Population Fund. However, the methods may not be appropriate for other types of data. In this respect, examination of suitability of the formulae is of interest.

Effect of Breast Feeding on Post Partum Non-Susceptible Period and Fertility

This study explored the differentials in breast-feeding among various socio-economic, cultural and demographic groups of the society and tries to find its determinants. The study also examined the effect of breast feeding on post partum amenorrhoea and fertility.

Concise Description of the Marriage Process Amongst Females of an Indian State and Bangladesh

The study suggested that the age at marriage distribution is not symmetrical, but is rather skewed to the right as evidenced from the mean age at marriage (SMAM) and median age at marriage (MAM). The values of SMAM as well as MAM are higher in West Bengal than in Bangladesh, an erstwhile constituent state of India. The first marriage frequencies, peak age at marriage followed by the risk of first marriage have shifted from the lower ages towards the higher ages in West Bengal and in Bangladesh. The marriage curves follow the same pattern since 1961.

Reconcilations of two Different Sets of Mortality Data for the Derivation of Smoothed Life Table : A Model Approach

In this study, the data relating to Children ever born (CEB) and Children surviving (CS) by age group of mother was considered along with the data on spouse survival based on widowhood status by age of the spouses. The approach taken in this study is to estimate two sets of survivorship probabilities and subsequently to blend these two sets at the junction, based on Brass Two parameter Logit Life Table, in order to derive a smoothed life table for West Bengal.

Explaining the Inconsistency in Census Based Age Data and its Effect on Fertility and Mortality : Results from West Bengal

As census report on age are subject to errors from a variety of causes, social relationship within a community are considerably affected by the relative numbers at each age. Many types of planning, particularly planning of community institutions and services are affected by this sort of errors. A greater part of age error or distortion results mainly from age misreporting, but irregularities in age distribution may be real and caused by post changes in levels or patterns of fertility, mortality and migration. Age mis-reporting is a result of preferential digit ending in "Zero" or "Five" mostly. But age shifting is a more serious problem in various cultures in India than age

heaping. Keeping the purpose of the study in view, an attempt was made to eliminate the inconsistency and effects of errors in age distribution of fertility and mortality, the two major components of population change.

Status of Obsetetrics and Gynaecological Morbidity in Urban Area in North 24 Parganas, West Bengal

This study is focussed on : (a) Measuring different aspects of reproductive morbidity in the area of obstetricts and gynaecological morbidity, (b) Methodological issues in reproductive health measurement and (c) Assessing non-contraceptive benefits of contraceptions on obstetrics and gynaecological moribidity among women aged 15 years and above. A survey was conducted and the preliminary data analysis was completed. The results are being interpreted.

Replacement Rates and its Components

The objectives of this study were to (a) Develop a model which take into account all the major determinants of population growth from marriage through conception and live birth to the biological maturity of the second generation, (b) Examine the magnitude of the various components in the process and (c) Use these components to estimate the replacement of couples in India by analysing National Family Health Survey Data (NFHS) 1992-93. The compilation and preliminary analysis of the has been made.

Health Sector Reforms : An Evaluation of Impact and Patterns of Utilisation Among Vulnerable Groups in three Indian States (Andhra Pradesh, Tamil Nadu and West Bengal)

In India the rule of the state has historically been essential to public health and disease eradication programmes. There has not been much valuation of the impact of the reforms upon access to public health services and the quality of care. This study assesses the extent to which a "safety net" constituting an integral element of the reforms is working as an effective means of promoting allocative efficiency as part of the changes that have taken place in India.

The study used both quantitative and qualitative approaches. The first one consisted of a cross sectional survey of 5,776 households spread over Calcutta city, other urban and rural areas in West Bengal. It covered over 28,000 population. A structured questionnaire was canvassed in the six selected districts of the State during May-September 1999. Subsequent to data cleaning and entry into computer, the analyses were undertaken. Simultaneously, the work for qualitative phase was also taken up. It included in-depth interviews in a sub-sample of the main sample and focus Group discussions with users and providers of health care. The processing of qualitative information has recently been initiated.

Psychology Research Unit

Research Activities

Attainment Level of Primary Students at the End of Class IV in West Bengal – Particularly the Non-Scholastic Achievements

The study aimed to obtain a clear picture of the non-scholastic achievements of the primary students of the school leaving class of West Bengal covering all the 18 districts of the state. The study was completed during the year under review.

Self-efficacy, Intrinsic Motivation and Cognitive Functioning

Self-efficacy and intrinsic motivation on cognitive functioning i.e., academic achievement was studied in a group of primary school students. On the basis of pilot study tests in the area of language and arithmetic were prepared. Data collection from three districts, namely, Murshidabad, Birbhum and Bankura was completed. Analysis of the data is going on.

Development of Computer Algorithm for Construction of Aptitude Test Battery for Computer Programmers

Computer aided aptitude testing is important for selection, training and guidance. The purposes of this ongoing project are to (i) identify job and personnel profile of computer programmers, (ii) determine relative importance of specific aptitudes for success in computer programming ,(iii) develop job satisfaction questionnaire for computer programmers, (iv) develop computer algorithm for assessment of aptitudes and to relate computer aided aptitude test battery with paper pencil aptitude tests. Through job analysis, job and personnel profiles were identified. Data were collected from 179 computer programmers. 16 specific aptitudes were identified as relatively more important by more than 70% of respondents. These were classified into five groups – logical reasoning, verbal reasoning, creative and aesthetic aptitudes, memory, and numerical reasoning. The interview with programmers revealed four areas of job satisfaction (feeling of worthwhileness in job, satisfaction with creative opportunities and intellectual stimulation and with co-workers' support) and four areas of job dissatisfaction (high work load, poor upgradation of computer, lack of challenge and repetitive job).

Study of Invariance of Item Parameters Across Social Groups of Likert Type Scale : an IRT Approach

Draft of 1st report on the basis of Prolonged Deprivation Scale (PDS) for girls group was prepared. Another set of 617 observations using PDS on boy groups was computerised and analysis is in progress. Besides these about 215 observations using Semantic Differential Scale was computerised. It was found from the results that multidimensional approach is more suitable for deprivational scale.

Development of Questionnaire for Assessment of Reading and Writing Motivation of Boys and Girls of Grade III and IV

Encouraging children by developing internal motivation is a major problem today. The purpose of this ongoing project is to identify the motivating and demotivating factors of reading and writing motivation among 3rd and 4th grade children. Responses from students through unstructured interview and survey of literatures revealed 18 factors for reading motivation. These are spiritualism, pragmatism, environmental awareness, individualism, idealism, courage, self knowledge, reading efficacy, challenge, curiosity, reading involvement, importance, recognition, grades, social, competition, compliance, reading work avoidance.

Analysis of the Results of Madhyamik Examination in West Bengal

Schedules for school information were prepared and printed. For the purpose of data collection 17 districts of West Bengal were stratified into 3 strata and besides these the 4th stratum is Calcutta. Two districts from each stratum were selected randomly. A sample of 197 schools (both boys and girls) was selected by SRSWOR. Visit to schools was started.

In the case of evaluation of content of Mathematics, question papers for the last ten years were taken up. The domain of School Final Mathematics was stratified according to curriculum given by the Board and each of these stratum was further divided into four categories. These categories were defined according to the nature of task involved in actual question items. Analysis of the results is in progress.

Repeated Measurements (SURDAC Funded)

The objective of the project was to determine significant variation of state anxiety, physiological and ecological data across 12 months in the Antarctica expedition. The following conclusions were drawn: (i) significant variations across months of item total correlations exist for only 12 out of 20 items of the Spielberger's state anxiety inventory; (ii) high and significant state anxiety profile similarity (using rp index) exists between logistic personnel and scientists; (iii) state anxiety scores of January, February, June and July (cluster I) were significantly more varied than scores of other months (cluster II) as evidenced by repeated measurement design (the clusters being obtained by hierarchical cluster analysis of the monthly data); and (iv) there are significant variations of the ecological variables (temperature, visibility, wind speed, station pressure).

Sociological Research Unit

Possibilities of Small -Scale and Cottage Industries and the Role of Caste Occupations in Birbhum District of West Bengal

Data collected in the "Survey of possibilities and problems of small-scale industries in the district of Birbhum, West Bengal", conducted by ISI during 1995-96, indicate an increase in income of the rural poor during the recent years as a result of implementation of land reforms and other factors. This has led to considerable increasse in demand for various types of consumer goods and services in the villages. Data also show an increase in estimated total number of enterprises in 1995-96 compared to the total number in 1990-91. On disaggregation of the over-all rate of increase of enterprises in the district, data indicate that two processes of growth are unfolding. One process is related to family enterprises, which are based on caste occupations, such as carpentry, smithy, pottery, processing of food items etc.

These are usually called "traditional rural enterprises". We would refer to them as traditional sector or "Sector T". The second process consists of certain new types of enterprises which have been established recently by families where 'caste' or family tradition has not played any major role. We can mention a few examples of this category, such as paddy husking mills, bakery, manufacturing of transistor/radio/electric heater as well as services provided by repairing of electric pumps, manufacturing of cement poles, chalk queries and stone crusheries. This sector of enterprises may be denoted as modern sector.

We have ascertained from our survey data that the rates of increase of the two sectors, i.e., T and M, during 1990-91 and 1995-96 are sharply different. It is 2.34 in case of Sector T and 11.04 for Sector M. Sector T has increased more or less at the same rate in all the Blocks of Birbhum district, while the increase of Sector M tends to vary from Block to Block.

With these background information, we may submit the following questions which we will seek to answer through field investigation. Do the family enterprises of Sector T, based on caste occupations, provide better economic security for certain types of small-scale and cottage industries in responding to the local market forces in a stable manner? Is the economic aspect of the caste structure - not the inter-marriage and inter-dining and other aspects--still needed to extend the required resilience in cases of certain traditional enterprises even in the present rural context of West Bengal? Sociological literature is saturated with studies on cultural and ritual aspects of caste, but its possible role in rural economic growth is yet to be investigated in depth. On the other hand, is the growth of small-scale industries in Sector M going to be sustainable? If so, what are the specific socio-economic factors which are providing this sector with optimum security independent of the traditional support of caste occupation?

We have indicated earlier that we will try to situate our investigation in the context of the impact of rising purchasing power of the peasants on the growth of small-scale and cottage industries in the district of Birbhum. We will, therefore, delimit the scope of our field work by selecting a few example of industrial enterprises, from both Sector T and Sector M, whose products are being regularly purchased by the villagers of Birbhum during the present decade. Field work has been completed. Final report writing is in progress.

Lab-Land Interaction : Experience and Potential of Experiments at the Agricultural Farm at Giridih

ISI Agricultural farm at Giridih develops and grows different varities of Paddy seeds under different combination of inputs in the form of water, manures/chemical fertilisers etc. The purpose of such experimentation has been to identify which variety of seeds under what combination of inputs provide better yield in which land situation : Tanr (upland), Baad (medium), Garha (low) and Ajan (semi-low). Seeds identified through the process are distributed to farmers in surrounding villages. Since the region is mostly rainfed, characterised by highly irregular distribution of rainfall and the farmers, predominantly small and marginal, resorting to subsistent monocropping (Kharif rice), the improved inputs derived from the experiments at the farm are likely to play an important role in the agricultural activities of the target farmers.

Briefly, the objectives are (a) to assess the degree of acceptability of the seeds supplied by the farm, vis-a-vis the socio-economic, eco-geological, motivational, capability (of providing supplementary inputs required) and other factors contributing to such responses, (b) to find out the impact of the adaptation of varieties supplied from the farm on the community of local farmers as well as their overall perception of any introduction of improved input packages; and (c) to find out the response of the scientists in the farm on the feedback from the land. Field is in progress.

Water Resource Utilization - a Social Ecological Study in Sunderban Area

The proposed project aims to investigate the level of disorganisation as well as resilience to recover and identify important factors adversely affecting the established ecological niche. It also intends to find out what is happening to those communities who were traditionality utilising local water resource as a consequnce of this ecological disruption.

This is an exploratory work, which will deal with the social, cultural, economic and ecological aspects of the populations who are utilizing the water resource in Sunderban areas. For the purpose of this study Sunderban (both forest and reclaimed areas) would be selected. At least 200 sample households will be selected for the purpose of the proposed study. Field work has been completed. Final report writing is in progress.

Impact of Closure of Mica Industries in and Around Giridih Town of Bihar: A Sociological Study

Agriculture in Giridih region is rainfed and mono-crop, mostly growing Kharif rice. Irregular nature of rainfall adds another serious hazard to this condition. In this situation, from our records, we find that large section of households in the villages around Giridih town combined agriculture with work in Mica and Coal industries for their survival. This has been continuing since the beginning of this century. For many agricultural households, Mica provided an important source of both employment and income which was used to meet family expenditure and also additional funds for improvment of agriculture, as and when necessary. This is observed to be particularly true for some middle/low castes who are middle/small or marginal farmers.

This market of Mica, however, remained mainly an international market. Due to a sharp fall in demand in international market, most of Mica industries have closed down their work during last few years and others are also in the process of closing their work.

In this context, the proposed project intends to investigate consequences of closure of Mica enterprises/agencies for Mica-related agricultural households, with a special emphasis upon how newly unemployed Mica workers are adjusting themselves -- migrating out or starting new occupation or going back to local agriculture; and its effect upon agricultural development.

It is also envisaged that the possibilities of revival of Mica industries would be ascertained from the industrialists as well as from the memorandum already submitted by different affiliated trade unions. Field work has been completed. Data Analysis is in progress.

Documenting Prasanta Chandra Mahalanobis's Literary Work on Rabindranath Tagore,

Compiling an Annotated Bibliography of Raja Rammohun Roy,

Editing the Correspondence of Edward Thompson and Rabindranath Tagore

Besides doing organizational and innovative research in the field of statistics, Professor P.C. Mahalanobis did signilficant literary work on Raja Rammohun Roy and Rabindranath Tagore. Indeed, he was Tagore's first bibliographer, and he was regularly analysing Tagore's ideas on humanism as well as on India's history tracing it back to the world of Rammohun Roy. Literary work of Professor Mahalanobis forms part of ISI archives. This part of the archives is being processed. Preparation has been made for press copies of some of this work. Four instalment has been published in DESH, a leading literary magazine in Bengal.

Collating the works of Raja Rammohun Roy, and works on him, and classifying these works under Political, Social and Religious Ideas is in progress. Editing the correspondence of Edward Thompson and Rabindranath Tagore is taking shape for publication in the near future. Edward Thompson wrote the first literary criticism of Rabindranath Tagore's work in the 1920s. His main resource for this work, besides the poet himself, was Prasanta Chandra Mahalanobis.

Interpersonal Contacts and Social Development: a Rural Experience in West Bengal

The process of data collection and analysis has been completed. Final report is being prepared.

The SURDAC Funded Inter-Disciplinary Project - "Changing Social Relations - Social Network Approach"

The study was undertaken in two villages of Birbhum district where comparable data are available from a similar study done during 1971-72. The major findings are (i) reciprocity has decreased significantly but connectedness has increased; (ii) demographic changes during the intervening period have not much affected the changes in patterns of social network; and (iii) the political and economic changes such as, land reforms, Panchayat, minor irrigations have contributed largely to induce the changes in social network relations. The pyramidal (hierarchical) social network structure of 1971 has broken down in the village, where the political economic changes have occurred strongly. It has been replaced by mini-pyramidal structures emerging from the groups in the lower rung of the village. The other village lacking any significant political-economic change, does not show any noticeable change in network relations.

Research and Other Activities of SRU, Giridih Branch

In the context of the broad theme of social transformation, SRU since 1958 has been effectively pursuing in Giridih research projects concerning the problems of urbanization, migration, dimensions of integration in rural life, inter-caste and inter-class relationship in Giridih and surrounding villages, controlled measurement of fertility, application of Mahalanobis's D^2 to social science data of intergroup relations, appraisal of households of stocks of handicraft and machine-made products in the village, exploration in Palamau area to measure the impact of development plans on the rural population, eco-systemic programme of work and agro-sociological collaborative study on rain-fed farming. Some of these investigations were taken up solely by SRU as TAC- DCSW approved projects; some others were recently carried out in collaboration with the Agricultural Science Unit, while a few other projects were funded by important external agencies approved by ISI and the Government of India.

A special initiative has been recently taken, to begin the task of computer processing of the huge socio-economic data collected and stored in Giridih since the days of pioneering field surveys of Professor Ramkirhsna Mukherjee, involving more than 1 lakh filled-in questionnaire schedules. This task was recommended by the ISI Council's Committee on Giridih, which was unanimously accepted by the ISI Council.

Statistical Quality Control and Operations Research Division

The basic objective of the Division is to propagate the use of SQC & OR and allied management techniques for improving quality, enhancing productivity, reduce manufacturing cost and losses in industries. This is realised through academic programmes, consultancy services, inplant and general training courses for industrial personnel, systems and software development, organising conferences, seminars & research in the methods and procedures of quality control, operational research and allied techniques. The Institute which was made a permanent member of the *Quality Council of India* in recognition of its pioneering role and rich contributions in country wide quality movement is also representing in the National Accredation Board for Auditing and Training (NABAT).

The Division is running a two-year professional programme, M.Tech (QR & OR), at ISI, Calcutta and Part-time Certificate Courses in SQC at Bangalore, Hyderabad and Chennai. The division also provides faculty support for the SQC & OR Specialisation in the IInd Yr. Of the M.Stat programme conducted by the Institute. Besides, the faculty members of the division participates in teaching for B. Stat, M.Stat (I Yr.), part-time evening course in Statistical Methods and Applications at New Delhi and Calcutta and training programme conducted by International Statistical Education Centre. The Division also assists other Institutes and Universities for conducting their academic programmes. The Division also offers a Specialist Development Programme (SDP) to provide career in industry through on the job training and guided development.

Consultancy Services

The Division has earned a reputation for providing consultancy services in all areas of Quality Management and Productivity.At present 136 organisations throughout the country are taking services of the Division.Besides this, the division has assisted a good number of organisations in developing and implementing quality system based on ISO 9000 series & QS 9000 quality management standard & ISO 4000 environmental management standard. Division carried out quality system audit for a number of organisations in India and abroad.

The Division has embarked on promoting Quality Management and related activities in SAARC and other countries. A Cell for Export of Consultancy has been formed at Calcutta. The Cell carried out a project in a transport organisation in OMAN. Projects have been taken up in Mexico and Iran. The Division is continuing with QS 9000 Surveillance Audit for organisations in Malaysia, Phillippines and Thailand. As advised by Dr. Bimal Jalan, Chairman, ISI five organisations in Srilanka, Mauritius and USA were contacted. A meeting was held with the Business Advisory Service of Dacca, Bangaldesh. The faculty members of the Division have spent 70 mandays abroad for consultancy work during the year.

Quality Improvement Projects Highlights

The Division carried out a number of projects (Plan projects as well as externally funded projects). Some of them are listed below :

The Food Corporation of India stores in its different godowns spread all over India food grains amounting to Rs. 33,000 crores at any given time point. The Division has been entrusted with the important project on Physical Verification of this huge Stock on Sampling basis. Prof. S.B. Rao, Director, is involved in this project as an Advisor.

The project on 'Enumeration of mail through sample survey in Delhi and West Bengal, Dept. of Posts, Ministry of Communication, Govt. of India' was completed and the report submitted to the Dept. of Posts.

The external project given by MCL (Coal India) on 'Developing longtime profitable strategy of coal supply to HNPCC power plant from Mahanadi Coal field' was completed in collaboration with other scientists of the Institute and a simulation model along with the computer package was handed over to Coal India.

A project on 'Data Analysis of Proficiency Testing Programme' covering about 125 laboratories from 30 countries sponsored by NABL, Dept. of Science & Technology, New Delhi was taken up.

A project on 'Estimation of Warranty Costs' sponsored by Hero Motors Ltd., Dujana, Distt. Ghaziabad was taken up.

The plan Project on 'Quality Status in Service Sector' was carried out by SQC & OR Unit, Delhi. The survey has been completed and data is being analysed.

The project on 'A Quality Approach to Manpower Planning' was carried out by SQC & OR Unit, Baroda for ORG-MARG Research Ltd.

An innovative study was carried out by SQC & OR Unit, Baroda on Improvement of Gauge R & R for Important Dimensions of Radiator Components.

A Project on Verifying the Methodology to Project Future Profitability for Newspaper Industry was carried out jointly by SQC & OR Units, Chennai and Hyderabad.

A plan project titled Developing a Model for Application of Statistical Methodology for Quality Improvement in Small Scale Industry through a Survey which was taken up in 1998-99 was continued during the year.

The SQC & OR Unit, Calcutta conducted a Commuter Survey of Calcutta Metro Rail to know the perceptions of commuters. This study has helped in a great way in improvement of the services of the Metro Rail.

The SQC & OR Unit, Calcutta carried out a project on 'Implementation of a Quality Management System in Line with ISO 9002' for Britania Industry Ltd., Calcutta.

The SQC & OR Unit, Coimbatore has developed one textile unit for producing '100% Cotton Fashion Yarn Through Fibre Dyeing' at reduced cost by 5 US Cents for every Kg of production.

The SQC & OR Unit, Coimbatore developed 100% Cotton Stretch Yarn (Value-added Product) for infant uses using synthetic Lycra (DUPONT) for a the textile unit through various twist studies.

A new scheme of Income Sharing for Externally Funded (ISEF) Projects has been introduced wherein 25% of the earnings of a project is distributed to the team members of the project. The purpose of the scheme is to encourage faculty members to take up more externally funded projects. During the year 16 ISEF projects have been sanctioned.

Quality Mission Project (QMP)

The Quality Mission Project entered in its seventh year. A fresh batch of 9 Quality Mission Executives (VI Batch) has been recruited during the current year and three months orientation programme for them was completed. These QMEs, have now been posted to different SQC & OR Units. With the fresh batch included the total number of Quality Mission Executives was 17 as on 31.03.2000.

For the first time, the three months orientation programme was made available to fresh candidates without the required experience for recruitment as QMEs. 4 Graduate Engineers have utilised this opportunity of undergoing this programme by paying the prescribed fee.

The Quality Mission Executives have been deployed in new types of projects. They have assisted in developing and in implementing ISO 9000 Quality Management Systems in Marma-Goa Trust, ORG Marg, Market Research Organisation, Garment and Textile Industries, Chemical, Fabrication, Process and other Engineering industries, including Children Playfield equipments. QMEs have also assisted in implementation of QS 9000 Quality Management Systems. A special training programme was organised for Small Scale Industries in collaboration with National Institute of Small Industries under Quality Mission Project.

7 in-plant training programmes have been organised with the assistance of Quality Mission Executives. 540 mandays were spent in consultancy and training programmes by the Quality Mission Executives.

One paper was presented by Quality Mission Executive jointly with a Technical Officer and was presented in Industry sessions of International Conference on Operations Research and Game Theory organised by SQC & OR Division of the Institute.

Millennium Measure

The Division has identified the following focus areas for the new millennium :

(a) to expand its activities in the Software and IT industries. A research project on 'Developing a measure for overall Performance Quality of a Software Industry' is already on.

(b) to apply modern management techniques in Service Sectors for measuring and improving its performance.

(c) to popularise the use of Statistical Concepts of Design of Experiments in CSIR laboratories for conducting laboratory and plant scale experiments.

(d) to organise an International Conference on TQM.

(e) to extend the activities of the Institute in relatively neglected North Eastern regions and to conduct collaborative studies with different universities and agencies in the region.

An ISI team visited Guwahati during 5-8 March, 2000. The Chief Minister of Assam was pursuaded to provide a suitable piece of land at Guwahati to start a new SQC & OR Unit at Guwahati.

Training Programmes

One hundred and sixty tailor-made in-house specific programmes were organised for different organisations during the year. Sixteen short term general training programmes on Statistical Process Control, Design of Experiments, TQM, ISO 9000, QFD, FMEA, Reliability etc. were organised. . Appreciation and motivational programmes were also conducted for workers in regional languages for some organisations. A six month part time special training programme on Statistical Methods in Industry and Applications was organised by SQC & OR Unit, Chennai in Sundaram Clayton. A six month correspondance course on SQC in Manufacturing was launched in October, 1999 by SQC & OR Unit, Baroda. Twelve special programmes on Six Sigma Implementation were organised in GE Electricals Operations Inc., and TELCO by SQC & OR Unit, Delhi. A general training programme on Statistical Techniques for ISO 9000 and QS 9000 was organised by SQC & OR Unit, Delhi. Dr. Manmohan Singh, Ex-Fianace Minister, Govt. of India addressed the participants and distributed the certificates.

The extent of consultancy, inplant and general training programmes are summarised below :

(i)	Number of Industrial units served	136
(ii)	General Programmes	
	Number of programmes	45
	Number of participants	246
(iii)	Inplant programmes	
	Number of programmes	160
	Number of participants	3236

(iv) Number of Seminar talks 37

(v) Number of promotional visits 129

A list of inplant and general programmes organised by the Divison for Engineers, Senior and Junior Executives, Managers, R&D Personnel, Supervisors and Operators are given below.

Inplant Training Programme

Sl. No.	Title of the Programme	Duration	Name of the Organisation	No. of Participants
1.	Statistical Process Control	April 1999	Hindustan Packaging Co. Ltd., Itola (Senior)	25
2.	Statistical Techniques For ISO 9000	April 1999	Elecon Engineering Co. Ltd. Anand (Junior management)	30
3.	Refresher Programme for 1 year trained engineers	April 1999	Bharat Heavy Electricals Ltd.	27
4.	Mistake Proofing	April 1999	Ashok Leyland Limited	30
5.	Application of Statistical Method	April 1999	Supercoat Industries	6
6.	QS 9000 for the Managers & Executives	April 1999	Hindustan Motors Limited	50
7.	SPC	April 1999	Viraj Alloys Ltd.	20
8.	Programme on Statistics	April 1999	Dte. Of Economics & Statistics, Hyderabad	25
9.	SQC/SPC Techniques	April 1999	Indian Aluminium Co. Ltd Muri	25
10.	QS 9000 & Six Sigma Quality	April–May'99	Satyam Computers	16
11.	QS 9000 Quality System Standards	May 1999	Dr. Ambedkar Institute Of Productivity	20
12.	SQC & SPC Techniques	May 1999	BPL Display Devices Ltd.	25
13.	SQC/SPC Techniques	May 1999	Chittaranjan Hocomotive Works (Ply)	4
14.	Statistical Process Control	June 1999	Tata Chemicals Ltd. Mithapur	35
15.	Design of Expts.	June 1999	J.K. Files & Tools	25
16.	Basic QC Tools and SPC Fundaments	June 1999	Indian Natural Medical Products	5
17.	Six Sigma (Phase I)	June 1999	TELCO, Lucknow	25
18.	SQC/SPC Techniques	June 1999	Indian Aluminium Co. Belgaum	15
19.	Basic Statistics, Measurement System Analysis & Process Capability Analysis	June-July' 99	Hydraulics Limited	13
20.	Six Sigma (Phase I)	June– July'99	TELCO, Jamsehedpur	25
21.	SPC using Minitab	July 1999	L&T Cements, Awarpur Cement Unit, Maharashtra	20
22.	Six Sigma (Phase I)	July 1999	GE Lighting (I) Ltd.	75
23.	Statistical Process Control	July 1999	Hindustan Packaging Co. Ltd. Itola	30
24.	TOPS – 8D	July 1999	Banco Products (India) Ltd. Baroda	20

25.	TOPS – 8D	July 1999	Banco Products (India) Ltd. Baroda	30
26.	SPC	July 1999	Gabriel India Ltd.	23
27.	Statistical Methods in Industry	July-Dec'99	Sundaram Clayton Ltd	25
28.	Six Sigma (Phase II)	August 1999	TELCO, Jamshedpur	40
29.	Six Sigma (Phase II)	August 1999	TELCO, Lucknow	25
30.	Statistical Process Control	August 1999	Ester Industries Ltd. Khatima	28
31.	SPC using Minitab	August 1999	L&T Cements, Hirmi, M.P.	15
32.	ISO 9000 Awareness	August 1999	M/s Mikroflo Filters Ltd.	7
33.	Six Sigma (Phase II)	Aug-Sep'99	GE Lighting (I) Ltd., Ahmedabad	75
34.	Statistical Techniques For ISO 9000	September'99	ORG-MARG Research Ltd. Baroda	35
35.	Six Sigma for Business Benefits	September'99	Larsen & Toubro Ltd.	26
36.	Basic of Quality Control	September'99	Shasun Chemicals & Drugs Limited	15
37.	Six Sigma (Phase II)	September'99	TELCO, Jamshedpur	40
38.	Statistical Process Control	September'99	Ester Industries Ltd., Khatima	27
39.	SQC & Statistical Process Control	September'99	ITI Limited, Rae Bareli	28
40.	Six Sigma (Phase III)	Sep-Oct'99	GE Lighting (I) Ltd., Ahmedabad	30
41.	Six Sigma Quality	October'99	Lear Seating Pvt. Ltd. Halol	15
42.	SPC for Software	October'99	Silverline Industries Ltd.	25
43.	Design & Analysis of Experiments	October'99	Dr. Reddy's Research Foundation, Hyderabad	20
44.	Six Sigma (Phase III)	October'99	GE Lighting (I) Ltd., Ahmedabad	30
45.	SQC & Statistical Process Control	October'99	ITI Ltd., Naini Plant, Allahabad	26
46.	Reliability Engineering for Executives & Engineers	October'99	TVS Electronics Ltd.	22
47.	ISO 9000 Awareness	October'99	M/s Mikroflo Filters Ltd.	45
48.	Advanced Statistical Tools (Phase I)	November'99	TVS Electronics Ltd.	19
49.	FMEA	November'99	JK Files & Tools	20
50	Six Sigma for Business Benefits	November'99	Larsen Toubro Ltd.	30
51.	ISO 9000 Awareness (Telugu)	November'99	M/s Mikroflo Filters Ltd.	110
52.	Internal Quality Audit	November'99		20
53.	On-line Control Charts	November'99		20
54.	Sampling Schemes	November'99		20
55.	SQC/SPC	November'99	Ichapure Rifle Factory	25
56.	Six Sigma (Phase III)	November'99	TELCO, Lucknow	30
57.	Six Sigma (Phase II)	November'99	GE (IOC) Inc.	25
58.	On Quality Costs	November'99	ITI Limited, Mankapur Plant	24
59.	Advanced Statistical Tools (Phase II)	December'99	TVS Electronics Limited	19
60.	Top Management Seminar on Six Sigma Quality	December'99	Godrej Sara-lee	31
61.	SQC/SPC Techniques	December'99	India Foils Ltd.	30
62.	Six Sigma Implementation Programme	January'2000	Godrej Sara-lee	28

63.	Six Sigma Implementation Programme	Feb' 2000	Godrej Sara-lee	28
64.	Advanced Statistical Tools (Phase III)	Feb'2000	TVS Electronics Ltd.	15
65.	Internal Audit Programme	Feb'2000	M/s Hyquip Rotoloc Pvt. Ltd.	14
66.	Basic Statistical Techniques for Type Setting Operations	March'2000	Thomson Press (India) Limited	10
67.	Workshop on FMEA & MSA	March'2000	ACMA	25
68.	SPC (2 programmes)	———	Ordnance Factory, Ambarnath	46
69.	SPC (4 programmes)	———	Tata SSL Ltd.	72

General Training Programme

Sl. No.	Title of the Programme	Duration	Place	No. of Participants
1.	SPC	15-16 April 1999	Mumbai	3
2.	Vendor Quality Management	25-26 June 1999	Hotel Sayaji, Baroda	
3.	Road Map for Imlementating ISO 9000 Q.S.	5 June 1999	Mumbai	4
4.	Experimentation for Product And Process Robustification	20-22 July 1999	Hotel Sayaji, Baroda	4
5.	Six Sigma for Business Benefits	4-5 August 1999	Mumbai	15
6.	Six Sigma for Business Benefits	20-21 Sept.'1999	Mumabi	28
7.	Statistical Techniques for ISO 9000 & QS 9000	23-25 Sept.'1999	ISI, New Delhi	41
8.	Measurement Process Control	5 October 1999	Hotel Sayaji, Baroda	8
9.	Six Sigma Quality	25 November 1999	Hotel Sayaji, Baroda	25
10.	Applied Statistical Method-A Software Oriented Approach	1-6 November 1999	Mumbai	15
11.	On Quality Costs	12 November 1999	ITI, Delhi	26
	Senior Management Seminar	25 November 1999	ISI, New Delhi	33
12.	Six Sigma for Business Benefits	21-22 January 2000	Mumbai	11
13.	Statistical Process Control	9-11 February 2000	Mumbai	7
14.	Six Sigma for Business Benefits	18-19 Feb' 2000	Mumbai	4

A partial list of factories served under the consultancy programmes are given below :

Coates of India Ltd., Tata SSL Ltd., Godrej Saralee Ltd., WIMCO Ltd. (Ambarnath), Technova Imaging Systems Ltd, Dr. Reddy's Research Foundation, Hyquip Rotaloc Pvt. Ltd., Mikroflo Filters Pvt. Ltd., Vam Organics Ltd., B.P.L. Ltd., GE International Corpn., GE Lighting Ltd., GE Medsystems Ltd., TELCO Ltd. (Lucknow), TELCO Ltd. (Jamshedpur), TELCO Ltd. (Pune), Ester Industries, I.T.I Ltd (RaeBareli), I.T.I. Ltd., (Mankapur), I.T.I. Ltd. (Naini) Food Corporation of India, Thomson Press (I) Ltd., Hero Motors Ltd. (Ghaziabad), Indian Aluminium Co. Ltd. (Belgaum, Karnataka), Indian Aluminium Co. Ltd. (Hirakud, Orissa), Indian Aluminium Co. Ltd. (Taloja, Maharastra), Indian Aluminium Co. Ltd. (Kalwa,

Bombay), Indian Aluminium Co. Ltd. (Belur), India Foils Ltd. (Kamarhati), India Foils Ltd. (Hoera), India Foils Ltd. (Taratala), Hindustan Motors Limited (Tiruvellore), Hydraulics Limited (Hosur), Exide Industries (Chennai), Lucas TVS Limited (Chennai), Enfield India Limited (Chennai), Bharat Heavy Electricals Limited (Chennai), Ashok Leyland Limited (Hosur), Supercoat Industries (Chennai), Satyam Renaissance Consulting Limited (Chennai), Sundaram Clayton Limited (Chennai), Indian Natural Medical Products Private Limited, Sam Consultancy Services Private Limited, Shasun Chemicals & Drugs Limited (Cuddalore), TVS Electronics Limited (Chennai), Godrej Sara-Lee Limited (Pondicherry), Thomson Press (India) Limited (Chennai), Rajaplayam Mills (RJM), Sudharsanam Spg. Mills (RJM), Sri Vishnu Shankar Mills (RJM), Sambandam Spg. (Salem), Kandagiri Spg. (Salem), Mallur Siddeswara Spg. Mills, Sangeeth Textiles (Annur), Durairaj Mills (Pasur), Palani Andavar C.S (Udumal), Medallion Knitwear (CBE), Divyar Garments (Palladam), Sri Amman Mineral Water (CBE), SITRA, Design Garden, Banco Products (India) Ltd. (Baroda), ORG-MARG Research Ltd. (Baroda), Tata Chemicals Ltd. (Mithapur), Hindustan Packaging Co. Ltd. (Itola), Elecon Eingineering Co. Ltd. (Anand), Gujarat State Fertilizers & Chemicals Co. Ltd. (Baroda), Gujarat Machivery Manufacturing Co. Ltd. (Anand), Gujarat Cycles Ltd. (Waghodia), Wipro Consumer Products Ltd. (Amalner), RHW India Ltd. (Bangalore), WIPRO Fluid Power (Bangalore), WIPRON Supportdivision (Bangalore), IFB Autoliv (Bangalore), Motorola, HMT Bearings Ltd. (Hyderabad), HMT Die Casting Division (Bangalore), Stumpp Smuele & Somappa Ltd. (Bangalore), J. K. Tyres (Delhi), Grasim Industries (Harhar), Indal (Nanjangud), I.F.B. Ltd. (Bangalore), NVT-QC (Bangalore),Hwelet Packard Ltd. (Bangalore), Hewlet Packard Ltd. (Bangalore), BHEL – EPD (Bangalore), BHEL EDN (Bangalore), HICAL Magnetics (Bangalore), Centum Electronics (Bangalore), OTO Bilz Ltd. (Doddaballapur), Hnchon Helios (I) Ltd. (Bangalore), TVS-Suzuki (Hosur), Cosmos- Tumkur, MOR Mugoa Port Trust (Goa), Kavosh Company (Iran), Kirloskar Institute of Advance Mgt. Studies (Harihar), Grindwell Norton, Bhel, EDN, Kar Mobiles, Thermax Ltd. (Pune), BEML, Citicorp, India Meters (Hosur, Bangalore), Institute Wood Scince & Tech. (Bangalore), Max Pharma, CICB

Research Activities

The research activities of the Division covered areas like Linear Complementarity Problem (LCP) and its Generalisation (Vertical LCP, Horizontal LCP, Extended LCP, GOLCP etc.); Non-smooth optimization; Study and Development of some special classes of Matrices useful in LCP and Game Theory; Cooperative Games, Non-cooperative Games and Stochastic Games; Integer Programming and associated Matrix Classes; Generalised Convexity; Symmetrical Travelling Salesman Problem; Component Importance in a Consecutive k-out-of-n System; Scheduling – Variance Minimisation; Software Reliability; and Construction and Combinatorial Problems in Design of Experimentation and Taguchi Methods. During the year 16 papers of published, 7 papers were accepted for publication and 17 papers were sent for publication in journal. 24 papers were presented in conferences. In addition to this a number of technical reports were prepared.

Other Activities

Conference /Seminars

The Division organised the Third International Conference on Operations Research and Games Theory during January 3-7, 2000 at IIT, Chennai. About hundred and twenty delegates both from India and abroad participated and shared their experiences. Dr. S. B. Rao, Director, ISI delivered the Presidential address and Director, IIT delivered the inaugural address. Several eminent personalities like Dr. David Gale, Dr. Chandrasekaran, Dr. J. F. Mertens, Dr. K. Kikuta, Dr. M.L. Petit etc. participated in the conference. The most important aspect was that the conference brought together experts from industry and academia. The focus areas includes various topics like Mathematical Programming, Stochastic models in Operations Research, Cooperative and noncooperative game theory, Nonsmooth optimization, statistical decision theory and Industrial/economic applications. There were three parallel sessions on the above mentioned topics in most of the days. Several state-of-the-art lectures were also arranged for Game theory, Reliability, Matching Problem, Integer Programming and Six Sigma Quality.

Multimedia Project

This project is undertaken with the main objective of developing teacherless interactive training modules on Quality Management and related topics. This project was initiated in 1998 and continued during this year.

Summer School

A Summer School on Design of Experiments was conducted at ISI, Calcutta during 06-18 February, 2000. Twenty six participants from different universities and research institutions, engineering and technological institution and CSIR participated in the programme. The programme generated interest and appreciation among the participants. As an aftermath, the Central Fuel Research Institute, has a agreed to organise a similar in-house programe to be conducted by the Division at Dhanbad.

Newsletter

The Division is publishing a Newsletter quarterly incorporating various important events and activities of the Division, articles in Quality Management and related areas, book reviews and significant contributions in the field of Quality. The circulation of the Newsletter has gone upto 5000 copies per quarter.

Staff Development Programme

A six days staff development programme on Computer Awareness was organised at ISI, Delhi during 14-19 February 2000 with active cooperation of Dr. Debashis Sengupta (ASU) and Dr. Aditya Bagchi (CSSC) of the Institute. 26 participants (Faculty members and QME, Students) attended the programme.

21 faculty members attended the programme on Blue Prints for Success organised by Shri Shiv Khera at different cities in the country. Additionally training programmes on e-commerce, Capability and Maturity Model for software and ISO 9000 Lead Assessor Programme (FICCI) were organised for staff members.

Library, Documentation and Information Science Division

Documentation Research and Training Centre (DRTC), Bangalore

The DRTC regularly conducts a course of 24 months duration leading to the award "Associateship in Documentation and Information Science' (ADIS). This award is recognised by the Govt. of India and several other universities, such as equivalent to Master's Degree in Library and Information Science.

Apart from the research, teaching and training activities, DRTC also has the following programmes : (i) Advisory services programme, (ii) Publication programme, (iii) Employment information programme, (iv) Continuing educational and training pogramme and (v) Faculty development programme.

Research Activities

The main areas of research in which the different memebrs of the DRTC Faculty were engaged during the period, April 1997-2000, (i) The study of various methods of knowledge representation, such as, semantic nets, frames, and predicate calculus, etc. (ii) The application of the "Modern scientific management techniques to the planning and management of information system, centers and services (iii) The study of the methodologies of information analysis and consolidation (iv)The development of bibliometric and scientometric measures for evaluating the use of library and information services and scientific out put respectively (v) The preparation of guidelines and actual development of software and application packages for library house keeping operations, such as, circulation control service control and acquisition control.

Projects Undertaken

Although, the following projects were sanctioned :

(i) Compilation of Internet Information Resources
(ii) Scientomerics

Due to lack of manpower, projects could not be carried out.

Library (Calcutta)

With the addition of 1349 books and 707 bound journals to the stock, the total collection of the Library rose to 2,13,258.

Acquisition Unit

The Unit accessioned 1349 books during the period under report out of which 1042 books were purchased and 307 books were received on complimentary basis. Out of 1042 purchased books, 170 books were funded by NBHM. The Unit sent 1370 books to Technical Processing Unit during the period. The Unit accessioned 328 books of different projects.

Periodicals Unit

The Unit received 3131 loose journals and 707 bound journals, placed orders for 448 titles for 2000-2001, processed bills for the year, made 3131 kardex entries for loose journals and newspaper, accessioned 707 journals, catalogued 886 journals, classified 25 titles, and prepared 2,658 catalogue cards out of which 1,772 cards were filed. The Unit processed 1,200 journals for binding, 1809 journals were issued and 1,850 journals were received back and 3700 journals processed and issued for Xeroxing. The Unit prepared 48 list/bulletins and sent 100 reminders for non-receipt of journals , invoices, and related matter. Computer inputting was done for ordering, billing and other jobs.

Circulation & Stack Maintenance Unit

The Unit issued 63,952 books and journals to the users on loan and references. The total membership of the Library was 1,819 which includes ISI staff, Research Scholars, Project Assistants, B.Stat. & M.Stat. students, ISEC Trainee etc. as well as outside students and institute members. 1,395 readers were given special permission to use the Library for a short period. 102 books and journals were borrowed from other libraries and 95 books and journals were loaned to other libraries under the inter-library loan arrangement. The Unit processed 1,897 books for binding and 14 books for lamination and de-acidification from the rare collection, photocopied 13 of out of print rare and mutilated books, fumigated 472 books, Bar-coded 8,165 books approx. during the period under report.

Reports & Records Unit

The Unit processed 290 titles, 695 titles were issued to users for reference. Four hundred volumes were sent for binding, and 900 catalogue cards were typed.

Circulating Library

The Workers' Circulating Library acquired 342 new titles bringing the total collection to 37,059. It issued 2,400 books to the members.

Technical Processing Unit

The Unit classified and catalogued 1707 new books and developed the database in OPAC on LIBSYS following CCF data structure. The database is searchable by author, title, series, class no. and keywords/subjects. The Unit issued 12 issues of current addition to the Library. printed 11,949 computer cards have been filed.

Documentation Unit

The Unit has been issuing current contents list services to the users on the following group of subjects: (i) Statistics and Mathematics, (ii) Electronics and Communications Science, (iii) Geology, (iv) Life Science, (v) Economics, (vi) Recent additions of books to the ISI Library. A total number of 63 requests for photocopies were sent against specific request across the country.

Reprography & Photography Unit

The Unit provided 6,57,607 Xerox prints to the users. 2,770 photographic enlargements were made during the period. 2,06,045 pages of off-set prints and 1,206 frames of lecture slides and computer output colour print 1,082 pages were made during the period.

Projects Undertaken

Development of Computerised Catalogue in ISI Library, Calcutta has been completed during this financial year. Approximately 1,04,000 of retrospective collection of books has been entered into computer through "LIBSYS" package and edited.

North-Eastern Region NBHM Collection : The Library received Rs. 15 lakhs from National Board of Higher Mathematics for development its collection (Books and Journals) in the areas of Mathematics, Applied Mathematics, Statistics, and Theoretical Computer Sciences. A Consortium has also been formed with the Universities and Institutions of North-Eastern Region for accessing on-line database of the Mathematical Review with the support of the National Board of Higher Mathematics. The Chief Librarian is acting as Coordinator to the Consortium.

Electronic Library

In addition to Math Sc. That (Mathematical Review as line) the library has subscribed Econlit on-line services. Steps has been taken to develop electronic collection in CD-ROMs.

Library (Delhi)

Acquisition

The Library with its holdings of 36973 volumes of books and periodicals, caters mainly to the needs of bonafide students, scholars and academic staff members of the Institute. However, it is also open for reference to academic and research users of other educational and scientific institutions of the city and its neighbouring regions.

During the above period, 553 new books have been added to the stock. 260 purchased under NBHM grant, 219 purchased from ISI funds and 74 received as gift from various sources.

Periodicals

During the above period, Library subscribed to 245 titles of journals, both foreign as well as Indian, out of which 140 are exclusively Mathematics and Statistics titles.

In addition to the above 9 journals are being received under an exchange program established with some of the scientific institutions in the regions of China, Korea, Netherlands, Poland, Spain and Vietnam for getting their publications in exchange for our journal sankhya.

17 journals, both Indian as well as foreign are being received as Gift from various sources.

467 sets of loose issues of periodicals duly bound have been added to the stock.

Approximately 200 Technical Reports/Discussion Papers in Economics have been received in the library during the above period, in exchange to ISI Delhi Centre Discussion Papers.

From this year onwards, Delhi Centre Library has taken an online subscription to Mathematical Reviews, by joining an Eastern Region consortium and getting an access to "MathScinet". As a result all the users here now have an access to the full text of all AMS journal articles.

Delhi Centre has also taken academic membership of the "Society for Industrial and Applied Mathematics", and has got an online access to all the SIAM journals and can now download full text of journal articles. In addition to it, will get 20 % discount on all SIAM books, plus 30% discount will be given on three additional subscriptions to the journals.

Circulation

During the period April 1999 to March 2000, 180 members availed lending facilities as permanent members, 625 members availed reference facilities as temporary members. More than 7520 publications were circulated among members, 23 publications were borrowed on Inter Library Loan from neighbouring Institutes and 22 publications were lent out under the said program.

Reprographic Services

Reprographic services are being provided to the users, internal as well as external, as and when asked for.

More than 49870 photocopies were made during the period. 34523 photocopies were provided to the internal members of the library, whereas 15348 photocopies were provided to the external members on a nominal charge of Rs.0 – 50p. per page.

Other Activities

Since 1994, Delhi Centre Library has been designated as "Regional Library" by the National Board for Higher Mathematics, Department of Atomic Energy, Government of India, to serve the academic users of the Northern Region. Under the scheme, funds are being provided by NBHM for maintaining and developing library resources in the fields of Mathematics and Statistics. To keep the academic users of the Northern Region informed, Delhi Centre Library is bringing out a monthly issue of the "Current Contents" by photocopying the contents of Statistics and Mathematics journals received in the library and sending the same to the various "Departments of Mathematics".

All the activities of the library have been fully automated by getting "LIBSYS" library automation package installed. The system is under LAN. All the users have been given an access to the data through "Online Public Access Catalogue". For the users, away from the campus who cannot view the data thru LAN, a Web Page has been created on the net. All the journals with its holdings have been put. On the said Page. A "Search Engine" has also been made to help the users for retreiving the information easily with any keyword, author, title, or publisher.

For resource sharing with Social Science Institutions, combined efforts are on way, for creating a Union Catalogue on the web.

Library (Bangalore)

Acquisition

During the above period 430 books were added to the library by purchase, 150 were received on gratis.

Stock position : The total stock position as on 31st March 2000 is as follows : Books 15917, Books on gratis 1298, Bound volume of periodicals 8829, No. of periodical subscribed 240, No. of periodical received on gratis 23.

Technical Processing

About 400 books were classified and catalogued during the period.

Circulation Statistics

During the period library facilities were enjoyed by 500 users. 310 of them availed lending facilities. 8 visiting professors of different units of ISI were also provided with lending facilities. A total of about 151000 books and periodicals (including loose issues) circulated by the library. The in-house use of books and periodicals were around 45000. About 65 inter library loan transactions were registered.

The membership includes ISI staff, Research Scholars, Project Asst., M. Stat students M.-Tech students, SDP fellows, DRTC students, Trainees of DRTC short term courses etc.

Inter Library Loan Service

Inter library loan facilities were availed by the ISIBC library users from the local library : (i) British Library, (ii) Indian Institute of Management, Bangalore, (iii) Indian Institute of Science, Bangalore, (iv) Tata Institute of Fundamental Research, Bangalore.

Indian Statistical Institute, Bangalore Centre library extends inter library loan facility to : (i) Indian Institute of Science, (ii) Tata Institute of Fundamental Research, Bangalore.

Reprographic Service

Library provided 110000 Xerox copies to the users during the period April 1999 to March 2000.

Documentation Service

The following publications were broughtout regularly from the library : (i) Bimonthly list of books, (ii) Monthly list of current periodicals, (iii) Current content of journals, (iv) Online Public Access Catalogue (OPAC).

Computer and Statistical Service Centre

The Computer & Statistical Service Centre (CSSC) manages the central computing facilities of the institute at Calcutta. The Campuswide newtwork and INTERNET facility at Calcutta are also managed by CSSC. The bandwidth of Radio Link for INTERNET connection has been increased to 512 kbps from 128 kbps. It serves about 500 users including students, research scholars and scientific workers with inhouse computer systems SUN E 3000 Server, Six SUN ULTRA 30 workstations, DEC Alpha 4100 Server , IBM AS-400 Server

and 55 PCs. SAS, BMDP, NAG, IMSL, SHAZAM , TSP, Matlab, and Mathemetica softwares are available on SUN E 3000 Server.

Installation of Compuswide Networking has been completed during the year. Two SUN ULTRA-10 , two SGI O2 and three SGI 540 visual workstations have been acquired and installed in different units as departmental servers. Four Laser Printers have been acquired and installed in different hostels of the institute.

CSSC is actively involved in the implementation of accounting softwares at ISI. Statistical and Computational services are provided by CSSC. Six external scientists were provided statistical services by CSSC during the year.

Training Programme for the Administrative workers of the Institute has been organised by CSSC during the year.

CSSC staff members served as faculty in the training programme organised by SQC for their Technical Officers. The computers facility for the training programme was provided by CSSC.

Like all other years, the staff members of CSSC have served as faculty in various courses of the institute and supervised dissertation carried out by the students. The staff members of CSSC are also involved in research covering the areas like database and knowledge bases, image processing, computational geometry and Cryptology.

3. EXTERNALLY FUNDED PROJECTS

Ongoing Projects

1. Name of the Project : Martingale Problems, Markov Process and Their Applications to Filtering and Control Theory
Principal Investigator : R. L. Karandikar
Unit involved : Statistics-Mathematics, Delhi
Funded by : Department of Science and Technology, Govt. of India

2. Name of the Project : Statistical Expert Opinion on a Contractual Dispute Between Gujrat Electricity Board and South Eastern Coalfield Ltd
Principal Investigator : R. L. Karandikar
Unit involved : Statistics-Mathematics, Delhi
Funded by : Multiplex Trading and Industrial Company Ltd., Delhi

3. Name of the Project : E_0–semigroups and Dilation Theory (INSA – Young Scientist Project)
Name of the Coordinator : B.V. Rajarama Bhat
Unit involved : Statistics-Mathematics, Bangalore
Funded by : Indian National Science Academy

4. Name of the Project : Geometric Invariants of Quotients of Hilbert Modules
Name of the Coordinator : Gadadhar Misra
Unit involved : Statistics-Mathematics, Bangalore
Funded by : National Board for Higher Mathematics

5. Name of the Project : Software Development for Cryptanalysis
Name of the Project Leader : Bimal Kumar Roy
Unit involved : Applied Statistics
Funded by : Defence Research and Development Organisation

6. Name of the Project : Audit Sampling
Name of the Project Leader : Arijit Chaudhuri
Unit involved : Applied Statistics
Funded by : Govt. of West Bengal

7. Name of the Project : Compilation and Optimization for Reconfigurable Co-Processors
Name of the Coordinators : B.B. Bhattacharya, B.P. Sinha, Susmita Sur-Kolay and S. Rajopadhye
Unit involved : Advanced Computing & Microelectronics
Funded by : Indo-French Centre for the Promotion of Advanced Research

8. Name of the Project : Speech Synthesis in South Indian Languages for Application to the Blind and Speech Output for Machine Translation
Name of the Chief Investigators : B.B. Chaudhuri and V.I. Subramoniam
Unit involved : Computer Vision and Pattern Recognition and ISDL
Funded By : Department of Science and Technology, Govt. of India.

9. Name of the Project : Bilingual (Bangla and Devnagari) OCR System Development
Principal Investigator : B.B. Chaudhuri
Co-investigator : S.K. Parui
Unit involved : Computer Vision and Pattern Recognition
Funded by : Department of Science and Technology, New Delhi.

10. Name of the Project : Development of a Spell Checker and Morphological Process in an Indian Language with Speech Output for the Blind
Principal investigator : B.B. Chaudhuri
Co-investigator : P. Sengupta
Unit involved : Computer Vision and Pattern Recognition
Funded by : Department of Electronics, New Delhi.

11. Name of the Project : Application of Fractal and Multi-fractal Technique in the Processing of Atmospheric Data Images
Principal Investigator : Jyotirmay Das
Co-Principal Investigators : Arun K. De and Dipti Prasad Mukherjee.
Unit involved : Electronics and Communication Sciences
Funded by : Department of Science and Technology, New Delhi.

12. Name of the Project : Development of Image Processing Techniques for Improved Wind Estimation Using INSAT Cloud and Water Vapour Imageries
Principal Investigator : Jyotirmay Das
Co-Principal Investigator : Arun K De and Dr. Dipti Prasad Mukherjee.
Unit involved :Electronics and Communication Sciences
Funded by : ISRO, Bangalore

13. Name of the Project : Development of Methodologies for Self-organizing Fuzzy Logic Controllers with Special Emphasis on Neuro-fuzzy Techniques, Genetic Algorithms and Stability Analysis
Principal Investigator : Nikhil Ranjan Pal
Unit involved : Electronics and Communication Science
Funded by : Department of Science and Technology, NewDelhi, Govt. of India.

14. Name of the Project : Development of a Real-time Intelligent Decision Making System for Range Safety
Principal Investigator : Nikhil Ranjan Pal
Unit involved : Electronics and Communication Science
Funded by : Defence Research and Development Organisation, Govt.of India.

15. Name of the Project : New Techniques of Fast Image Compression Based on Human Vision Semetric Data Structures
Principal Investigators : M. K. Kundu and B. B. Bhattacharya
Units Involved : Machine Intelligence and Advanced Computing & Microelectronics
Funded by : INTEL Corporation, U.S.A

16. Name of the Project : Cancer Management in Soft Computing Paradigm
Name of the Chief Investigator : S. K. Pal
Unit involved : Machine Intelligence
Funded by : Council of Scientific and Industrial Research, New Delhi

17. Name of the Project : Khagen Babu - II
Name of the Chief Investigator : S.K. Pal
Unit Involved : Machine Iintelligence
Funded by : Birla Industrial and Technological Museum

18. Name of the Project : Structural and Petrological Constraints on the Evolution of Granulite-greenstone Relations Around Paikmal, Orissa
Name of the Project Leader : Samarendra Bhattacharya
Unit Involved : Geological Studies
Funded by : Department of Science and Technology, Govt. of West Bengal

19. Name of the Project : Interaction of Water Waves and Structures
Name of the Project Leader : B.N. Mandal
Unit involved :Physics and Applied Mathematics
Funded by :Council of Scientific and Industrial Research, New Delhi

20. Name of the project : Water Wave Scattering by Obstacles and Surface Discontinuities
Name of the Project Leader : B.N. Mandal
Unit involved :Physics and Applied Mathematics
Funded by : National Board for Higher Mathematics, Department of Atomic Energy, Govt. of India, Mumbai,

21. Name of the Project : Pattern-forming Instabilities and Interface Waves
Name of the Project Leader : Krishna Kumar
Unit involved : Physics and Applied Mathematics
Funded by : Department of Science and Technology, New Delhi

22. Name of the Project :Topological Investigations of Quantum Field Theory and Statistical Mechanics
Name of the Project Leader : P. Bandyopadhyay
Unit : Physics and Applied Mathematics
Funded by : Council of Scientific and Industrial Research, New Delhi

23. Name of the Project :Researches in Magnetism and in the History of Indian Work in Anti Ferromagnetism and Ferrimagnetism
Name of the Project Leader : C.K. Majumdar
Unit involved :Physics and Applied Mathematics
Funded by : Indian National Science Academy, New Delhi

24. Name of the Project : Sustainable Livelihood Studies Under Environmental Stress In Eastern Plateau Of India.
Name of the Project Coordinator : D.K. Bagchi.
Unit Involved : Agricultural Science and University of East Anglia, UK
Funded by : University of East Anglia, U.K.

25. Name of the Project : Rice Based Cropping System Studies In Rainfed Regions of Eastern India Plateau.
Name of the Project Coordinator : D. K. Bagchi
Unit Involved : Agricultural Science and International Rice Research Institute, Philippines
Funded by : International Rice Research Institute, Philippines.

26. Name of the Project : Genomic Diversity in Indian Populations Project: Investigations Through Biotechnological Tools in Eastern Indian Populations
Name of Project Investigator : Partha P. Majumder
Unit involved : Anthropology and Human Genetics
Funded by : Department of Biotechnology, Govt. of India

27. Name of the Project : Glutathione S-transferase (GSTM1 and GSTT1)"null"Mutations and Incidences of Tobacco-related Oral Cavity Precancer and Cancer in India.
Name of Project Investigator : Bidyut Roy
Unit involved : Anthropology and Human Genetics
Funded by : Department of Science and Technology

28. Name of the Project : Molecular Genetics of Schizophrenia and Bipolar Disease
Name of the Project Investigator : Partha P. Majumder
Unit involved : Anthropology and Human Genetics
Funded by : Department of Biotechnology, Govt. of India

29. Name of the Project : Environmental Conservation and Valuation of East Calcutta Wetlands
Principal Investigator : Kunal Chattopadhyay
Unit involved : Economic Research
Funded by : World Bank

30. Name of the Project : Environmental Management Capacity Building Technical Assistance Project: Environmental Economics Component
Principal Investigator : Robin Mukherjee
Co Principal Investigator : Dipankar Coondoo
Unit involved : Economic Research
Funded by : World Bank

31. Name of the Project : Efficiency of Air Pollution Control Technology in Iron Foundry Industry, Howrah
Principal Investigator : Snigdha Chakraborty
Unit involved : Economic Research
Funded by : West Bengal Pollution Control Board

32. Name of the Project : Sustainable Development Framework for India
Principal Investigator : Robin Mukherjee
Unit involved : Economic Research
Funded by : Institute of Advanced Studies, United Nations University, Tokyo

33. Name of the Project : Health Sector Reforms : An Evaluation of Impact and Patterns of Utilisation among Vulnerable Groups in Three Indian States (Andhra Pradesh, Tamil Nadu, And West Bengal)
Project Coordinators : B.N. Bhattacharya and S. Guha Roy
Unit involved : Population Studies
Funded by : European Commission

34. Name of the Project : Gender Study of District Primary Education Programme (DPEP)
Name of the Project Coordinators : Anjali Ghosh, Atis Dasgupta and Suraj Bandyopadhyay
Units involved : Psychology Research and Sociological Research
Funded by : Paschim Banga Rajya Prathamik Shiksha Unnayan Sanstha, Govt. of West Bengal.

35. Name of the Project : Guidance and Consultancy Services in Data-processing
Name of the Project Coordinator : Asok Maiti
Unit involved : Sociological Research
Funded by : Indian Council of Social Sciences Research (ICSSR), New Delhi

36. Name of the Project : Change in Livelihood Trajectories
Name of the Project Coordinators : D.K. Bagchi and Ajay Kr. Ghosh
Units involved : Agricultural Science and Sociological Research
Funded by : University of East Anglia, UK.

37. Name of the Project : Status of Women Study in West Bengal.
Name of the Project Coordinators : Atis Dasgupta and Suraj Bandyopadhyay.
Unit involved : Sociological Research
Funded by : State Womens' Commission, Govt. of West Bengal