Sixty Ninth Annual Report

April 2000 - March 2001

INDIAN STATISTICAL INSTITUTE

203 Barrackpore Trunk Road

Kolkata - 700 035

PRESIDENT OF THE INSTITUTE, CHAIRMAN AND OTHER MEMBERS OF THE COUNCIL AS ON MARCH 31, 2001

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

1. Chairman : Dr. Bimal Jalan, Governor, Reserve Bank of India
2. Director : Prof. K. B. Sinha, FNA

Representatives of Government of India

3. Dr. N.S. Shastri, Director General & CEO, National Sample Survey Organisation
4. Shri R.S. Prasad, Joint Secretary & Financial Adviser (Statistics), Ministry of Statistics & Programme Implementation.
5. Dr. R.B. Barman, Executive Director, Deptt. of Statistical Analysis & Computer Services, Reserve Bank of India.

Scientists not employed in the Institute

Representative of ICSSR

6. Dr.(Mrs.) R. Barman Chandra, Member Secretary (In-Charge), Indian Council of Social Science Research.

Representatives of INSA

7. Prof. S.K. Malik, Chairman, CAS in Mathematics, Punjab University, Chandigarh.
8. Prof. D. Dutta Majumder, Professor-Emeritus, Indian Statistical Institute, Kolkata.
9. Prof. K.R. Parthasarathy, Emeritus Scientist, Indian Statistical Institute, New Delhi.
10. Prof. M.R.S. Rao, Chairman, Department of Bio-Chemistry, Indian Institute of Science, Bangalore

Representative of the Planning Commission

11. Shri. K.L. Dutta, Joint Adviser (PP), Planning Commission, New Delhi.

Representative of the University Grants Commission

12. Prof. J.V. Deshpande, Professor, Department of Statistics, University of Pune, Pune.

Scientists co-opted by the council

13. Dr. M. Vidyasagar, Executive Vice President, Tata Consultancy Services, Secundrabad
14. Prof Sushanta Dattagupta, Director, S.N. Bose National Centre for Basic Sciences, Kolkata.

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

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

Elected representatives of the employees of the Institute

18. Dr. Deba Prasad Mandal, Representative of the Scientific Workers.
19. Shri C. Periasamy, Representative of the Non-Scientific Workers.

Officers of the Institute

20. Dr. Rajeeva L. Karandikar, Professor-in-Charge, Theoretical Statistics & Mathematics Division:
21. Prof. Bimal Kr. Roy, Professor-in-Charge, Applied Statistics Division.
22. Prof. Satya Ranjan Chakravarty, Professor-in-Charge, Social Sciences Division.
23. Prof. Himadri Pai Majumder, Professor-in-Charge, Physics and Earch Sciences Division.
24. Prof. Ranjan Gupta, Professor-in-Charge, Biological Sciences Division.
25. Prof. Nikhil Ranjan Pal, Professor-in-Charge, Computer & Communication Sciences Division.
26. Shri K.M. Date, Head, Statistical Quality Control & Operations Research Division.
27. Prof. Alok Dey, Head, Delhi Centre.
28. Prof. Gadadhar Misra, Head, Bangalore Centre.
29. Dr. P.S.S.N.V.P. Rao, Dean of Studies.

Non-Member Secretary

Shri D.C. Bandyopadhyay, Chief Administrative Officer.

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(www.isical.ac.in)

INDIAN STATISTICAL INSTITUTE
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CONTENTS

A BRIEF HISTORY OF THE INSTITUTE

Researches in the theory and applications of Statistics as a new scientific discipline began in India in the early twenties through the pioneering initiative 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 was picked up by him to start the Statistical Laboratory, in the Department of Physics, Presidency College, Calcutta, where he was a Professor.

In the early thirties, realising the necessity of a concerted effort for the advancement of theoretical and applied statistics in India, Professor Mahalanobis together with the Professors P.N. Banerjea 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 Institution. Now the Institute has its headquarters in Calcutta and two 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 (SQC-OR) Division at Baroda, Mumbai, Pune, Coimbatore, Chennai, Hyderabad.

From the very beginning, Professor Mahalanobis and his associates including Professors S.S. Bose, R.C. Bose, S.N. Roy, K.R. Nair, K. Kishen and H.C. Sinha worked with untiring enthusiasm for the development of statistical theory and 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 surveys. This led to a large number of high quality 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.

In 1937, Professor Mahalanobis started sample surveys to estimate the area under jute crop in Bengal as an exploratory work, which later grew to a full-scale survey of the entire province in 1941. At the request of the Government of Bengal in 1944, a survey of economic and social conditions in Bengal was undertaken by the Institute to assess the cause and impact of the severe famine which had occurred in 1943. This survey yielded information of much social significance. 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 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 on the NSS from 1950 till it was transferred to the Government of India in 1972.

The ISI also played 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 December, 1947 and later by inviting other experts like Dr. W.E. Deming, Dr. Ellis R. Ott, Dr. H.C. Tippett and Dr. Genichi Taguchi. The 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 in the Institute 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. 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. It is worth mentioning here that the application of statistical techniques in many areas in Social and Natural Sciences began in the Institute in the fifties. For example, the Institute developed new statistical methodologies for the analysis of directional geological data.

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 statistician one must also learn to 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, while in 1958 a digital computer URAL was received as a gift from U.S.S.R. Since 1956 till mid sixties, the Institute was de facto a national computer centre. In early sixties, the Institute, in collaboration with the Jadavpur University, undertook the design, development and fabrication of a fully transistorized digital computer, called ISIJU-1 which was commissioned in 1966 by Shri M.C. Chagla, the then Minister of Education, Government of India. The Institute has regularly upgraded its computing facilities and currently has a network of high-performance computers and a large bandwidth connection to the Internet.

The Institute expanded its research, teaching, training and project activities and earned national and international recognition over time. The outstanding contributions of the Institute to theoretical and applied statistical work culminated with Prime Minister Jawaharlal Nehru piloting the bill in the Parliament leading to the Indian Statistical Institute Act of 1959, which recognized the Institute as an "Institution of National Importance". By this act, the Institute was empowered to award degrees and diplomas, and the already existing teaching and training programmes were consolidated, expanded. Furthermore, the courses for the degrees of Bachelor of Statistics [B.Stat. (Honours)] and Master of Statistics (M.Stat.) as well as Ph.D. programmes were started from June 1960. Later on, courses leading to Master of Technology degrees in Computer Science and in Quality, Reliability and Operations Research were introduced. These programmes have been eminently successful in turning out well-trained students, many of whom have gone on to attain international reputation.

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. Following the amendment, a Master of Science course in Quantitative Economics and an undergraduate course, B.Math (honours) in Mathematics have been added to the teaching and training programmes.

The role and importance of ISI in conducting teaching and training in Statistics has been appreciated by international bodies as well. In 1950, the International Statistical Institute in Netherlands has 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 impetus to research activities not only in Statistics and Mathematics but also in various branches of the natural and social sciences, which often

provides live problems for testing available statistical methods as also for the development of new statistical methods. The Institute has always remained on the forefront of research in Statistics, Probability and Mathematics, both nationally and internationally. In Computer Science, new research areas were introduced in keeping with global developments. Selected areas in natural sciences began with small groups and saw some spectacular development like the excavation of important dinosaur fossils from the Godavari Valley. This also justifies the adoption of "Unity in Diversity" as the motto of the Institute. The Memorandum of Association of ISI was updated first in 1976 and subsequently in 1995. The objectives 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 fulfillment 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 interacting with many internationally reputed 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 considerable support to its organization and development. Professor J.B.S. Haldane, a geneticist of international repute, was a member of the faculty for several years beginning from 1957. The celebrated mathematician, Norbert Wiener visited the Institute twice in 1954 and again in 1955-56 when he stayed for seven months and gave a course of 60 lectures. The other academic personalities whose longer visits influenced the development of the Institute include the statisticians Harold Hotelling, Frank Yeats, Herman Wold, Edwin Harper (Jr.) and H. Cramer; the mathematicians A.N. Kolmogorov, Yu.V. Linnik, J.L. Doob and more recently Vaughan F.R. Jones; the experts in Statistical Quality Control Walter Shewhart and G. Taguchi; the Economists Simon Kuznets, Paul A. Baran, Joan Robinson, Jan Tinbergen, Nicholas Kaldor, R.M. Goodwin, David and Ruth Glass and J.K. Galbriath; the geologist Pamela Robinson; the biochemist N.W. Pirie and the linguist D. Kostic. All along the Institute has tried to live up to Ronald Fisher's dictum that Statistics is 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.

For a long time the Institute has been organising international conferences and symposia, sometimes on focussed topics, sometimes on a broader field. Particular mention may be made of the 1974 Symposium on Probability and Statistics, the Golden Jubilee Conferences of 1981-82, the Haldane Centenary Conference of 1992, the Mahalanobis Centenary Conference of 1993, and the ISI-Bernoulli Society Conference of 1997, each of which, through the participation of a very large number of statisticians, probabilists and scientists of other disciplines from all parts of the world, were truly global meetings on the subjects.

DIRECTOR'S REPORT

The year under consideration saw some changes and new initiatives in the Institute which is hoped to be the harbinger of many more to come in near future. We have started to critically re-evaluate ourselves and our programmes to examine if we have lived upto our promise of being an Institution of National Importance.

The Indian Statistical Institute is primarily a research Institute in which teaching plays an important role. As was articulated in the last convocation address, the time has come for introspection if all the research/training programmes are meaningful in the present context, and whether some of them have more than run out of relevance. I urge the faculty members of the Institute to rise above petty differences and to help make this happen. Such introspection will give us the necessary adaptability for our scientific work force to continue to contribute their best and secure the reputation of the Institute.

Nevertheless, the year saw some interesting and promising research projects - some are ongoing like 'Cryptoanalysis' (funded by DRDO and Navy) and 'Genomic Diversity' (funded by DBT) and some are new ones. In the latter category, I would like to highlight a few. The collaboration between ISRO and ISI began with a high-level meeting of a group of ISRO scientists led by the Chairman, ISRO, and similar group led by the Director, ISI. Some areas of collaboration have been identified. Subsequently, an inter-institutional workshop on "Current Status of Land-cover Classification and Ground Truth Survey Methodology" has been held in Ahmedabad, organised by Professor N.R. Pal of CCSD. Dr. Arunava Goswami of BSD has just begun a project "Biotic and Abiotic Stress Response in Jute" and has begun interacting with other scientists and the West Bengal Government in thinking how to organise the huge existing databases on plants and animals in this State which may lead to a viable beginning in biotechnology. The first Indo-US Workshop on "Spectral and Inverse Spectral Theory" was successfully organized in Goa in December'2000 by Dr. K. Maddaly of I.M.Sc., Chennai and myself as a part of DST-NSF exchange programme in Mathematics.

Amongst various other initiatives that the Institute has undertaken are (i) an agreement of transfer of technology of OCR system in Bengali and Devnagari scripts developed in the CVPR Unit to CDAC, Pune; (ii) formation of a Centre of Excellence in Population Genomics in collaboration with The Chatterjee Group; (iii) preparation of an IPR/Copyright guidelines for the Institute; (iv) a national workshop on "Probabilistic Methods in Mathematical Physics" organized by ISI and SNBCBS, Kolkata in February'2001; (v) international conferences on Stochastic Processes (in honour of Professor G. Kallianpur) and on Statistics (in honour of Professor C.R. Rao), both in Kolkata; (vi) a meeting on Statistics organized by I.S.I. and I.I.S.A. in Delhi; (vii) Indocrypt 2000 in Kolkata.

While the primary aim of the teaching programmes of the Institute is to produce potential researchers, the secondary aim is to train students in Statistics, Mathematics, Economics and Computer Science so that they can use their knowledge to infuse value-addition in Industry and Government. The B.Stat and M.Stat courses are doing precisely that over the last 4 decades. Recently, new courses have been added, viz. M.Tech (Computer Science), M.Tech (QROR), MSQE to further broaden the base to realize these goals. The new B.Math programme, whose first batch has just completed one year in the Bangalore Centre, is expected to fill the much-discussed void in good undergraduate education in Mathematics in the country and is hoped to provide a number of well-trained students going into a research career in Mathematics. The Institute is also proud to conduct the National Mathematical Olympaid and the 'Nurture' programmes of the NBHM at Kolkata and Bangalore Centres. The International Statistical Education Centre (ISEC), sponsored jointly by the Institute, the International Statistical Institute and Government of India since 1950, celebrated its Golden Jubilee in October 2000 by holding conferences in Delhi and Kolkata on "Statistical Education" and "Demography, Health and Education".

It gives me some pleasure to state that our funding agency, the Government of India through the Ministry of Statistics and Progarmme Implementation has enhanced significantly both the non-plan and plan support for the years 2000-01 and 2001-02. For example, the figures for the year 2001-02 stand at Rupees 4049.10 lakhs and Rupees 1347 lakhs for non-plan and plan, respectively. This has facilitated augmentation of our research activities. However, the need for a substantial enhancement in allocation for better maintenance and re-construction in Kolkata Campus is being felt increasingly.

The Delhi Centre of the Institute has seen the completion of the transit flats, while in the Bangalore Centre the Guest House building is nearing completion. At Kolkata Campus, various projects for major building activity are being finalized and new constructions are expected to start soon. It is hoped that in another two to three years, this campus will have the requisite space for academic activities that it needs.

Finally, I come to the most pleasant part of this report, viz. acknowledging those colleagues who have received academic recognitions outside the Institute. During the year, Professors Aloke Dey from Delhi Centre and Partha Pratim Majumder from Kolkata Campus have been elected to the fellowship of the INSA, Professor B.B. Choudhury to the fellowship of IEEE, Professor C.A. Murthy to INAE. Professor R.L. Karandikar of Delhi Centre shared the C.R. Rao Award of the Ministry of Statistics and Programme Implementation for the year 2001, and Drs. Arup Pal of Delhi Centre and Sanghamitra Bandyopadhyay from Kolkata received the Young Scientist Medals of INSA. I am sure these achievements will inspire all the workers of the Institute (academic and non-academic) to attempt to scale greater heights in near future.

March 31, 2001

K. B. Sinha

Part I. Teaching and Training, Convocation, 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 2000-2001 is given below :

During the academic session 2000-2001, a total of 9160 candidates applied for admission and were called for written selection tests for the various courses offered by the Institute, viz., B.Stat. (Hons.), B.Math. (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, Associateship in Documentation and Information Science (Bangalore), Research Fellowships in Statistics, Mathematics, Economics, Computer and Communication Sciences, Discrete Mathematics and Theoretical Computer Science, Physics and Applied Mathematics, Anthropology, Biochemistry, Psychology, Demography, Library and Information Science, Specialist Development Programme in SQC & OR and one year part time course in Statistical Methods and Applications and course on Computer Programming and Applications. Admission tests were conducted at 24 different centres spread all over the country. A total of 6997 candidates finally appeared for admission tests and a total of 482 candidates who qualified in the written tests were called for interviews. Based on the performance in the written tests, interview and the academic record 221 candidates were offered admission to various courses during the academic session under review.

Thirty eight trainees in Engineering and Technology from various Universities/ Institutes like (i) Indian Institute of Technology, Kharagpur (ii) Vallabhbhai Regional of Engineering & Technology, Surat (iii) University College of engineering Burla, Sambalpur, (iv) Indian Institute of Science & Information Technology, Bhubaneswar (v)Assam Engineering College, Guwahati, (vi) Regional Engineering College, Durgapur, (vii) Jadavpur University, (viii) Utkal University, (ix) Jorhat Engineering College, (x) Indira Gandhi Institute of Technology, Sarong, (xi) Indira Gandhi Open University received a two-week/six-week/six months M.C.A./Project training in different Computer Sciences units of the Institute viz.,Electronics and Communication Sciences Unit, Computer Vision and Pattern Recognition Unit, Computer and Statistical Services Centre, Machine Intelligence Unit, Advanced Computing and Microelectronics Unit and Applied Statistics Unit.

The Multimedia Laboratory was set up in 1999 with the objective of developing a multimedia-based teaching aid for introductory statistics. The module would contain five parts. Previously the introductory part had been designed and developed. The work done in 2000-2001 was on the next two parts : Tabular/Graphical representation of data and Mean & Median. The module includes some narration with illustrations followed by interactive exercises and data analysis. Apart from this work, the Multimedia Lab. helped the ISI Website committee in bringing about certain modifications to the ISI website. It also helped Sankhya in creating/cleaning/computerizing images for various issues of the Journal.

The number of candidates admitted to the different degrees, diplomas and training courses in 2000-2001 and the number of students passed in the annual examinations in 2000 are given below.

NUMBER OF STUDENTS ADMITTED AND PASSED IN DIFFERENT COURSES

Sl. No.	Course	Number of Students: Passed in the annual examination in 2000	Number of Students: Enrolled in 2000-2001
	(1)	(2)	(3)
	Degree		
1.	Bachelor of Statistics with Honours [(B.Stat. (Hons.)]		
	1st year	19	18
	2nd year	13	19
	3rd year	20	13
2.	Bachelor of Mathematics with Hons. [B. Math (Hons.)]		
	1st year	-	7
3.	Master of Statistics (M.Stat.)		
	1st year	6	2
	2nd year	23	30
	3rd year	49	29
4.	Master of Science in Quantitative Economics [M.S.(Q.E.)]		
	1st year	13	23
	2nd year	20	13
5.	M.Tech. in Computer Science		
	1st year	34	27
	2nd year	27	34
6.	M.Tech. in Quality, Reliability and Operations Research		
	1st year	11	10
	2nd year	12	11
	Certificate/Diploma		
7.	Course in Computer Programming and Applications		
	1st year	10	8
	2nd year	9	10
8.	Associateship in Documentation and Information Science (Bangalore)		
	1st year	6	6
	2nd year	6	6

Sl. No.	Course	Number of Students: Passed in the annual examination in 2000	Number of Students: Enrolled in 2000-2001
	(1)	(2)	(3)
9.	One Year Part-time Course in Statistical Methods and Applications		
	Calcutta	11	--
	Delhi	4	--
	Hyderabad	--	--
10.	Six-month Part-time Course in Statistical Quality Control		
	Bangalore (July.-December 2000]	7	8
	Hyderabad (July - December 2000]	13	16
11.	Junior Diploma in Statistics		
	(January 2000)	2	36
	(September 2000)	-	40
	Senior Diploma in Statistics		
	Senior Diploma in Statistics		
	(January 2000)	-	4
	(September 2000)	3	7
12.	Junior and Senior Research Fellows, and Research Associates in different disciplines	9	23
GRAND TOTAL :		327	400

Ph.D. Degrees Awarded in 1999

(A) Ph.D. Degrees awarded by the Institute :

i) Palash Sarkar : "Studies on Finite Linear Cellular Automata"
Supervisor : R. Barua, ISI, Kolkata

ii) Pratima Panigrahi : "On the geometrisability of some strongly regular graphs related to Polar Spaces".
Supervisor : B. Bagchi, ISI, Bangalore

iii) Manisha Chakraborty : "On measuring the cost of children : The case of Rural Maharashtra"
Supervisor : Amita Majumdar, ISI, Kolkata

B) Ph.D Degrees awarded by other Universities to the Research Fellows of the Institute:

i)	Tirthankar Ghosh	: "Child labour in West Bengal : A Sociological Study Supervisor : B. Chaudhuri, Calcutta University (Awarded by Calcutta University)
ii)	Susanta Chakraborty	: "Studies on Redundancies and Robustly testable design of Logic Circuits Supervisor : B.B. Bhattacharya, ISI , Kolkata (Awarded by Kalyani university
iii)	Chitralekha Bhattacharya	: "Studies on the Regulation of C-X-CR_1 and C-X-CR_2 Interleukin-8 Receptor Expression by Lipo-Polymor Phonaclear Neutrophils" Supervisor : S.K. Gupta, ISI, Kolkata (Awarded by Jadavpur University)

Ph.D. Degrees Awarded in 2000

(A) Ph.D. Degrees awarded by the Institute :

i)	Suresh Mutuswami	: "Essays in mechanism Design" Supervisor : Bhaskar Dutta, ISI, Delhi
ii)	Arindam Sengupta	: "Time-Space harmonic Polynomials for Stochastic Process" Supervisor : A. Goswami, ISI, Kolkata
iii)	Arijit Mukherjee	: "International Joint Ventures and Technology Transfer in Developing Economics : Theoretical Analysis" Supervisor : S. Marjit, CSSS, Kolkata
iv)	Nilabja Ghosh	: "Studies of Supply Responses in Indian Agriculture : Some Models of Planning Rational Food Supply" Supervisor : K.C. Majumdar, ISI, Kolkata
v)	Supratik Roy	: "On Logistic and some New Discrimination Rules Characterizations, Inference and Applications" Supervisor : Ashis Sengupta, ISI , Kolkata,
vi)	Sitabhra Sinha	: "Chaos, Control and Synchronization in Excitatory-Inhibitory Neural Network Models" Supervisor : S. K. Pal, ISI, Kolkata

INDIAN STATISTICAL INSTITUTE

vii) Natarajan Balasubramanian : "Kalecki's Macro Syatem : The Alternative Theoretical Structure"
Supervisor : Sanjit Bose, ISI , Kolkata

viii) Rajat Kumar De : "Feature Evaluation, Classification and Rule Generation Using Fuzzy Sets and Neural Network"
Supervisor : S.K. Pal, SI, Kolkata

ix) Swagato Kumar Ray : "Uncertainty Principles on some Lie Groups"
Supervisor : S.C. Bagchi, ISI, Kolkata

x) Sukanta Pati : "Perturbed laplacian Matrix and the Structure of Graph"
Supervisor : R.B. Bapat, ISI, Delhi

xi) Suchismita Ghosh : "Engel Curve Estimation from Budget Data Relating to Short Reference Periods"
Supervisor : N. Bhattacharya, ISI, Kolkata

xii) Debashish Goswami : "Quantum Stochastic Dilation of Company Positive Semigroups and Flows"
Supervisor : K.B. Sinha, ISI, Delhi

xiii) Swapan Raha : "Similarity Based Approximate Reasoning"
Supervisor : Kumar S. Roy, ISI, Kolkata

xiv) Manipushpak Mitra : "Essays on First Best Implementable Incentive Problems"
Supervisor : Arunava Sen, ISI, Delhi

xv) Amit Kumar Biswas : "Stability and Largeness of the Cooperative Games"
Supervisor : T. Parthasarathy, ISI, Delhi

xvi) Snigdhansu Bhusan Chatterjee : "Generalised bootstrap Techniques"
Supervisor : Arup Bose, ISI, Kolkata

xvii) R. Srinivasan : "Connections on small vertex models"
Supervisor : V. S. Sunder, IMSc., Chennai

xviii) Amitava Dutta : "On some Self-organising Models and their Applications"
Supervisor : Swapan K. Parui, ISI, Kolkata

xix) Sidhartha Bhattacharya : "Topological Conjugacy and Regidity of Affine Actions"
Supervisor : S. G. Dani, ISI, Bangalore

xx) Bha-Eldin Khaledi : "Stochastic Comparison and Dependence among Order Statisitcs, Spacings and Concomitants of Order Statistics" Supervisor : S. C. Kochar, ISI, Delhi

xxi) Anirban Ray Chaudhuri : "Some Studies on Shape of Dot Patterns" Supervisor : B. B. Chaudhuri, ISI,Kolkata

(B) Ph.D. degrees awarded by other Universities to the Research Fellows of the Institute :

i) Sanghamitra Ray : "Endothiodont dicynodonts from the Lower Gondwana of the Pranhita Godavari valley Decan India" Supervisor : Saswati Bandyopadhyay, ISI, Kolkata (Awarded by Calcutta University)

ii) Arun kumar Dey : "On certain characteristics of troposheric propagation of radiowaves in the coastal region of eastern India" Supervisor : J. Das, ISI, Kolkata (Awarded by Calcutta University)

iii) Mrinal Kanti Mukherjee : "Structures Kinematic framework and shallow crustal deformation mechanism in the Southern Nallamalai Flod Fault belt, Cuddapah District, Andhra Pradesh, South India" Supervisor : Dilip Saha, ISI, Calcutta (Awarded by Calcutta University)

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 the UNESCO and the Government of India. The Centre functions under a Joint Board of Directors. Professor P.C. Mahalanobis was the Chairman since the inception of the Centre in 1950 until his death in 1972. Since then Professor C.R. Rao has been the Chairman of this Board.

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 of varying durations and in different subject-fields.

ISEC successfully completed its training program of 54th term of the Regular Course. This year, there were twentysix trainees from eleven countries viz. Sri Lanka (3), Maldives (5), Bhutan (5), Myanmar (1), Kenya (4), Uganda (1), Zambia (1), Thailand (1), Seychelles (1), Bangladesh (2) and LAO PDR (2). All of them have successfully completed the course and have been awarded Statistical Training Diplomas. Besides, ISEC organized two Special Courses. The first one was on Sample Surveys and the second one was on Official Statistics. There were 11 trainees from Sri Lanka and one trainee from Bhutan for Special Course on official Statistics and Sample Surveys respectively.

Professional Examinations in Statistics

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

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

These examinations are separate from, 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 held now-a-days twice in a year usually in or about the months of April/May and November/December at different cities in India (Bangalore, Calcutta, Chennai, Delhi, Hyderabad, and Mumbai).

The total number of candidates and their results for September 2000 are shown below :

Examinations	Registered	Appeared	Passed*
Junior Diploma in Statistics	60	40	14
Senior Diploma in Statistics	12	07	04

*Passed in one or more papers only, not necessary completed the examination.
Preparation of the model -answer booklets for the two papers of Junior Diploma in Statistics are completed and updatation of another two papers are in progress.

The cumulative total number of candidates who have qualified for the award of the Diplomas in the Professional Examinations in Statistics including those who qualified in September term is 288.

2. CONVOCATIONS

Thirty fourth convocation

Indian Statistical Institute held its Thirty fourth Convocation for awarding the Ph.D., M.Tech. (Computer Science), M.Tech (Quality, Reliability and Operations Research), M.Stat., B.Stat. (Hons) degrees and Diplomas, Associateship etc. on 28 April 2000.

Professor M.G.K. Menon, FRS, President of the Institute presided over the convocation and awarded Degrees, Diplomas, Associateships and Awards to the students. Professor S. B. Rao, Director of the Institute presented the annual review of teaching and training activities of the Institute. Dr. K. C. Pant, Deputy Chairman, Planning Commission delivered the convocation address.

The number of students who obtained Degrees, Diplomas, Associateships and Awards in the Convocation are given below :

Degree/Diploma	Number of Candidates
Doctor of Philosophy	15
Master of Technology (M.Tech.) in Computer Science	23
Master of Technology (M.Tech.) in Quality, Reliability and Operations Research	7
Master of Statistics (M.Stat.)	34
Master of Science (M.S.) in Quantitative Economics	14
Bachelor of Statistics (Hons.) {B.Stat. (Hons.)}	13
Associateship in Documentation and Information Science, Bangalore	6
Diploma on Operation and Programming of Automatic Data Processing Equipment	13
Professional Examinations in Statistics Junior Diploma in Statistics	3
Total :	128

AWARDS

1. Award of Mahalanobis International Symposium on Statistics Prize to the most outstanding M.Stat. student of the Institute

   Debashis Paul

2. Award of ISI Alumni Association and Mrs. M.R. Iyer Memorial Prizes to outstanding students of the Institute :

   B.Stat. (Hons) : Ritabrata Munshi
   M.Stat. : Debashis Paul

3. ISI Alumni Association Rashi Ray Memorial Medal and M. R. Iyer Memorial Prize for ourstanding performance in M .Tech. in Computer Science

Sabyasachi Dey

4. Award of ISI Alumni Association Prize for outstanding performance in M. S. in Quantitative Economics.

Sanmoy Chakroborty

5. Haldane Memorial Prize 1999-2000 for best research work done in India by a young scientist in India in Medical Statistics/Bio-Statistics/Problems involving application of Quantitative Techniques to Biological/Medical Science.

C. N. Madhava Rao (University of Pune)

Thirty fifth convocation

Indian Statistical Institute held its Thirty fifth convocation for awarding the Ph.D., M.Tech. (Computer Science), M.Tech (Quality, Reliability and Operations Research), M.Stat., B.Stat. (Hons.) degrees and Diplomas, Associateship etc., on 08 January, 2001.

Professor M.G.K. Menon, FRS, President of the Institute presided over the Convocation and awarded Degrees, Diplomas, Associateships and Awards to the students. Professor K.B. Sinha, Director of the Institute presented the annual review of teaching and training activities of the Institute. Dr. K. Kasturirangan, Chairman, Space Commission, Secretary, Dept. of Space and Chairman, Indian Space Research Organisation delivered the convocation address.

The numbers of students who obtained Degrees, Diplomas, Associateships and Awards in the Convocation are given below.

Degree/Diploma	Nunber of Candidates
Doctor of Philosophy (Ph.D)	9
Master of Technology (M.Tech.) in Computer Science	27
Master of Technology (M.Tech.) in Quality, Reliability and Operations Research	12
Master of Statistics (M.Stat.)	49
Master of Science (M.S.) in Quantitative Economics	20
Bachelor of Statistics (Hons.) {B.Stat. (Hons.)}	20
AssociateshipinDocumentationandInformation Science,Bangalore	6
Diploma in Computer Programming and Applications	9
Professional Examinations in Statistics Junior Diploma in Statistics	2
Total :	154

AWARDS

1. Award of Mahalanobis International Symposium on Statistics Prize to the most outstanding M.Stat. student of the Institute :

   Arka prasanna Ghosh

2. Award of ISI Alumni Association and Mrs. M.R. Iyer Memorial Prizes to the outstanding students of the Institute :

B.Stat. (Hons)	:	Sourav Chatterjee
M.Stat.	:	Pritam Kanti paul
M. S. (QE)	:	Sudeshna Maitra

3. Award of ISI Alumni Association Rashi Ray Memorial Medal for outstanding performance in M. Tech. in Computer Science :

   Sanjiv Kumar Mishra

4. M.N. Murthy Memorial Prize : 2000-2001 for Research work done in Applied Statistics.

   Atanu Biswas

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 Science

In addition, there is a well equiped 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 etc. can now access the computing facilities from any terminal. The network provides computing on Vax 8650, Sun Ultra, DEC Alpha, SGI and IBM AS400 platforms. 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 takes a major part in the teaching of Mathematics, Probability, Statistics and Theoretical Computer Science to the B.Stat., M.Stat. and M.Tech. students of the Institute. Courses are also run for research fellows and there are regular seminar activities all round the year. Yet other teaching programmes, in which the members of the Division take part are the six-month course of the International Statistical Education Centre, the two-month JCCS course for Government Personnel and the UGC refresher course for college/university teachers, each of which is organised by the Institute every year. Apart from these, there are courses for the ISS (Indian Statistical Service) Probationary Officers and various summer and winter Instructional schools that the Institute holds from time to time. The Division has also taken the responsibility of the NBHM Nurture-Programme for the 1998-2002 batch. A number of faculty members of the Division are engaged in the editorial functions of Sankhya and in the administration of the Mathematics Olympiad Project of the NBHM at the regional and national level.

Under the sponsorship of the National Board for Higher Mathematics, one-day seminars on some basic areas in modern mathematics were organized in seven Calcutta colleges during the year. The lectures in these seminars were delivered by the faculty of the Stat-Math Unit, Calcutta and the Department of Pure Mathematics of the Calcutta University.

Stat-Math Unit, Calcutta

The unit is actively engaged in research in many areas of Statistics, Probability, Mathematics and Theoretical Computer Science. An account of the active areas of research of the unit, major work done and projects undertaken during the year is given below.

Research Activities

Theoretical Statistics

The main areas of research included Asymptotic theory in Statistics, Sequential Analysis, Bayesian Inference, Ranking and Selection, Multivariate Analysis, *M*-estimation, Asymptotic inference, specially in dependent models, Non-parametric Inference, Inference in Stochastic Processes, Directional Data Analysis, Linear Models, 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, Epidemiological studies on AIDS and HPV infections, Human Brain Mapping

Work on Bayesian nonparametrics, high dimensional model selection and finer aspects of model selection for small dimensions was continued. Among new areas of interest are variable selection and classification in high dimensional problems, specially for binary data coming from DNA analysis. Various applied problems of public health, environmental statistics, marketing and statistical quality control were also looked into. A monograph on Bayesian Nonparametrics is under preparation.

Theoretical research on the rates of CLT and allied topics continued. Research on flexible and adaptive discriminant analysis is continuing.

Various aspects of bootstrap in linear models, including the situation where the dimension of the parameter space increases to infinity with the sample size, have been studied. Generalised bootstrap schemes in martingale estimating equations have been introduced and their first and second order behaviour have been studied. New as well as unifying results on resampling plans in a large class of M_m estimators have been obtained which include all standard resampling schemes and a huge class of common estimators used in statistics. The performance of the bootstrap for nonregular models when the standard conditions often assumed are violated, have been investigated.

Estimation problems and asymptotic robustness issues in dependent models have been looked into, with special emphasis on ARCH type models.

Work is continuing in the direction of optimality of Experimental Designs. Constructional problems in 2-way heterogeneity eliminating designs are being investigated.

The Institute has taken up a project for estimating the life distribution of currency notes of different denominations in circulation in the market. The Institute was approached by the Reserve Bank of India for undertaking such a project as the findings of the project will have significant impact on the management of printing and circulation of currency notes. The project is sponsored by RBI and a team of statisticians from the

Applied Statistics and the Theoretical Statistics and Mathematics divisions are working on it. The project officially started from June 2000.

As a part of the exchange program between Indian Statistical Institute and University of Leeds, UK, a three day workshop was organised in July 2000 at the University of Leeds on *The Statistics of Directions, Shapes and Images*. Scientists from the Machine Intelligence Unit, Applied Statistics Unit and Stat. Math. Unit participated in the workshop and gave lectures

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, Markov chain simulation.

A contemporary review paper on Infinite Divisibility, with emphasis on statistical applications has almost been completed. A boundary crossing problem for maximums has been studied with application to sequential estimation.

Necessary and sufficient conditions were obtained for the convergence of convolution powers of a probability on the space of $d \times d$ stochastic matrices. Random continued fraction expansions and related ergodic transformations were studied. Explicit formulae were obtained for the moments of escape times of simple random walk from bounded intervals. Complete characterization was obtained for Markovian motions with non-negative velocities on the line.

In the regular probability theory seminar, recent results on the following topics were discussed: Empirical Processes, Decoupling, Bootstrap, Percolation theory, and random iteration of quadratic maps.

Mathematics

The main areas of research included Commutative Algebra, Geometry of Banach Spaces, Spectral Theory of Differential Operators, Non-Commutative Geometry, 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, Theoretical Computer Science, Harmonic Analysis, Ergodic Theory, Functional Analysis, Operator Algebras, Differential Geometry, Spectra of Laplacians, Sediment Transport, Graph Theory, Combinatorics and Construction of Designs.

A problem of embedding of certain planes in the affine three-space over arbitrary commutative rings containing a field of characteristic zero is being studied: An Epimorphism theorem has been proved.

In Functional Analysis two lines of investigation have been pursued. The first is to determine, in terms of nested sequences of open p-balls, necessary and sufficient condition for the uniqueness of Hahn-Banach extension of a linear functional on a subspace to the whole space with respect to a sublinear functional p. The second is to describe the form of linear diameter-preserving bijections from one function space to another.

Work on a project entitled *Techniques of topology, geometry, and analysis on manifolds* which is supported by the Department of Science and Technology under its USERS scheme has been started.

Research continued in Analysis on Semisimple Lie Groups. Some results were obtained on Heat kernels from the point of view of uncertainty principles.

In Topology, Function Space Topologies and related problems were studied and some problems in Set Topology were investigated.Work on some problems in Descriptive Set Theory is going on.

Work in the area of approximation algorithms and hardness of approximation is being continued. Polynomial time 2-approximate solutions of Minimum Linear Ordering and a few Feedback Set problems have been obtained using Goeman-Williamson primal-dual algorithm for Hitting Set problem. Results have also been obtained about hardness of approximating several NP-hard optimization problems on general as well as degree bounded graphs and digraphs.

Projects Undertaken

Robust Discriminant Analysis

Weighted likelihood estimators based on certain minimum divergence criteria have recently been shown to retain first order efficiency under the model while having attractive robustness properties away from it. In the year 2000-01, these estimators and the weighted likelihood estimation procedure have been used to develop classifiers which are robust alternatives to Fisher's discriminant function. The usefulness of the proposed methods have been illustrated through extensive simulation study and have also employed them on real data. The work has been reported in a paper.

Uterine Cervical Cancer: Database, Statistical Modeling and Other Issues

As a result of joint collaborative research with scientists of sociology and biochemistry units significant demographical, cytological and clinical information has been collected, which can be very useful in studying epidemiology and cost-effective management of uterine cervical cancer among female population in India from lower socio-economic background. The collected data have been analyzed using modern statistical techniques. This project on Epidemiological studies on HPV infections and its role in the development of Uterine Cervical Cancer is continuing in collaboration with Biochemistry unit.

Statistics in Ecology

The objective of the project is to analyze, using Bayesian approach, the available data on bird-watching to estimate the abundance of different species of birds. There is no satisfactory method for doing this estimation based on bird-watching data. The existing methods use capture-recapture technique which has been found impracticable in this context. Attempts are also being made to get more extensive data about vegetation and habitats for different species of birds and build a model integrating all aspects of the environment and abundance of the species. A good database will also be built up on all aspects of environment for at least a small part of the country. Work on the project has begun.

Selected Papers of C.R. Rao

Volume IV of the Selected Papers was published in 1999. The last of the volumes planned so far, namely Vol. V was published before the Conference held during 29-31 December, 2000, in celebration of the eightieth birthday of Professor C.R. Rao.

Regional Mathematical Olympiad

Preliminary work for conducting The Regional Mathematical Olympiad 2001 for West Bengal, sponsored by National Board for Higher Mathematics, for classes IX, X and XI students has begun. Over the years, this annual event has generated a great deal of interest and enthusiasm in Mathematics in this region.

Stat-Math Unit, Delhi

Research Activities

Research was carried out in the following broad areas: Block Design, Estimation of parametric functions of distributions, inference under order restrictions, stochastic orders for order statistics, spacing and concomitants of order statistics, inference problems for a class of partial differential equations, stability and

largeness of core in game theory, robustness of filters in filtering theory, characterisation problem for Levy processes, asymptotics for spectral elements in matrix theory, operator calculus.

Using finite projective geometry, a large class of fractional factorial plans for symmetric factorial designs was obtained. These plans are shown to be universally optimal under a model that includes the mean, all mean effects and a specified set of two-factor interactions. Block designs for mean effect plans with possibly non-orthogonal blocking were also obtained.

Estimation of parametric function of two distributions has been investigated. The results and its applications to estimation of intra-class correlation, common mean problem and recovery of inter-block information, known earlier, have been improved. Multiple range test for analysis of covariance due to Dhrypen and Paulsen in the special case of a single variate has been extended to several covariates and a new method of computing the percentage points of the test statistics has been worked out.

Estimation problem for survival functions under constraints has been studied. Studies have been made in the interface problems for estimation of survival functions and competing risks. In the area of stochastic ordering, results have been obtained regarding order statistics and spacing and concomitants of order statistics of non-homogeneous observations.

Nonparametric and parametric statistical inference problems for a class of stochastic partial differential equations when the process is observable continuously over space and time or when the process is observable at discrete time points but continuously over space, have been studied. Sequential version of Cramer-Rao type integral inequality has been established for sequential Bayes risk. Cramer-Rao type integral inequalities for general loss functions have also been derived. Hajek-Renyi type inequality for associated sequences and Whittle type inequality for Banach space valued martingales have also been established.

In Game Theory, research regarding the stability and largeness of the core has been carried out. Nice conditions under which stability of the core coincides with the largeness of the core have been found. In particular, these results solve the problem for all symmetric transferable utility cooperative games.

The question of robustness of the filter in non-linear filtering theory has been studied. Significant results regarding the behaviour of the filter when the model specification is approximate have been obtained.

Characterisation of Levy processes through a finite sequence of time space valued polynomial martingales has been established. Two classes of Levy processes has been found - one containing the homogeneous Levy processes and the other more general Levy processes. Exact number of polynomials required has been found in terms of the cardinality of the support of the Kolmogorov measure of the process.

Asymptotics of eigenvalues and eigenvectors of a perturbed matrix has been studied. Computing the asymptotics of spectral elements is a key problem which relies on the characteristic polynomial and the Jordan canonical form. Results have been obtained to explicitly determine the dominant exponents of eigenvalues. These results can also be viewed as versions of a matrix Puisuex problem. The new approach has enabled to solve some cases which were previously considered as singular.

Calculus of operator functions was developed further with the computation of norms of derivatives of some operator maps. These results answer some questions in mathematical physics and numerical analysis. Techniques developed in operator theory have been applied in the study of the stability of the solution of Lyapunov equation unifying the works of several numerical analysts and engineers.

Stat-Math Unit, Bangalore

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 NBHM, the Mathematical Olympiad and the educational activities of the Indian Academy of Sciences.

A brief resume of research carried out during the year is given below:

Research Activities

Mathematics

The main areas of research included Functional Analysis, Geometry of Banach space, Ergodic theory, Operator algebras and Operator theory, Harmonic analysis, Differential Geometry and Topology, Non-linear partial differential equations and Geometry, Finitely additive measures, g-inverses, Algebraic groups, Combinatorial Number theory and Algebraic geometry.

The main objects studied related to tensor product systems of C*-Hilbert modules were completely positive definite kernels, morphisms of product systems and time ordered Fock modules. The classification theory for these product systems was initiated, and the main results obtained include: (i) A criterion for a set of units to generate a product system; (ii) A complete description of positive, projection, unitary morphisms of time ordered Fock modules; (iii) Identification of product systems of dilations of CP semigroups with bounded generators as time ordered Fock modules. Also considered was the problem of obtaining minimal dilations of operator cocycles of E_0-semigroups of type I factors. The main result here was that the minimal isometric dilation of cocycles always exists and is unique in a certain sense. Also obtained were results analogous to Sarason's characterization that subspaces to which compressions of semigroups are again semigroups are semi-invariant subspaces, in the context of cocycles and quantum dynamical semigroups.

A classification of homogeneous Scalar Shifts was obtained. The technique of "blowup" was used to understand quotients of Hilbert modules better.

A simpler proof over the complex numbers of a classical result of algebraic geometry known as the Hilbert-Mumford criterion was established. A number of generalisations of the classical Erdos-Ginzburg-Ziv theorem was proved.

The binary code generated by the characteristic functions on a finite symplectic space over a field of characteristic two of the quadrics of a fixed witt index is shown to be independent of the witt index. Its radical and socle structures and, in particular its dimension, as a module for the corresponding symplectic group was determined. A formula for the code generated by the characteristic functions on k-hypersurfaces in a projectic spaces was obtained using some elementary algebraic concepts initiated by Moorhouse and a close anologue of the classical formula of Hamada was derived.

Refined versions of Hardy's theorem for the Euclidean Fourier transform as well as for the Helgason Fourier transform on rank one symmetric spaces have been established. A characterisation of the heat kernel associated to the sublaplacian on the Heisenberg group was obtained.

The precise blow up behaviour was studied and a priori estimates were obtained for bounded energy solutions of the subcritical exponent problem on the CR Sphere. This is the first step towards understanding the problem of prescribing curvature functions for the CR Yamabe problem on the Sphere. As in Riemannian case, it was shown that the blow up sequence necessarily converges to a critical point of the curvature and the flatness conditions on the curvature function decide the nature of the blow up point.

Considerable progress has been made in the writing of a monograph (book) on Chaotic Dynamics on the Real Line. Many popular and a few highly technical and mathematical books exist describing this subject. The aim of the proposed work is to present details of various claims in popular books with rigorous proofs at elementary level using only real variable theory.

It was proved that if u non-reflexive Banach space is an M-ideal in its bidual then it continues to be an M-ideal in all the duals of even order. A long standing question in the geometry of Banach spaces was settled by exhibiting a Banach sapce in which every unit vector is an extreme point of the unit ball of the bidual but none are extreme in the unit ball of the fourth dual.

One of the important classes of linear codes is that given by the characteristic functions on linear subspaces (of a fixed dimension, say r) in a projective space P^n. The celebrated Hamada's formula (proved in 1968) gives the dimension of these codes. Hamada's formula takes on a very cumbersome form even in the simplest case of codes generated by hyperplanes. Despite many attempts made at finding a simpler version of this formula, a simplication is found only in some very small number of cases.

The codes given by the characteristic functions of hypersurfaces of a fixed degree r in P^n were investigated and a formula for its dimension was obtained. It was also proved that this code is the code given by linear spaces of dimension $n-r$ thereby giving an alternative to Hamada's formula.

Krengel-Lin decomposition for measures on algebraic structures such as Tortrat groups, commutative hypergroups and central hypergroups was proved. Siebert factorization theorems (which say that a full or a symmetric T-decomposable measure can be written as a product of a strongly T-decomposable measure and a T-invariant measure) for measures on unipotent groups and on p-adic Banach spaces was proved. A characterization of compact hypergroups within the class of hypergroups admitting an invariant Haar measure is proved, viz. a hypergroup with an invariant Haar measure is compact if and only if the hypergroup has normed convergence property.

Statistics and Probability

The main areas of research in Probability Theory included Quantum Probability, Diffusion Processes and Skorokhod 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 estimation, Robust Bayesian analysis and Optimality and construction of experimental designs.

Skorokhod Problem in an Orthant (which arises in the study of diffusion processes with reflecting boundary conditions) was suggested as a Subsidy-Surplus Model in a multisectoral economy; comparison results and consequent applications to asymptotics of reflected Brownian motion were investigated

Feynman-Kac semigroups associated with reflected Brownian motion in a bounded Lipschitz domain were studied; (the potentials in the interior as well as on the boundary could belong to generalized Kato class). In addition to proving a conditional gauge theorem, a connection with conditioned Brownian motion was obtained.

Existence, uniqueness and characterisation of solutions of the infinite dimensional equation corresponding to the finite dimensional Brownian motion were proved. Also characterised are solutions of the infinite dimensional equation corresponding to a finite dimensional semi-martingale.

An important development was the nonparametric Bayesian estimator of a general regression function using wavelets. Multi-resolution analysis was used here to derive a wavelet smoother as an estimated regression function for a given set of noisy data. The hierarchical Bayesian approach was employed to model the regression function using a wavelet basis and to perform the subsequent estimations. The Bayesian model selection tool of Bayes factor was used to select the optimal resolution level of the multi-resolution analysis. Error bands were provided as an index of estimation error.

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 consists 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 the areas of Network Sampling and Adaptive Sampling through Networks, respectively, covering situations where the sampling units and the observational units for which a parameter is to be estimated are different and are not different, some theoretical work was done covering stratified, multi-stage unequal probability sampling without replacement. Some empirical exercise using Economic census data was also done to provide guidelines in formation of networks suitable to produce serviceable estimators for total numbers of people with specified features that are widely scattered in various localities.

In the context of randomized response (RR) techniques results were developed to yield estimates of people with sensitive characters when samples are drawn according to complex designs. Both maximum likelihood and method of moment estimators were employed yielding mean square error estimator in this context. Efficacy of IPNS technique was also demonstrated in the RR surveys.

In the context of multi-stage sampling in unbiased estimation of the mean square errors (MSE) standard results start with the MSE formulae as quadratic forms suggesting complications in case a standard MSE is in a different form. Appealing to commutativity in expectation operators in the initial and later stages of sampling simplified procedures were developed.

Based on the well-known Hajek's (1958) approach an MSE-estimator form differing from a quadratic form is amenable to easy check for its uniform non-negativity which is not available for the latter, provided both are unbiased for the same MSE. When this is not the case alternative MSE-estimator forms were developed with easy checks for uniform non-negativity.

Taking interest in the methods followed by various state Governments and also by the government of India in estimating (i) areas under principal seasonal crops, (ii) their yield rates and (iii) amounts of their yields certain corrective measures have been recommended and they are accepted by the Governments. For the CSO Industrial Wing, Government of India also certain revisions in the sampling designs were recommended and found acceptable to them.

At the instance of the National Statistical Commission ISI undertook a project in collaboration with NSSO and in connection with this it was demonstrated how using NSSO data, improved district level estimates for several socio-economic variables could be obtained employing the Small Area Estimation techniques applying methods of Generalized regression (GREG) estimation, empirical Bayes (EB) and Kalman filtering.

Finally, using Economic Census data it was demonstrated how in stratified two-stage sampling, improved estimation is possible in estimating the first-stage unit level values employing the GREG and EOS methods essentially by appealing to the Small Area Estimation principle of borrowing strength.

Design of Experiments, Combinatorial Methods and Their Applications

"Strongly balanced" and "uniform" are stringent conditions on repeated measurement designs. A new concept of nearly balanced and nearly uniform was introduced. Though such designs are not optimal, these have good efficiency. Construction issue for such design when $\lambda = 1$ or 2 was settled.

Research was carried out on the allocation problem (and related inferences) in the clinical trial set up. An allocation rule was introduced for the clinical trial set up for allocating the entering patients among two competitive treatments in such a way that eventually the better treatment will have a larger allocation. Responses were assumed to be continuous and the presence of prognostic factors was also handled. An adaptive allocation design was also introduced in the group sequential set up. This method bridges the two approaches in clinical trial research, namely group sequential methods and adaptive allocation designs. Some Bayesian adaptive design was also studied in the context of clinical trials.

An adaptive technique was also suggested for simultaneously selecting the optimal model and efficiently estimating the parameters involved in that model among a class of nested linear models. This problem has an application in chemical engineering.

Some cross-over experiments are such that the carryover effect is a fraction of the direct effect. Data sets were found where such a model fits well. Under such a model, surprisingly, the SBURMD is not optimal and another class of designs are highly efficient. These designs are also smaller in size. Some research in this direction was carried out.

Some designing was done towards finding the best Puja in Kolkata.

Biostatistics

Research was carried out for adaptive allocation (and related inference) for repeated observations from patients with reference to an application and the resulting data set on the treatment of patients with rheumatoid arthritis.

Some review works were done on the statistical perspective of carcinogenic potency.

A Bayesian epidemiological study was done for bivariate ordinal data with covariates resulting from the Wisconsin Epidemiologic Study of Diabetic Retinopathy. Some theoretical studies followed by the analysis of the data were carried out.

Research on modeling and analysis of environmental/air pollution data were also carried out. A Poisson process approach for recurrent event data with environmental covariates was adapted. A test of homogeneity across groups with Poisson count data was also done.

A robust method was developed for estimation in the survival analysis scenario with right censored data. The method has bounded influence and performs well compared to classical methods of estimation.

Reliability, Life Testing and Survival Analysis

In a continuing analysis of accidents in Indian coal mines, the rates of non-fatal accidents in the mines operated by the Eastern Coalfields Limited were analyzed.

A goodness-of-fit test for log-concave distributions in the context of lifetime data was derived. Although this problem has relevance both in Reliability and Econometrics, no other solution was previously known.

Calculation of coherent system reliability was considered in various stress-strength scenarios in which stress can be common for all the components in the system and also present at the component level. Some formulation of stress-strength reliability was also worked out in a regression set-up.

Availability of a maintained system with or without spares and with different (prefect or imperfect) repair mechanisms was calculated. The class of distributions admitting L-optimal tests for no contamination was characterized, and applications to reliability models was studied.

A battery of diagnostic plots for detecting systematic departures from the Proportional Hazards (PH) model for life time data was proposed. Methods of making adjustment for better adherence of the data to the PH model were also examined.

Nonparametric estimation of cause-specific hazards in a competing risks problem with general missing pattern in failure type information was considered. A method using the EM algorithm is found to have some difficulty regarding estimability. On this point, a counting process based approach leads to a Nelson-Aalen type estimator which seems to work better. This approach links the observed processes with the underlying processes for different failure types under some assumptions on the missing mechanism.

Multivariate Analysis

Classification procedures were studied when the populations are correlated. Linear discriminant functions (LDFs) were constructed, depending on the knowledge of the parameters associated with the populations, with unmatched training samples from the populations. Exact densities of the LDFs were derived. Simulation studies were made to assess the probabilities of correct classification in using the LDFs.

Studies were made on near exact and asymptotic distributions of some Bahadur optimal tests, derivation and optimal inference for bivariate Von Mises conditional distribution, optimal P-cube and LMMPU tests in multivariate and multiparameter multicomponent mixtures.

Inference

In the area of clinical trials with two competing treatments, fixed width confidence intervals for treatment differences were derived for both independent and adaptive sampling schemes. Alternative tests for testing normal mean against two-sided alternatives were developed, using some adaptive sampling scheme.

In the context of circular data, new optimal tests for isotropy against the wrapped stable mixture family were derived. Optimal tests for change-point for change in mean direction were also proposed. Other work in this area included construction and inference for some asymmetric circular families and computational Bayesian techniques for some circular families.

Some work has been done with regard to an estimating equation approach for estimation of mean regression parameters with unspecified variances.

New classes of divergences useful for minimum distance estimation were developed. Methods of improving the power of the standard goodness of fit tests for bump and dip alternatives were proposed. Some density-based divergences were developed. These led to highly efficient estimators with bounded influence and a method, based on minimum distance ideas, for robust discriminant analysis.

Cryptology and Computer Science

Significant work was done for studying cryptographically important properties (like non-linearity, resiliency, algebraic degree, balancedness, symmetry etc.) of the Boolean function of LFSR-based stream cipher systems. This is important for enhancing the robustness of the scheme. Various state-of-the art techniques were developed for construction of resilient Boolean functions having high non-linearity and algebraic degree. Some of these techniques yield best results known so far in this field. Different combinatorial aspects of the Boolean

function and its properties like SAC, PC. Autocorrelation (important in connection with design of S-boxes in Block Cipher Systems) were also investigated for their proper utilization.

Catastrophic Fault Patterns (CFP) in VLSI architecture were studied. Enumeration of CFPs for a given link redundancy was worked out for both bidirectional as well as unidirectional links. Given a CFP, finding out a minimal set of link redundancy which will allow flow of information, is a non-trivial problem. An algorithm was devised to tackle this problem. Characterization and enumeration of CFPs in two-dimensional architecture was also considered.

Projects Undertaken

A. Internally Funded Project

Regression Models for Survival Data

The purpose of this project was to make a systematic study of the available diagnostics for some regression models for survival data. During the first year, properties of the various residuals in Cox's Proportional Hazards (PH) model had been examined. The focus of the second year's work was on those diagnostic plots which check the validity of the proportional hazards assumption, irrespective of the validity of other related assumptions (such as additivity/linearity of the covariate effects). If the proportional hazards assumption does not hold, then it may still be possible to use a modified version of this model after suitable adjustment. The set of plots available in the literature and some new plots were examined from this point of view. Two specific types of violation were considered: (a) a covariate contributing as a scale factor of the failure time (rather than a scale factor of the hazard rate) (b) a regression coefficient being time-dependent. It was assumed that the effects of all the covariates except one are proportional on the hazard rate. Simple and intuitive methods of adjusting for the non-proportional effect of a single covariate were then explored and studied via simulations. The procedures considered here can be organized to form a gateway to the proportional hazards model. The entry could be automatic (if the plots are good), conditional (if the plots are not good but satisfactory remedial measures are available) or rejected. Other diagnostics for the Proportional Hazards model come into the picture only after automatic or conditional entry has been gained.

Winter School on Applied Statistics

The unit organized the 2nd Winter School on Exploration of Patterns in Spatial and Other Types of Large Data' in Calcutta during 6-23 February 2001. The objective of the School was to generate research/teaching interest among the faculty and scholars on Spatial Statistics and to emphasize, to the scientists and officers, the vast potential for applications in the use of Remote sensing data and Statistical Modelling of large data sets.

IASRI, ICMR, IIPS, RBI, ASCI, IIT, and various Universities from 11 States nominated 38 applicants. Other than the faculty of the Institute, the resource persons were drawn from CRSE, IIT Bombay and Burdwan University.

Lecture topics included Spatial Processes, Statistical Image Processing and Remote Sensing Image Classification, Models for large data and their applications in DNA mapping, Statistical Approach to Geological mapping, Bayesian Approach to Spatial Data Analysis and Simulation, and some Research Topics aimed at applications; compared to the first School, extra emphasis was put on Spatial and Large Data File handling Mining, and hands-on training on GIS.

A bound volume of Lecture Notes was distributed at the beginning of the School.

Indocrypt 2000

In December 2000, the Applied Statistics Unit successfully organized INDOCRYPT 2000 - the first International Conference on Cryptology in India. Prof. Bimal Roy of ASU was the Program Co-chair of the conference. This four-day conference (including a single-day workshop) was able to bring together the academicians and professionals in India involved with research and development of cryptology and was a major step towards organized study of cryptology in India. The conference was attended by a number of foreign delegates, including stalwarts in this field like Prof. Adi Shamir, Prof. Eli Biham, Prof. Jennifer Seberry and Prof. Cunsheng Ding. The proceedings of the seminar was published by the renowned international publishing house Springer-Verlag in their LNCS series. INDOCRYPT has become an annual international event and has helped India to earn a prominent place in the international Cryptology community.

B. Externally Funded Project

Software Development for Cryptanalysis

ASU has successfully completed this Defence Research & Development Organization (DRDO)-funded project. The three-year long project was a joint collaboration with Bengal Engineering College (Deemed University), Howrah. The main objective of the work was development of mathematical and statistical framework for formulation of cryptananlytic attacks for LFSR-based stream cipher system, its software simulation and hardware implementation. The hardware implementation portion was handled by the B.E. College and the methodological research work was carried out by the ISI. The outcome of the project was development of some improved cryptanalytic techniques for estimation of initial condition of LFSRs and the unknown Boolean function and the connection Polynomial.

Audit Sampling Project

On a request from the Finance Department, Government of West Bengal, a survey design was introduced and implemented to carry out audit by sampling for the Health Sector leading to its continuation with appropriate modifications to cover the Public Works, Irrigation and the Engineering Sectors. 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 records in respect of both quantitative and categorical data was examined through this sample survey and estimates of various characteristics were prepared.

Computer and Communication Sciences Division

The Division comprises Computer Vision and Pattern Recognition Unit, Advanced Computing and Microelectronics Unit, Electronics and Communication Sciences Unit and Machine Intelligence Unit. Faculty members of the Division are also engaged in teaching and training 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 Sciences, Electronics and Telecommunication, Electrical Engineering and students of MCA courses from different universities and institutes undergo their vocational/semestral training under the supervisions of the faculty members of this division. Research work carried out in these units is described below.

Advanced Computing and Microelectronics Unit

During the period 2000-01, the faculty members of the Unit were engaged in research in the field of Computer Science. The specific areas of research included Parallel/Distributed Computing, VLSI design and Mobile Computing.

Research Activities

Parallel Architecture for Fast Recognition of Simple Geometric Image Patterns

This is an on-going project which deals with the problem of identifying simple geometric patterns from the digitized black and white image pixels. The conventional algorithms used for this purpose usually consume a lot of computational time. The objective of this project is to devise a suitable parallel architecture and the corresponding algorithm, so as to identify the simple geometric patterns in a given image in a fast and cost-effective manner.

During the year in question, an O(N) time algorithm has been developed using content addressable memory for recognizing all the N straight lines in a 2D image. Using an associative memory-based architecture, a parallel O(N) algorithm has been developed for identification of all the basis polygons formed by these lines. As a first level benchmark, the algorithm has been applied on images consisting of a finite number of simple geometric patterns like rectangles, squares, triangles, parallelograms, rhombus, etc. with varying locations, sizes and orientations. It is hoped that the results of the investigation on images consisting of polygons, may also be successfully used to devise algorithms for fast recognition of patterns containing curved lines as well, on the proposed architecture.

Performance Analysis of Multiprocessor Systems

This is also an on-going project which concerns the performance analysis of a shared memory multiprocessor system. An N x M shared- memory multiprocessor architecture consists of a set of N processors $\{P_1, P_2, \ldots, P_N\}$, and a set of M memory modules, $\{M_1, M_2, \ldots, M_M\}$. In such a system, contentions occur when more than one processor in the same memory cycle generate requests for a common memory module. Contentions degrade the acceptance rate of memory requests and hence the overall system performance. One measure of the performance is the effective memory bandwidth, i.e., the number of modules that are busy during the same cycle. Other performance indices include mean waiting time for a memory request and expected queue length.

During the year, the effect of finite buffer (queue length) on the performance of the system has been studied. In a system with hot spot traffic and finite length buffers, buffers may become full even under realitively light traffic, because of the condensation of traffic in the switches leading to the hot spot. In such cases, one mode of reducing traffic is to combine two different requests to the hot spot having some attributes in common. Such a system and derived formulae for network latency, throughput, etc. have been analyzed. Simulation studies have been conducted and the results compared with the formulae. The behavior of the system in presence of cache memory at each of the processors has also been studied. Intuitively, use of cache memory would reduce the access traffic at the memory modules, which would result in lesser conflict with increased memory bandwith. However, this will also bring about the issues of cache inconsistency. Theoretical analysis as well as simulation experiment have been undertaken to reveal the system behavior under such conditions.

Efficient Utilization of Caches in Designing Algorithms

This research project deals with the issue of cache-conscious design of algorithms. In order to speed up memory accesses, small high speed memories called caches are placed between the processor and the main memory. 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 a 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. 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, and to redesign the algorithms in the presence of cache.

During this year, as an initial step, the all-pair-shortest-path algorithm by Floyd was taken up and redesigned, taking the presence of cache in the computing system into account. The basic idea was to re-order the sequence of operations in the algorithm depending on the available cache size of the system for utilizing the current data present in the cache as much as possible, resulting in what is called a blocked version of the Floyd's APSP algorithm. The experiment was made on SGI and SUN workstations using the cache simulation tool Shade. The experiments indicate that the blocked version of the algorithm delivers a speed-up (relative to the original unblocked algorithm) between 1.6 and 1.9 on a SUN Ultra Enterprise 4000/5000 for graphs that have between 480 and 3200 vertices. The measured speed-up on an SGI 02 system for graphs having 240 to 1200 vertices is between 1.6 and 2.

Another class of problems where cache-consciousness may improve performance is in the area of Image processing. Particularly interesting are the relaxation algorithms, which are iterative in nature and hence may yield higher improvements for a small change. Investigations have been carried out on improving performances of different image processing algorithms like Canny's edge detection algorithm, segmentation algorithm, etc.

Mobile Computing

Because of the growing demand for mobile communication throughout the world, mobile computing has emerged as one of the important areas of recent research. There are various aspects which have drawn the attention of the researchers over the past few years. These include channel allocation, efficient location management and hand-off management with a view to achieve the desired QoS (Quality of Service), etc.

In a mobile computing environment, all the neighboring base stations are connected to a Mobile Switching Centre or MSC. When a mobile user is about to leave a cell, the cell's base station transfers the ownership of the mobile to another base station getting the strongest signal from the mobile user. If a call were in progress at this point of time, then this call should be switched to a new channel (as the old one is not used in any adjacent cell).

Base stations should provide separate channels to each mobile under its control. Further, channels must be assigned so that there is no interference with the channels of the adjacent cells. On the other hand, the number of available channels in any practical situation is limited. Two sufficiently distant base stations can, however, use the same channels where inter-cell interference is negligible. Optimal channel assignment is an important issue to be resolved.

During this year, assuming a k-band buffering system where the inter-cell interference does not extend beyond k-cells away from the originating cell, two different formulations have been provided for the channel assignment problem - distance-k chromatic number problem, and k-band chromatic bandwidth problem. Existing algorithms on the first problem are non-optimal, and a new optimal algorithm for this problem has been developed. Using the elitist model of the genetic algorithm, a near-optimal algorithm for channel assignment has been developed. Corresponding to a 2-band chromatic bandwidth problem and single demand per cell, this algorithm shows a performance improvement over the earlier results by a factor of 4/3. In addition, an integer linear programming formulation of the general channel assignment problem has been given. This leads to an algorithm which provides optimal bandwidth for all the eight benchmark instances. The computational time involved with this algorithm is about one-tenth of the earlier best results reported in the literature.

A new technique has been proposed for the exact location identification of a mobile user, in case of emergency like fire, accident, medical emergency, military applications, etc. The technique is capable of detecting the location with an accuracy of about 12 meters. The associated overhead in terms of extra hardware attachment, number of messages to be communicated, message complexity and message length is negligible.

Different location updation startegies have been simulated on a mesh architecture of cells. The performance evaluation results have shown that distance-based location updation strategy is better compared to the others.

Interconnection Networks - Phase II

Multistage interconnection networks have received more and more attention for interconnecting parallel computers and ATM switches in broad band networks because of their property of deadlock-free routing and equal communication latency between any network input and output. During the year in question, an $O(N \log N)$ algorithm has been developed N being the number of input/output lines, to find the minimum number of stages of a Benes network (which is a rearrangeable one) to route a given permutation. This technique would be helpful to route any permutation with minimum delay. Moreover, for hybrid optical networks, where the optical signal gets attenuated as it passes through a number of couplers at each stage, this technique would be highly important to keep the path-dependent loss of the signal to its minimum.

Computer Vision and Pattern Recognition Unit

Apart from research activities, faculty members of this unit were involved in teaching seven courses at various levels (B.Stat., M.Tech.(CS), M.S.(QE), etc.) in the Institute, as well as in consultancy. ISI has agreed in principle to transfer Bangla and Devanagari OCR technology developed in this Unit to C-DAC, Pune, for commercialization. It is expected that an MoU will be signed soon.

Research Activities

Document Analysis

The unit continued to improve the Optical Character Recognition system for printed Bangla and Hindi texts. A prototype system for the recognition of basic printed characters in the Oriya script was also implemented. Preliminary work on recognition of hand-written text, particularly numerals has been completed. Investigation is being done on other aspects of document analysis, such as automatic separation of scripts in a multilingual document, automatic skew correction, identification of type styles (bold, italic, etc.), recognition and segmentation of mathematical expressions, and searching for keywords in a document image. Investigations into document data compression have also been initiated.

Biomedical Image Analysis

Work commenced on the analysis of functional Magnetic Resonance Imaging (fMRI) data for the study of the human brain. Currently existing techniques are being studied for the processing and analysis of such data. It is planned to explore various problems currently of interest to the neuro-imaging community, such as estimation of atrophy, locating areas of the brain responsible for neuro-psychiatric disorders such as seizures, hallucinations etc.

Neural Networks and Genetic Algorithms

Investigation is being carried out on the use of self-organizing neural network models for solving problems in Computational Geometry, such as finding the smallest hypersphere enclosing a given set of points in arbitrary dimensions, and the k-centre problem. Application of such models to document analysis tasks will be taken up later.

Natural Language Processing

Work continued on the detailed linguistic analysis of Bangla noun, adjective, adverb, and pronoun word forms, and compound, reduplicated, and onomatopoeic words. Some preliminary work was completed on stylo-statistical analysis of Bangla sentences. A multi-lingual dictionary is being constructed for some of the major Indian languages. A dictionary that allows phonetic searching has been constructed, and has been incorporated into the sophisticated spell-checker for Bangla developed by the unit. Work has started on constructing a semantic net for Bangla.

Speech and Signal Processing

An improved pitch detection program that uses state phase analysis was implemented. A study of the intonational and prosodic patterns in Bangla speech was also initiated. Some speech data has been collected for this purpose.

Methodology Development

In addition to applied research in the various areas mentioned above, the unit continues to be involved in the development of theoretical methods and algorithms related to fuzzy sets namely definition of a fuzzy correlation measure, dot pattern analysis (shape estimation and border analysis of dot patterns), computational geometry (computing convex hull of a Jordan curve), data clustering especially for noisy data, etc.

Information Retrieval

A prototype information retrieval system for Indian languages, specifically Bangla was implemented. Currently work is progressing on the problem of hierarchically classifying natural language text documents such as Web pages. A simple classification algorithm has been implemented and tested. Ways to improve classification accuracy is being investigated. Moreover, the TREC document collection has been acquired and indexed. A few benchmark tests have been conducted on this collection.

Electronics and Communication Sciences Unit

Research Activities

The broad areas of research activities carried out during the period April 1999 to March 2000 are: (a) Theoretical and Experimental Investigations in Computer Vision, Biomedical Imaging and Image Analysis, (b) Theory and Applications of Fuzzy Logic, Neural Nets and Other Soft Computing Paradigms in Pattern Recognition, (c) Remote Sensing and Data Analysis in Atmospheric Science and Wave Propagation and (d) Acoustic Phonetic Studies on Indian Speech Sounds Leading to Automated Speech Recognition.

Computer Vision, Biomedical Imaging and Image Analysis

Document Image Analysis

Preliminary experiments on content based image retrieval were carried out. An algorithm was tested on b/w binary logo images. Contours of each logo object were decomposed into eight differently oriented edge planes which give rise to an 8-dimensional feature vector. This vector is rotation, scale and position invariant. Seven additional invariant features were generated with geometric moments. A simple similarity measure based on Euclidean distance in conjunction with a user defined threshold is used for retrieval.

Mathematical Morphology

A multiscale morphological algorithm was developed for image segmentation. The algorithm is implemented using an already proposed concept of morphological tower. Experimental results reveal the superiority of the proposed method to the existing algorithms for the same purpose. A fast algorithm for opening by reconstruction is being developed.

Image Segmentation for Content Based Image Retrieval

A non-linear filtering based on area morphological techniques was already implemented. The task at this stage is to extend this filtering so that meaningful segments can be extracted from the image. The segment extraction is based on user input defining possible area of a segment. This is perceptually an acceptable parameter. The size parameter involved in the process could also be used as a query index for Content Based Image Retrieval applications. The segment determination algorithm is based on principles of agglomerative clustering.

Digital Watermarking

This is a technique to introduce digital signature in an image. Random patterns are introduced in the image as a digital signature and it is demonstrated that such patterns could be recovered even after a variety of image transformations and image forging attacks. The novelty of the technique is that based on cryptographic principles it is assumed that the attacker is fully aware of the watermarking technique while only the image specific keys are kept secret.

Theories and Applications of Fuzzy Logic, Neural Nets and Other Soft Computing Paradigms in Pattern Recognition

Soft Computing in Pattern Recognition

Several schemes have been developed for generation of decision trees using exploratory data analysis along with their tuning with genetic algorithms. Schemes are also suggested for generation of fuzzy rules from decision trees. A rule minimization process then removes redundant and bad rules from the initial rule-base thus obtained and finally the rule parameters are tuned to result in a small but adequate rule-base with excellent classification performance. The proposed schemes were successfully applied to several benchmark data sets and also to the analysis of remotely sensed multi-spectral satellite images. A rank based pattern classification technique for multivariate data was proposed and applied to the analysis of breast cancer data.

Computational intelligence techniques were applied to pattern recognition and image analysis, in particular to design neural, fuzzy rule based and neuro-fuzzy systems for classification and different applications were made including "blind detection" of targets from LADAR images. Multilayer perceptron type networks usually exhibit good generalization for test data points that are close to the training set. But such networks may (usually will) produce a significant output, even for test data that are far away from the training data. This problem of bad generalization has been attacked and a methodology was developed to avoid such bad generalization.

A few multi-layer self-organizing networks for computation of the convex hull and convex layers of a set of planar points were developed and their computational complexities analysed and compared with those of similar models.

Cybernetic Approach to Medical Technology

Cybernetic approach including that of second order cybernetics is being theoretically and experimentally investigated in the area of bio-medical science and technology including cancer screening and cancer regression.

Evaluation and Mapping of Human Brain

Multimodal image processing/registration, fusion in the context of brain mapping is being investigated in collaboration with the National Brain Research Centre (NBRC) and some other Institution both in the context of Computational Neuro-Science and Neuro-Imaging.

Remote Sensing and Data Analysis in Amospheric Science and Wave Propagation

Analysis of Satellite Image

For estimating the cloud motion vector (CMV), a hybrid technique has been developed. Around the tracer cloud patch, having considerable shape stability, an active contour (snake) is initialized and is allowed to evolve based on gradient vector flow (GVF) method. The target image is then classified into two classes by a multilayer perceptron network. But this needs information/features computed from previously mentioned two regions on the source image. Finally by the Hopfield network the two contours were matched after finding out significant curvature points on those contours, one on source and the other on target image. This technique of optimal matching gives the necessary CMV.

Fractal Algorithm for Study of ABL Dynamics

The wind field in the surface layer is turbulent in convective condition of the atmosphere and to characterise this wind, fractal and multifractal techniques are widely used. To investigate the complexity of wind field, four different measures of complexity, correlation coefficient, mutual information, multifractal and epsilon machine reconstruction are being tried on time series data collected by meteorological tower. The concepts of fractal and chemical dimension may be utilised in characterising cloud from IR images. An attempt has been made to apply the technique of physical erosion process on cloud IR image to identify clusters formed by pixels with gray values above a certain level.

Antarctic Boundary Layer Study

Statistical analysis of sodar data and surface meteorological data collected from lower planetary boundary layer (LPBL) of Antarctica, during 15th Indian Scientific Expedition to Antarctica (ISEA), has been conducted In order to investigate the effect of blizzards on LPBL, wind speed data sets were separately studied seasonally using statistical methods, self similar behaviour and information entropy. Results indicate that the model is especially suitable for predicting wind at Maitri site of East Antarctica.

Forecasting of Meteorological Parameters

Temperature variations depend on many factors like pressure, humidity, relative humidity, rainfall, lat/long of a place, seasons, radiation, cloud coverage, wind speed etc. Connectionist models have been used for short term prediction of temperature with encouraging results.

Acoustic Phonetic Studies on Indian Speech Leading to Automated Speech Recognition

Acoustic Phonetic Study of Oriya Vowels and Consonants and Bengali Glides and Dipthongs

Spectrographic analysis of 330 Oriya words spoken by four educated male informants were carried out to study the acoustic phonetic features of Oriya vowels. Studies on acoustic phonetic features of Oriya consonants and Bengali glides and dipthongs are continuing. Analysis of Bengali glides and dipthongs reveal that they can be grouped under four categories according to their spectral structures. The investigation confirms

the existence of two semi-vowels in Bengali. All these studies will provide reliable acoustic phonetic data needed for computer recognition and synthesis of speech for this language.

Perceptual and Acoustical Study of Stress and Intonation Patterns in Bengali Text Reading

Perceptual and acoustical studies on stress and intonation patterns are necessary in Bengali as well as other major Indian Languages to develop comprehensive knowledge base for computer recognition and synthesis of speech for these languages. Investigation was carried on a test bed consisting of first 5-minute excerpt of 10= minute long radio news broadcast in Standard Colloquial Bengali (SCB) recorded from All India Radio, Calcutta Centre. The examination of stress patterns indicates that Bengali is a language with bound stress, the stress being on the first syllable at least for text reading. Furthermore, the acoustic data supports the augmented articulatory effort theory of speech production. In a recent work intonation patterns of sentences in Bengali text reading was investigated. Intonation pattern is determined from observing movement of pitch contour in sentences. In Bengali two types of basic intonition patterns are noted. The intonation patterns are also found to indicate sentence boundaries, pauses and also word boundaries to a certain extent. This boundary detection is very important for automatic speech recognition (ASR).

Machine Intelligence Unit

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 coonsists of the development of these technologies individually as well as and in an integrated (hybridization) manner, and demonstration of their effectiveness in solving various problems of pattern recognition, machine learning, image processing, brain modeling, case based reasoning, expert systems, vision, data mining, etc. related to the design of intelligent systems. Hybridization such as neuro-fuzzy, neuro-rough, neuro-fuzzy-rough 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 Activities

Pattern Recognition

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 used for this purpose.

Use of a hyperplane based method for automatically clustering a data set is currently being studied. Hyperplanes are used to partition the data set, and a fuzzy measure based on entropy and π-ness is optimized for evolving the appropriate clustering. The developed system is proposed to be used for object-background classification. The utility of genetic algorithms and simulated annealing for clustering has also been studied. In this regard, the use of real coded genetic algorithms has been established. A simulated annealing based clustering technique with probabilistic redistribution of points has been developed.

Image Analysis/Processing and Computer Vision

Multi-scale decompositions are natural for texture characterization. A texture image can be modeled based on multi-scale M band wavelet coefficient and their local statistical properties. An optimal set of new features based on first and second order statistical properties of wavelet coefficients, which also represent more effectively local and global properties of texture, have been proposed. Texture segmentation (unsupervised) results obtained based on those features is found to be invariant under rotation, scaling, translation and gray scale changes. The method was tested with varieties of real life multi-texture data like normal, mixed/embedded (image, graphics, character set) text documents, medical images and natural scene images. The results are extremely encouraging. For enhancing the performance of segmentation scheme further a new set of hybrid features are being tested currently. A scheme for image de-noising using spatial adaptive wavelet thresholding is currently under investigation.

Digital watermarking is another research problem under consideration. A new digital watermarking technique based on homogeneity property of an image has been developed. The method is found to be tolerant against external attack like multiple low pass filtering and median filtering. A U.S patent application has been filed. The problems of image enhancement and edge detection techniques for color images are under investigation.

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 datasets. There are two aspects which make this endeavor challenging - the problem of scaling up learning and pattern recognition algorithms to huge datasets, and the problem of knowledge representation, interpretation and evaluation.

The following two aspects have been studied for the purpose of developing scalable algorithms: i) multiscale condensation of datasets and their underlying distribution (mathematical formulation of the data condensation problem and its convergence properties) and (ii) sequential and active learning to reduce computational complexity. Moreover, learning algorithms having low sample complexity like the support vector machine are used. Selection of features based on similarity of functions for efficient data mining is in progress.

Training of a Modular Rough Fuzzy MLP using GA, obtains a network suitable for extracting logical rules in human interpretable form. Rule extraction algorithms are developed. Quantitative indices for evaluating the extracted rule (knowledge) are defined and compared.

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. Various case selection methods both in neuro-fuzzy framework and rough-fuzzy framework were 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.

Fuzzy membership function have also been used in rough-fuzzy framework to represent different cases, instead of samples. Rough sets help in determining initial cases through rule generation from domain knowledge.

Genetic Algorithms (GAs)

Here the investigation involved both theoretical development of GAs and its different applications to pattern recognition and image processing problems.

The effect of emulating sexual discrimination in artificial genetic algorithms with different applications is being studied. The results, obtained so far, show a marked improvement over the conventional or asexual genetic algorithm. The study of chromosome differentiation for performing restricted cross-over operation for accelerating convergence of the GA process is under process.

A concept of "age of individuals" for deciding their 'parenthood' was introduced, and observed to maintain more diversity in the population. Utility of this concept to optimization in non-stationary environment (where the target changes with time) was studied; it is found that this model can trace the moving optimum in a much better way than the standard GAs. Usefulness of this concept for variable population size and multi-objective optimization is under progress. In another work, parents' fitness was used as a part to decide the fitness of individuals thereby giving more importance to individuals coming from 'better families'. Its different applications are in progress.

A GA based model to evolve Hopfield type optimum network architectures for object extraction is being developed using different fuzziness measures. The performance of GAs vis-à-vis simulated annealing for optimization is also being investigated theretically.

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.

An algorithm for feature evaluation using multi-objective Gas is being developed.

Fractals and Wavelets

A new image compression technique based on Iterated Function System (IFS) with probabilities was developed which is extremely fast in comparison to different fractal based compression techniques developed so far. This is amply suitable for online application and has good compression capability. A U.S patent based on this work has been filed.

An edge extraction algorithm for images in the process of fractal reconstruction has been developed. A new technique for image magnification from the coded version of an image based on fractals was developed. Attempts are being made to further enhance the performance of magnifier and edge extractor.

To segment a texture image, a technique was developed to find optimal wavelet basis on some maximal criterion of textural. Measures derived from the statistical parameters of each of the sub bands to locate the dominant information in each frequency channel (sub band) to decide about further decompositon based on the above scheme. A multi-texture for real life data like IRS image, medical image, segmentation has been developed and results obtained are quite satisfactory.

Neural Networks, Rough Sets, Neuro-Fuzzy and Other Hybridization

Various integrations were made in soft computing framework mainly among fuzzy sets, rough sets, genetic algorithms, and artificial neural networks for developing intelligent systems.

A modular approach is used to divide an l-class problem into l-two-class problems, and to design 1 set of subnetworks for each sub-problem. 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 structure of the subnetworks were automatically determined. The GA tunes the fuzzification parameters, network weight and structure of the evolved network 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. A decision tree-based approach, fuzzy ID3, was devised for knowledge encoding of the network. Applications have been developed in the staging of cervical cancer.

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 pursued its activity primarily in two areas of geological research - Proterozoic cratonic basins of south India, and Palaeozoic - Mesozoic Gondwana basin of the Satpura region in central India. The unit also continued to provide support to a programme on Colloid, Surface and Environmental Science.

Research Activities

Proterozoic Geology

The programme on Proterozoic geology included studies on different aspects of stratigraphy, sedimentation and deformation in the Pranhita-Godavari Valley and Cuddapah basin, and tectonic evolution of the Eastern Ghats mobile belt.

Pranhita-Godavari Valley

The work in the Pranhita-Godavari Valley was focused on reconstruction of stratigraphic succession, and analysis of stratigraphic architecture, to solve several intriguing problems of regional stratigraphy. About 800 sq. km. area around Mancherial and Ramgundam in the central part of the Valley was remapped, after careful evaluation of earlier geological maps, reports and papers. Stratigraphic status of different lithological units was carefully evaluated, and their relationship was rechecked through detailed mapping and checking of key areas and traverses. The areas for detailed checking were decided after studying aerial photographs and satellite imageries. It has been established that the Pakhal Group, the oldest Proterozoic sequence is unconformably overlain by the Penganga Group. The Sullavai Group unconformably overlies the Penganga Group at Mancherial, but overlies the Pakhal Group at Ramgundam. It has further been noted that the Penganga Group overlies the crystalline rocks of the Basement Complex, as well as different formations of the Pakhal Group at different places. The findings establish that the Pakhal, the Penganga and the Sullavai are three well defined unconformity bound sequences, and that the depositional basin was episodically uplifted and depressed across the base level. Different expressions of the stratigraphic relationship of the Sullavai Group with the other groups at different areas have been attributed to tectonic deformation, including uplift of fault blocks, and higher rate of erosion in the raised areas during the pre-Sullavai hiatus.

Classification of the succession in the southern part of the basin, around Mulug and Pakhal lake region was re-evaluated and some of the existing ideas have been modified. The succession comprises three unconformity bound sequences, the Pakhal Group, the Albaka Group and the Sullavai Group in ascending order. Direct field evidence to correlate the Penganga Group and the Albaka Group have not yet been observed. However, it has been suggested on sedimentological consideration that the Albaka Group represents a post-Penganga episode. The Albaka Group around Mulug - Pakhal Lake area has been correlated with the sequence in

the Albaka plateau, implying that the two outcrop belts flanking the two margins of the Valley were originally deposited in a single basin.

Analysis of deformation structures in the Penganga Group has been continued, and a sequence of development of the structures has been established. Deformation was progressive, initiated by layer-parallel shortening under regional compression in NE-SW direction, and culminated involving thrusting and folding. It was followed by development of extensional fractures. Lithological and structural mapping has established that Pakhal and Penganga Groups were co-axially folded about NW-SE axis, prior to the deposition of Neoproterozoic Sullavai Group. The Sullavai Group does not exhibit significant imprint of deformation.

Cuddapah Basin

Nallamalai fold belt: Main research activity was centered around structural evolution of the Cuddapah basin with emphasis on the northern Nallamalai fold belt (NFB). The multiply folded rocks of the Nallamalai Group are thrusted on top of the rocks of the Kurnool Group in the Palnad area representing the northern terminus of the NFB. While a set of northeast trending folds affect the rocks of the Kurnool Group, early reclined to recumbent folds and a subhorizontal cleavage in rocks of the Nallamalai Group are refolded by late northeast folds along the eastern boundary of the basin. Similarly, at the southern end of the Palnad area only one set of folds and cleavage are mapped in the Kurnool rocks. Contrary to this, between Vellatur and Nekarikallu rocks of the Nallamalai Group are multiply deformed (D1-D3) with an early set of recumbent to reclined folds overprinted by later structures.

Kinematics of Deformation: Kinematic indicators on mesoscopic and microscopic scales, such as multiple crenulations, extensional crenulation cleavage in mylonites or phyllonites, asymmetric folds and metre-scale fault displacements and oblique grain shape fabric in quartz mylonites provide valuable clue to the kinematics of deformation affecting one or the other group of rocks. Top-to-west shear displacement is prevalent in rocks of the Kurnool Group in the Palnad area, and along the eastern margin of the northern NFB.

Regional Tectonic Implications: Earlier work done by the unit has shown that D1-D2 events in the NFB is Mesoproterozoic (pre-Grenvillian). The events predate~1000 Ma old tectonic event widely recorded in the Eastern Ghats granulite belt (EGGB). However, the deformation of the Neoproterozoic Kurnool succession and D3 structures in the northern NFB are younger than the~1000 Ma event in the EGGB. The latter is correlated with similar tectonic events in East Antarctica and other East Gondwana fragments and form the basis of a super continent assembly (Rodinia). Both the Nallamalai and Kurnool groups were deposited in an intracratonic setting. One way of explaining compressional fold-thrust belt in intracratonic basins is to consider the effect of subduction/collision farther afield at an active continental margin (e.g., the intracratonic deformation of the Asian plate related to India-Asia collision). Considering this, the deformation of the Neoproterozoic Kurnool Group and other possible Neoproterozoic succession adjoining the Eastern Ghats may be interpreted to suggest greater extent of the continental fragment of India including the Eastern Ghats and the above intracratonic basins. The continental fragment of East Gondwana possibly had one active convergent margin farther afield from the present southeastern margin of Indian peninsula during the late Neoproterozoic - early Paleozoic.

The Eastern Ghats Mobile Belt: Presence of an Archaean granulite event (ca.3.0 billion years) in the so called Proterozoic Mobile belt is established with isotopic data. The newly acquired geochronological data, particularly Sm-Nd data, suggest an assembly of several lithological/tectonic units with distinct crustal residence times, and hence unconnected pre-metamorphic history, in the Eastern Ghats belt.

Gondwana Geology

Vertebrate Palaeontology

Taphonomic data of major Gondwana vertebrate assemblages of India has been analysed. On the basis of these analyses six taphonomic types have been identified for the first time in Indian Gondwana basins. The result has been accepted for publication. More than hundred specimens of metoposaurids from Pranhita-Godavari

(PG) basin, Deccan, India have been analysed and the status of Indian metoposaurid has been revised. Besides a review of the temnospondyl amphibians of the PG basin has also been completed. Shape analysis of several temnospondyl skulls has been carried out. The results will be published soon.

Vertebrate palaeocommunity of the Permian Kundaram Formation of the Pranhita-Godavari basin has been established on the basis of faunal study. Apart from two condothiodon species, five more dicynodont species and a gorgonopsid have been recognised.

During field work, excavation in the Triassic and overlying sediments in the Satpura basin has produced temnospondyl skull and some postcranial material of an archosaur.

Sedimentology and Stratigraphy

Geological mapping of the Talchir Formation in the Kanhan valley area has revealed that the Talchir-Basement contact is irregular with distinct E-W elongated tongues. There are also several isolated basement inliers with E-W elongation. Features indicating glaciogenic origin of the Talchir Formation have been recognized and it is inferred that the configuration of the Talchir-basement contact and the basement inliers could be the result of westward movement of glaciers as revealed from the orientations of the glacial striae. Three major lithotypes constitute the Talchir Formation: conglomerate, sandstone and shale. The conglomerates include different terrestrial till facies, whereas the sandstones and shales dominantly represent sub-aquatic deposition. Development of clast fabric and deformational structures in the till deposits due to glaciotectonism were studied in the field and are being simulated in the laboratory with the help of numerical and physical model experiments

A major temporal change in fluvial style during the deposition of the Denwa Formation has been identified. In the initial phase braided river channels and their flanking muddy alluvium were the main depositional environments, but, in the later phase sediment accumulation took place within a vegetated muddy alluvial plain transected by a number of meander rivers carrying a mud-rich load. A major angular unconformity has been recognized and mapped between the Denwa Formation and the overlying Bagra Formation. It has been noted that across this boundary a major change in provenance and basin configuration have occurred that gave rise to shallow pebbly – gravelly low sinuosity streams during the deposition of the Bagra Formation.

A model based on the fractal geometry has been developed to relate sinuosity of the meandering rivers and the bedform orientations. The model has been tested on data from modern rivers. It is expected that, with the help of this model, it will be possible to estimate the sinuosity of the Denwa palaeochannels by using the data that are being presently collected.

For the first time, a large number of vertisol-like palaeosols have been identified with the upper part of the Denwa Formation. The characters of these palaeosols suggest a highly seasonal semi-arid palaeo-climate during the time of Denwa sedimentation. Furthermore, from the stable isotope studies of the pedogenic carbonates from different formations of the Satpura basin the unit has been able to reconstruct the variation in the atmospheric concentration of carbon dioxide for the interval of Late Palaeozoic to the Late Mesozoic.

Micellar and Microemulsion Systems

Systematic investigation on microemulsions has been taken up for better understanding of the phenomena of solubilization of water, oil and and other active ingredients in single and mixed surfactant systems to improve both the cost competitiveness and performance of their products. Physicochemical studies with special emphasis to various technological and pharmaceutical applications are in progress.

Microemulsion systems consisting of mixed surfactants as well as their constituent individual surfactants in aqueous and nonaqueous (polar) media have been formulated for obtaining a large sing le phase microemulsion zone to solubilize different active ingredients. Short chain alcohols with different structures and butyl l lactate as consurfactants, and various oils (aliphatic, aromatic, alicyclic, polar and vegetable) have also been used in the formulation of such microemulsions. The effects of different additives (brine, urea, glucose, bile salt) and temperatures on the stability as well as on the area of microemulsion zone have also been

investigated. Phase volumes of these systems in presence of additives and also at different temperatures have been measured.

Physics and Applied Mathematics Unit

Research Activities

Physics

Condensed Matter Physics

Due to the availability of various modern techniques, the study of field theories of condensed matter systems are of much current interest. The study of topological aspects of frustrated antiferromagnetic Heisenberg systems, in our unified approach of chiral anomaly and Berry phase formalism, showed the importance of Berry phase in the pairing mechanism, which is of magnetic origin, of high Tc superconductivity. We have also shown the existence of transverse Meissner effect and Magnus force in our model.

Mathematical modelling of few electron systems like q-dots is being pursued. Study of an electron moving in two-dimensions with parabolic confinement and a perpendicularly imposed magnetic field has been studied.

Classical Optics

Mathematical modelling for extending the Lorentz model for a proper understanding of refractive index in case of a general optical medium has been undertaken.

Foundation of Quantum Mechanics

Unsharp observables, Bell-type correlations and large scale structure of the universe are the important areas of research in foundation of quantum mechanics and related topics. New experiments have been proposed to detect the unsharpness parameters using molecular detector. A new approach towards understanding the space-time at Planck scale has been proposed using the concept of quantum graphs and the set of hazy lumps.

Quantum Information & Entanglement

A programme has been undertaken to reveal the basic connection between quantum teleportation and entanglement of the channel. In this regard no disentanglement theorem is the key to reveal the connection. Connections between inexact quantum teleportation and optimal universal disentangling machine have been studied in detail.

Another important problem in quantum information, namely connection between teleportation of entanglement and required channel has been studied and will be studied further.

Along with these two major areas, some other problems like connection between measure of entanglement and Bell's inequality, constructing unlockable bound entangled state using unextendable product basis, distributing and concentrating quantum infonnation, have been undertaken for detailed study.

Quantum Optics

Displacement operator type nonlinear coherent states which are useful in the description of the motion of a trapped ion have been constructed and their phase properties have been studied.

Quantum Field Theory

CP(1) or O(3) nonlinear sigma model with Hopf self interaction in 2 + 1-dimensions has solitons. The issue of their having fractional spin is still being debated. We have been able to quantize the above model in the Batalin-Tyutin formalism and have shown that the Hopf term, though topological in nature, can contribute to the energy at the quantum level.

A unified gauge theory in 2 + 1 dimension has been proposed through which various popular models, such as Maxwell-Chern-Simons, Maxwell-Proca, Maxwell-Chern-Simons-Proca models can be studied.

Extended Electrodynamics and Non-Zero Rest Mass of Photon

An extended formulation of Maxwell electrodynamics has been suggested using the concept of space-charge in vacuo as well as the existence of conductivity in vacuum. This helps to solve some of the difficulties encountered in conventional Maxwell framework. Non-zero rest mass of photon has been shown to be associated with longitudinal solution, which might play significant role in astrophysics and quantum gravity. Moreover, new work has been done regarding the possibility of extraction of energy from vacuum.

Supersymmetric Quantum Mechanics

A number of results relating to exact solutions in the area of supersymmetric and PT symmetric quantum mechanics have been obtained. Some results on perodic potentials with PT symmetry have also been obtained.

WKB and SWKB formulas have been derived for confined quantum systems. These formulas have been applied successfully for Harmonic Oscillator and Hydrogen atom in confined systems. An attempt is being made to apply these formulas for different radial systems and in two dimensional problems.

Theoretical Plasma Physics

Solitary waves and double layers in relativistic multi-component plasma and dusty plasma are very important areas of research in plasma physics. Recently a new technique has been developed to derive Sagdeev's equations for a dusty plasma in electromagnetic field taking into account the dust charge fluctuation. This will be very useful to study double layers in dusty plasma.

Nonlinear Physics

Nonlinear 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. The possibility of asymmetric squares in the problem of thermal convection in high Prandtl number is predicted. The competition among various instabilities and resulting convective patterns are also studied by constructing a model for thermal convection in intermediate Prandtl number fluids.

High and Ultrahigh Energy Physics :

Some aspects of heavy ion collisions at high energies were the prime focus of studies in High and Ultrahigh Energy Physics (HEP+UHEP).

A unified approach to the Study on Average Phase Space Density (APSD) of pions was built up and was applied to analyse data. The approach had remarkable success in the study of some other problems of HEP as well.

Study on a Deformed Hilbert Space

A q-deformed Hilbert space was constructed and annihilation and creation type operators were studied to generate coherent vectors. Even, odd and orthogonal-even coherent vectors were defined and their squeezing properties were studied. A phase operator was proposed and phase vector was generated to study nonlinear phase changes in the deformed Hilbert space.

Fluid Mechanics & Applied Mathematics

Basic Fluid Flows

Industrial fluid mechanical problems were modelled with a view to understand the physical processes involved in their respective applications. On spin coating process, it is found that the film thins faster if the disk starts with the impulsive rotation and increases its spin continuously with a certain constant speed. It is also shown that the slower impulsive rotation produces more thinning at the initial stage than the stronger impulsive rotation. But film thinning is found to be more for latter type of rotation in large time. This anomaly is due to the fluid viscosity. How the magnetic field affects the rate of heat transfer on a stretching sheet is also a problem of interest.

Hydrodynamic Stability and Waves

In the context of designing heat exchangers and condensers, flow instability and formation of waves and their interactions on thin film of fluids flowing down a vertical / inclined plane are of current interest. In this field, we have characterized the wave field that include the spatial and temporal variations of wave amplitude, speed and frequency depending on the physical parameters such as Reynolds, Weber numbers and the angle of inclination as well as the non-Newtonian parameter 'n' for power-law fluid. It is shown that solitary waves may also develop depending on the above parameters.

Dynamical Systems and Chaos

Modelling various physical problems by dynamical systems is of considerable interest. They are very useful in the understanding unfolding of bifurcation mechanisms, when an externally controlled parameter of the physical system in consideration is continuously varied. The effect of rotation on self-tuned wavy instability is examined with the help of a dynamical system. The coriolis force leads to self-tuned quasi-periodic waves at the onset of zero Prandtl number convection.

Blood Flow in the Cardiovascular System

Adomian's decomposition method has been applied to construct a mathematical model for the pulsatile flow of blood through an artery. The effects of a transverse magnetic field on the Poiseuille flow of blood through an artery has been investigated. The investigation on the flow of Bingham fluid through a circular tube of nonuniform cross-section is in progress.

Laminar and Turbulent Flows

Several problems of viscous incompressible fluid flows are of high interest from both theoretical and practical point of view. Similarity transformations, as obtained from group-theoretic consideration are applied in solving problems of flow over a stretching sheet. Effects of a transverse magnetic field on the flow produced by an oscillating plane wall and the oscillating stream past a fixed plane wall have also been studied. Effective viscosity has been calculated in a two-layer flow of blood through an artery with inserted catheter. Role of pressure fluctuations in homogeneous isotropic turbulence, under a rotating framework has been analyzed. Effects of a feed-back control on some dynamical systems are under investigation.

Water Waves

Research work done in this area involves problems on source potentials, wave-maker 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, 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.. Problems investigated recently involve water wave scattering by thick barriers, reflection by slotted thick barriers under oblique wave attack, sattering by inclined barrier, scattering by thin curved barrier, scattering by surface discontinuities, modifications due to density stratification.

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.

A variety of integral equations, dual integral equations, Fredholm integral equations, hyper-singular integral equations arising in various areas of mathematical physics and water waves in particular are being studied.

Queuing and Inventory Models in OR

A few models in the area of inventory and queuing have been constructed. The inventory models involving stock-dependent demand have received wide appreciation in the OR literature.

Contaminant Transport

The release of waste materials from chemical plants or industries into rivers or atmosphere over a period of time is a common phenomenon. The dispersion of passive contaminants in laminar / turbulent flows is worth studying from a practical point of view because of its application in environmental problems. In practice, the processes controlling the dispersion of dissolved and suspended pollutants in natural flows are numerous and complicated. Numerical simulations on contaminant dispersion have been carried out in steady / unsteady laminar / turbulent flows in different geometry. Work presently undertaken provides insight into the basic problems of longitudinal dispersion of pollution in environments, such as, simulation of an accidental spill in rivers or estuaries, release of waste materials, technological field etc.

Interdisciplinary Research

Hydraulic Flume

During the year 2000-2001, a technical report on the influence of bed roughness on sediment suspension over five different sediment beds, each having the same model size but with different roughness, has been prepared. Comparative study for suspended materials above all five beds for various flow parameters has been made from the experimental data collected from ISI flume experiments conducted over the last three years. The amount of materials in suspension increases initially as the bed is composed of sand size only, but decreases drastically as soon as the gravel is added to the bed. This phenomenon is being pursued to explain through mathematical modelling.

Multivariable System and Control Theory

The aim is to develop computational methods for analysis, design and development of multivariable control systems. A numerical method to design non-interacting controller for a special form of descriptor variable system has been developed. Work to design observer for matrix second order system has been done.

Earlier, numerical methods have been developed for realization, identification and de-coupling of multivariable systems. Work on matrix fraction description (MFD) has also been done.

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 Sciences Unit

Research Activities/Projects Undertaken

Crop-Soil-Weather Relationship

To identify agro-ecologically suited cropping systems, rice based trials were conducted in different toposequences of Giridih farm. It has been found that productivity is related to soil moisture and weather parameters. Long term weather data have been collected from Purulia district of West Bengal to identify quantum, distribution and levels of uncertainty in rainfall pattern. Data analysis is in progress and the impact of rain fall on system performance is being examined. The study on relationship between weather parameters like temperature, humidity, sunshine, evapotranspiration on crop growth and yield is in progress.

Technology Performance Studies

Trials on eco-friendly and economically viable low input technologies as compared to farmers' technologies have been conducted. Results indicate that vermicompost can be recommended as potential organic source in rainfed farming when applied in combination with reduced quantity of inorganic fertilizers in rice management. Ecological and economical parameters in vermicompost production suggest its immense potential towards sustainable farming.

Subsistence Farming Studies of Bihar Plateau Region

To identify the natural resources and their utilization pattern and constraints for technology adoption, and to examine the indigenous knowledge of the villages in subsistence farming are the major objectives of the study. Household survey together with the studies on cropping pattern/productivity indicate that farmers' choice of technologies is based on the items providing productivity, stability and resilience. Socio-economic factors also have a major role in technology diffusion.

Horse Gram: Biodiversity of Local Germplasms, their Evaluation and Agrotechniques Standardization

This work has been continuing for the last three years with the aim to up-grade the genetic potentiality of horse gram and to standardize the agro-techniques. Seeds are being collected from different farmers' plots of horse gram growing areas of Bihar plateau. Fifteen horse gram germplasms are also collected from NBPGR Akola centre. The collected germplasms are tested at Agricultural Experimental Farm, Giridih for yield potentiality and adaptability of that area.

Work on the Family Palmae

The palms remain one of the most economically important groups of tropical plants, a major source of food and raw material that remains under-explored. The association between habits, physiology and edaphic preference still remains virtually unexplored for palms. Being a very hardy tree, three economically important semi-xerophytic palms, palmyra, wild dates and edible dates have been introduced in the ISI Giridih Farm to study their physiology, propagation and utilization aspects. The structural morphology of another palm, *Nypa fruticans*, has been critically studied.

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

The performance trial of oil palm (*Elaeis guineensis*) and eight cultivars of coconut (*Cocos nucifera*) which were transplanted in July 1997, are in the final stage of data collection and analysis. Regular data were collected in respect of number of leaves, height of the plant, girth at the base of the stem, flowering time, photosynthesis performance, number of male and female bunches (for oil palm) and number of nuts produced per coconut plant per year. The analysis of data is in progress.

Eco-Floristic and Anatomical Investigations on Mangroves of Sundarbans

In the eco-physiological study, considerable work has been done on the occurrence and estimation of proline and other amino acids, osmotic potential of leaves and roots, rate of photosynthesis, transpiration, stomatal conductance, soil characteristics etc. of many mangroves. Statistical analysis of these data is in progress. Data also have been collected on the community structure and biomass estimation of mangroves from eight randomly selected sites of Lothian Island of Sundarbans, which are being analysed.

Anthropology and Human Genetics Unit

Research Activities/Projects Undertaken

Effects of Microenvironmental Factors on Health

The effect of mother's working status and education showed statistically significant differences in fertility among the working and non-working and literate and non-literate Pod (Poundra Kshatriya) mothers, while no statistically significant difference was observed among the Munda. Significant difference in infant and child mortality among the working and non-working Munda mothers were observed, but not among the Pod. Significant difference in child mortality was observed among the literate and non-literate Munda and Pod mothers. Infant and child mortality in both the ethnic groups were not significantly related to level of poverty. Literate and above poverty level mothers in both the ethnic groups revealed better health status than their non-literate and below poverty level counterparts. The working Munda mothers and non-working Pod mothers have better health status in terms of greater percentage of them having Body Mass Index (BMI) values classified as Normal.

Factors like mother's working pattern, education, poverty level, child-care, immunization, time allocation, delivery practices and treatment showed differential effects on the health status of the mothers and their children below 5 years of age. The anaemic status of the mothers of the "under-five" children showed greater percentage of anaemic Munda mothers, than Pod mothers.

Growth Studies

Collection of data on physical growth was completed utilizing 22 body measurements from 1000 male subjects aged 6-16 years. Collection of socioeconomic data from their families is being continued by house

visits. In addition, 100 subjects have been measured in two occasions with an interval of one year to estimate the single year velocity data.

Epidemiology of Health of Tibetan Refugees in Exile

The Tibetan refugees in exile residing at Chandragiri, Gajapati district in Coastal Orissa have been selected. So far, demographic and socio-economic data and information on disease pattern and prevalence among the entire Tibetan population of Chandragiri (Total 590 households comprising about 3000 individuals) have been collected. The refugees are essentially high altitude natives and at present exposed to a drastically different disease and nutritional ecology as well as cultural milieu. It is worth investigating into how they are coping with the new environment (low altitude, coastal hot and humid cline) and the strategies for survival in a changing situation.

Genetics of Dermal Ridges

It was found that the overall heterogeneity of dermal patterns in populations is higher in females than in males in 5 populations. Inter-group variations in most of the dermatoglyphic variables do not correspond to the ranks of caste hierarchy, but correspond well with the known ethnohistorical records of these populations. This was also suggested by earlier studies on serological and biochemical markers. Dermatoglyphic affinities, both qualitative and quantitative traits, therefore, may be quite useful in tracing the ethnohistorical background of the diverse populations.

Principal components analysis has revealed a common feature of the principal component factors, e.g. "digital pattern size factor", in diverse populations indicating its degree of universality. This suggests that the finger ridge count is determined by the same genes which control the pattern types. The nature of variation of these components between sexes appears with a good similarity which suggests the biological validity of underlying component structure.

Relationship between Modernity of Lifestyles and Health Status in a Tribal Community in the Sikkim Himalaya

Data on some aspects of socio-economic, demographic and health characteristics (measured in terms of self-perceived morbidity) have been collected from about 200 selected Bhutia households located in Gangtok town and its neighborhood as well as from Ralong Block, South Sikkim. Data on blood pressure, lipid profile including serum creatinine, anthropometrics and selected behavioral aspects (e.g. smoking, alcohol intake, salt intake and so on) have also been collected from the urban study subjects. Data collected so far, are being analyzed.

The interim analyses of the data reveal : (i) prevalence of essential hypertension among the urban adult Bhutias of both sexes is high (28% among males; 22% among females) by WHO criteria, (ii) Blood pressures (both systolic and diastolic) of urban Bhutias increase with increasing age, (iii) Prevalence of diabetes and that of hyperlipidemia among the urban Bhutias are high, (iv) Diseases of long and short duration which are conspicuous by their presence in the community include : gastritis/hyperacidity/gastric, peptic, duodenal ulcers; hypertension; pain in joints; diseases of mouth, teeth and gum; skin diseases; visual disabilities; worm infections.

Women's Studies : Health and Well Being

The focus of the study is on the dynamics operating in the dual career families residing in Calcutta and ethnically/culturally different families in Gangtok, Sikkim. The objective is to examine the quality of life as experienced by couples in terms of the impact of work and non-work variables on career satisfaction, life satisfaction, physical and mental health. Data collection is in progress.

Genome Diversity Studies in Ethnic Populations of India

Ethinic India : A Genomic View

The evolutionary histories of ethnic populations of India have remained an enigma. Various anthropological theories have been proposed regarding the antiquities and origins of the different tribal and caste populations of India, who socio-culturally and linguistically belong to several broad classes. With a view to reconstructing the peopling of India and migrational trails, a project has been undertaken that seeks to evaluate the genomic diversities, compositions and affinities among ethnic populations of India. Blood samples were collected from about 50 ethnic populations, representing all geographical regions of India, as also socio-cultural and linguistic groups. Using molecular genetic methods, it was shown that there is an underlying genomic unity of mitochondrial DNA RFLP patterns of ethnic populations of India. Using a more rapidly evolving portion of the mitochondrial genome (the HVS1 region), DNA sequence data was generated and it was shown that the Austro-Asiatic tribal groups may represent the most ancient inhabitants of India. Using mitochondrial DNA and Y-chromosomal polymorphisms, trails of Dravidian and Indo-European speakers into India from central and west Asia were traced.

Origin and Genetic Composition of the Lyngngam of Meghalaya

All the major tribes and subtribes of Meghalaya are being studied using different sets of DNA markers – Y-chromosomal, mtDNA and autosomal. Considerable progress has been made and the DNA extraction and typing of 400 blood samples have just been completed in collaboration with CCMB, Hyderabad. Upon completion, this study will shed light on the origin and genome diversity of the tribal populations of this region.

DNA Polymorphisms in the Caste and Tribal Populations of Andhra Pradesh

About 1600 blood samples representing 35 castes and tribes of Andhra Pradesh have been collected. Extraction of DNA from these blood samples has also been completed. Typing of DNA for different markers has just begun at CCMB.

Health-Productivity Relationship

It is intuitively understandable that the nutritional and health traits are important components that influence the human ability to perform and to have prolonged physical activity. However, such relationships have not been adequately tested and worked out with empirical data, particularly in respect of specific types of job and health measures in the Indian context. In view of these, the present project was undertaken to examine the health-productivity relationship, if any, among the brick field labourers of Jalpaiguri district of West Bengal. The labour group consists of mainly three ethnic groups, viz., Santal, Mech and Oraon.

After removing the effect of age from all the variables, no significant differences were found to exist between high and low productive groups in any of the traits under study. Step-wise regression analysis of the data shows that out of 45 variables, 5 variables significantly determine the productivity in males and in females only one variable significantly determines the productivity. In males, transverse chest diameter, skinfold thicknesses: triceps and subscapular, back strength and age determine the productivity. In females, the more the haemoglobin level the more the productive output.

The Genetic Structure of Populations of Arunachal Pradesh

Field work was conducted in two districts of Arunachal Pradesh among three tribal populations, viz., Shredukpens, Aka of East kameng and Selung. Detailed demogrpahic information was obtained from Aka tribe of the largest settlement.

Genetics of Oral Cancer

Collection and DNA analysis of patients with oral carcinoma and precancer lesions are in progress. In particular, those genomic regions that are involved in metabolizing toxic substances are being examined.

Statistical Genomics

(a) Using a genetic algorithm, a new procedure for determination of haplotypes of members of a pedigree from information on genotypes at a large number of linked markers was proposed. It was shown that this procedure outperforms one of the most widely used procedures. (b) Using a EM algorithm, a procedure has been devised to obtain maximum likelihood estimates of haplotype frequencies in a population, from data on a sample of unrelated individuals drawn from the population. (c) A semi-parametric procedure for mapping quantitative trait loci using genome-wide scan data on sib-pairs was devised. It was shown that this procedure is statistically more efficient than one of the most widely used methods. The method has been extended for analysis of data on multivariate phenotypes.

Biochemistry Unit

Research Activities/Projects Undertaken

Human Uterine Cervical Cancer Prevention : Molecular Epidemiology

With the objectives to develop a molecular/ epidemiological data base on the natural history of HPV, the unit has been doing this work at the Child In Need Institute (CINI)- RCH clinic, Pailan, 24-Pargonas (S). For each subject, a pap smear and a cervical scrape for HPV-assay were taken alongwith several demographic information. Follow up visits were also made. The intention is to enroll one thousand women and make three follow up visits in a 18-month period. Thus far more than nine hundred women have been enrolled. An analysis on 850 subjects was completed. The salient features are: (a) Of 850 normal married women, 8.82% of HPV infection, 4.35% ASCUS (abnormal squamous cell of undetermined significance) and 2.47% LSIL (squamous intraepithelial lesion-low grade) were identified independently, while only 0.58% had both HPV 16/18 infection and abnormal cytology. (b) There was an age specific prevalence of HPV infection, 10.32%±0.018 in < 24 years, 8.75%±0.014 in 24-33 years and 8.5%±0.024 in 34-43 years of age, with a drop thereafter (3.9%±0.022) in > 43 years. The low-grade cytological lesions increased directly with age. (c) HPV infection was independent of ACM (age at the consummation of marriage), parity and EP (sexual exposure period), ASCUS showed significant association with ACM and parity but was independent of EP. LSIL was independent of ACM but associated with parity and EP. (d) HPV infection was not significantly associated with cytology or VIA (visual inspection with acetic acid) test but showed association with cervical erosion particularly in < 24 year old women. The findings showed a higher prevalence of oncogenic HPV at young age in rural India, justifying the need for inclusion of HPV testing in the screening of CaCx (cervical cancer). In order to capture the maximum number of subjects, who might be 'at risk' for developing CaCx, it is proposed that HPV testing must be done in women (i) aged < 24 years with cervical erosion and (ii) at age between 24-43 years, as an adjunct to Pap smears, since both HPV and abnormal cytology were prevalent in this group. For women aged > 43 years, HPV testing might not be useful since abnormal cytology was more prominent compared to HPV infection.

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).

A cell strain M5 and some transgenic Bcl-2 cell strains VB12 and VB13 were isolated from the rodent cell line, V79. These exhibited resistance to oxidative stress (inhibition of induction of apoptosis) compared to the parental cells. All the derived cell strains had higher GSH levels and enhanced Bcl-2 protein expression

indicating that both factors participated in the observed resistance of the cells to oxidative stress. But the M5 cells showed a greater resistance than the transgenic cells indicating that together with higher level of GSH and Bcl-2, there might be additional alterations leading to enhanced resistance of the cells to oxidative stress. The cell strain M5 and the Bcl-2 transfectants would thus be valuable for further analysis of the network of changes that lead to the observed resistance to induction of apoptosis by oxidative stress. The hypoxic cell sensitizer, AK-2123 (a nitrotriazole derivative) was found to preferentially enhance gamma ray induced killing of the radioresistant M5 cells, sparing the V79 cells, which was important from the point of view of radiotherapy. The drug appeared to utilize the altered GSH metabolic status of the M5 cells in modulating the radioresistance.

HPV Infection and Cervical Cancer in the Northeastern State of Manipur

The Northeastern State of Manipur has high incidence of both HIV infections and cervical cancer (CaCx). A study was initiated in Manipur during 2000-2001 by raising the question of the impact of HIV (human immunodeficiency virus) infection upon CaCx/human papillomavirus (HPV)infection. The objective is to find out whether variables like HPV (viral presence and type), HIV (positivity), demographic variables, sexual activity, other biological and clinical factors may act as 'risk factor(s)' for cervical dysplasia (SIL/CIN) and cancer. *The study will be particularly useful for women of socioeconomically weaker communities.* It will also establish the groundwork for an epidemiological data bank along with regular investigation and follow up care in Manipur. A major goal of the current study is to *develop and establish* a CaCx screening/prevention/control *team and program* in the State of Manipur for pursuing population-based detection/screening. Human resource development is also an important part of the study.

In 2000-2001 (November 2000-March 2001), data and samples were collected and processed on 131 women aged between 25-75 years from Imphal, Manipur. Four of these women displayed abnormal cytology and none had HPV-16 infection. A student was trained in the ISI laboratory for a period of 3-months as part of HRD. She was also trained in the Manipur field visit.

Biometry unit

Research Activities/Project Undertaken

Fishery Science

Conventional but sophisticated statistical methodologies are applied to longitudinal growth data analysis of the Indian major carps. In addition to Time series data analysis, Zerbe's nonparametric procedure has been applied to diagnose abnormal growth of carps. This has positive bearing with the location of 'lag phase' of growth of the carps during the early developmental period. Analysis of directional data generated from a longitudinal carp growth study points to the predominance of dissolved oxygen content of the ambient water.

Biomedical Sciences

Juvenile MRDM with Dietary Errors

This is an ongoing project where the different aspects of Malnutrition related Diabetes Mellitus (MRDM), specially the Fibro Calculus Pancreatic Diabetes (FCPD) among the young are being studied. After a few year's work on this topic some errors in the dietary habits were included as they are linked to all types of diabetes, specially Type II diabetes. In the current year (2000-2001) attempts have been made: (i) to make a dietary survey to find out the prevalence of dietary errors in different communities, (ii) to detect dyslipidaemia, atherosclerotic diseases or Type II diabetes among those surveyed and (iii) to correlate dietary errors with atherosclerotic diseases, dyslipidemia and type II diabetes.

It is proposed to extend this study to other types of diabetes such as MRDM, IDDM and NIDDM

Studies of Gymnema Sylvestre as Controlling Diabetes

This project started in April, 1996 with an aim to develop hypoglycemic drug from *Gymnema sylvestre*, a well-known and widely available Indian medicinal plant. Present study is based on thorough and systematic probe to find out the active principle of this plant leaf extract with therapeutic relevance and the mechanism of its antidiabetic action.

The activity during the current year was to separate the organic and inorganic part of the extract and to observe the fractionation of the extract containing the antidiabetic property for determining the number of chemical constituents present in the fraction.

Efficacy of Azadirachta Indica as a Drug with Special Reference to its Blood Sugar Lowering Effect

Water soluble portion of alcoholic extract of *A. indica* (Meliaceae; Neem) leaf extract was found to possess significant blood sugar lowering hypotensive, anti-inflammatory, antiserotonin, hypolipidimic, antifertility and hepatoprotective activity.

In order to find out the possible mechanism of blood sugar lowering effects of *A. indica* leaf extract, it was noted that *A. indicia* leaf extract blocks significantly the inhibitory effects of serotonin on insulin release mediated by glucose. Thus it can be speculated that blood sugar lowering effect of *A. indica* leaf extract may be due to its insulin releasing pancreatic effect.

Chemical analysis revealed that the extract contains the following six compounds. (i) Quercetin-3-O-B-D-glucoside (ii) Myricetin-3-O-rutinoside (iii) Quercetin-3-O-rutinoside (iv) Kaempferol-3-O-rutinoside (v) Kaempferol-3-O-B-D-glucoside (vi) Quercetin-3-OL-rhamnoside.

These compounds are collectively known to be responsible for blood sugar lowering effect. Further studies are needed both on extract and/or its chemical constituents to strengthen the findings.

Physiological Effects of PEMF

Pulse Electromagnetic Field (PEMF) therapy is a late nineteenth century development and a new biophysical tool for healing of tissues of regeneration of body parts. In the pilot study of 24 patients, 4 patients are under the control group and the rest are under the treatment group according to our model. PEMF therapy was given to treated group at a frequency of 72 HZ for 10 minutes/ joint to each patient thrice a week for 16 weeks. Blood samples were collected at monthly interval and their biochemical, haematological and serological parameters were measured using standard methods. X-ray of different bones and joints are periodically being performed on the patients as per work schedule.

From the observed findings it can be speculated that PEMF therapy has a promising effect on rheumatoid arthritic (RA) patients. In order to find out the therapeutic effectiveness of PEMF therapy on RA patients further studies are needed.

Chemistry Unit

Research Activities/Projects Undertaken

Investigation on the Level and State of Existence of Heavy Metals Related Micronutrient Elements in Some Soils of West Bengal

Heavy metal related micronutrient elements (Iron, Manganese, Zinc, Copper, Boron and Molybdenum) present in soils play an important role for producing high yields and good quality crops. Investigation on the assessment of micronutrient elements in soil provides baseline information of soil components with respect to which changes in soil composition produced by elution, pollution and agricultural manipulation occur. Soil samples comprise five groups namely: Alluvial Soils, Red & Lateritic Soils, Foot Hill & Hill Soils, and Coastal Soils. Of these, Coastal soils were examined to study the status of micronutrient elements. Elements like Iron, Manganese, Copper, Zinc and Boron were found more in these than in other groups of soil. The Cation Exchange capacity was high and soluble salts contained also higher than in other groups.

Embryology Unit

Research Activities/Projects Undertaken

To observe the role of toxic phytoplankton in planktonic community, since 1999 plankton was being collected from Orissa and West Bengal offshore region of Bay of Bengal. Both qualitative and quantitative enumeration of plankton had been carried out in the laboratory. Seawater samples were also being collected to study the physico-chemical properties viz. Water temperature, pH, dissolved oxygen and salinity. During this period altogether 228 plankton species were identified.

A phytoplankton-zooplankton model in which the growth rate of zooplankton is decreased by toxic substances released by phytoplankton species was proposed and analyzed. As the process of toxin liberation is still not clear to explain the excitable nature of blooms the following three characteristics of toxin liberation process were considered changing one at a time: (1) liberation process is instantaneous, (2) this process follows gamma distribution and (3) it follows the discrete time variation. Theoretical investigation indicates that plankton blooms through periodicity could be explained by the above model formulation when the liberation process follows only the discrete time variation. Numerical simulations by using the data collected from the field observations have been performed to substantiate analytical findings. The results show that toxic phytoplankton can be used as a bio-control for the termination of planktonic blooms.

Mathematical and stochastic modelling on Malaria Japanese encephalitis by incorporating seasonal function on the density of mosquito population have been further investigated.

Elevated salinity, accelerated eutrophication, blooms of deadly bacteria Avian botulism and dramatic water quality fluctuation are the key factors for massive die-off of Tilapias and Pelicans in the Salton Sea (located in the Southeast desert of California, U.S.A). A mathematical model for the susceptible Tilapia population, infected Tilapia population and their predator Pelican birds population has been proposed and its essential mathematical features were analyzed. It has been concluded that for sustainability of Tilapia and Pelicans in the Salton Sea, reduction of Tilapia in a considerable amount is required. Further a stochastic model for infected Tilapias and Pelicans was proposed. A simple and transparent technique was given for finding the safe region in which the chance of Pelican extinction was minimized. Numerical examples and computer simulations were also presented to validate the analytical findings.

Experimental work on allelopathic agent in root exudates (RE) and leaf leachates of different weeds was also continued. RE of Leonurus shows stimulatory effect in a certain range of concentration on bioassay of rice, wheat and mustard. Caffeic acid was found to be the main constituent of allelochemics in the RE of Leonurus.

Plant Chemistry Unit

Research Activities/Projects Undertaken

Screening of Leafy Vegetation

A short term in vitro study in terms of biodegradation and mineralization using forest leaf litter in different zones of social forestry circles Giridih, Jharkhand has been undertaken. Two different methods were adopted i.e., (1) with the addition of inoculum (2) without the addition of inoculum, keeping leaf litter in a litter

bag. It has been reported that addition of inoculum in the form of farmyard manure has a marked influence in the biodegradation process while litter bag experiment needs sufficient time in the process of biodegradation. In this process the first colony was detected on litter after six months from the very date of starting the experiment. The efficient colony formers were *Aspergillus fumigatus, Trichoderma lignorum, A. niger, A terreus, Paecilomyces, Trichothecum* and a number of actinomycetes and bacteria. 10-15% loss of weight was recorded indicating that isolated microbes are taking active parts in Saccharification and biodegradation.

Microbiological and Technological Aspects of Leafy Protein by-Products

A detailed chemical profile study was undertaken to assess the actual composition of the Agricultural wastes. Ten such crop residues were critically analysed, which included straws of rice, wheat, stalks of mustard, soyabean til, kulthi, black gram, groundnut shell, sugarcane bagasse and teak leaf. The results obtained were ash (1.5-13.7%) lipid (3-10%), Holocellulose (56.4-73.6%), α-cellulose (20.7-42.9%), lignin (11.9-30.3%), nitrogen (0.19-2.86%), organic carbon (31.5-40%).

Since cellulose is a replenishable raw material available in abundance in nature its conversion to glucose has attracted considerable interest. Microorganisms capable of hydrolysing cellulose by producing cellulase have been screened extensively from different soil samples and composts. The most efficient colonizer and cellulose degrader has been identified as an ascomycetous fungi - *Neurospore crassa*.

Nutritional and Biochemical Aspects of Leaf Protein

Leaves of Glinsadia maculata appeared to be a possible source for the production of leaf protein. The proximate composition as well as mineral content and amino acids were studied. Analysis showed that crude protein content of protein fraction were about 34-67% on dry weight basis. Leaf protein concentrate has appreciable in vitro digestibility. The presence of anti-nutritional factors like polyphenols and tannins has been detected.

While studying the antinutritional aspects of leaf protein fraction from eleven aquatic plants, the complete absence of alkaloids in the fraction has been noted. Although three plants namely, Alternanthera philoxeroides, Mikenia scandens, Polygonum barbatum exhibited the presence of alkaloids in the leaf sample, the process of extraction probably helped in their total removal.

Aquatic Weed and Water Quality Relationship

The chemical analysis of all water samples and aquatic plant data collected from two ponds located within the campus was completed. Annual mean of water quality parameters respectively for pond A and pond B are as follows - water transparency - 1.9 and 1.4 meter; dissolved oxygen - 3.0 and 2.4 mg/l; electrical conductivity - 111.0 and 103.1 ms/m, total nitrogen - 9.0 and 7.4 mg/l total phosphorus - 0.27 and 0.28 mg/l; chlorophylla - 0.3 and 0.6 mg/m3. Comparatively high coverage of different aquatic plants (*Vallisneria spiralis* 75.2%; *Nymphoides hydrophylla* - 24.3%; *Lemna minor* - 22% and *Alternanthera philoxeroides* - 14.9%) was observed in pond - A relative to pond B. Alternanthera philoxeroides contained high nitrogen (3.8% of dry weight) while highest phosphorus content was found in case of *Nymphoides hydrophylla* (0.4%).

Yield Performance of Sugar Beet Varieties at Different Growth Stages

Five sugar beet varieties (Raspoly, Solid, Monostar, Virtus and Mariboultramono) were studied so far and among them monostar and mariboultramono are included in this special experiment. The fertilizer doses were fixed with 120 kg nitrogen in the form of urea, 100 kg potash in the form of muriate of potash and 60 kg phosphorus as simple super phosphate/hactare. Data were collected at an interval of 20 days starting from 75 days of the crop and up to 155 days. Like Raspoly and Solid the variety Mariboultramono showed better performance in root yield of 60.50 ton and 45.25 ton/ha of shoot yield though highest root yields were given at last harvest of 155 days but highest shoot yields were given at early growth stages between 115 to 135 days of the crop for all varieties.

Enzymes from Soil Microbes

Population dynamics of lipolytic microbes including bacteria, actionomycetes and fungi were studied along the alluvial soil tract of West Bengal. In the first phase of investigation, paddy growing area was taken into consideration. Lipid hydrolysing microbes were screened on media containing Tween 80 and Tributyrin Total microflora, as well as lipolytic microflora were correlated with the various physico-chemical properties of soil such as carbon, nitrogen, cation exchange capacity, clay content and minerals. The relative prominance of the lipolytic microbes is exhibited on the basis of frequency (%) and relative abundance (%). The efficient lipase producing bacteria was *Bacillus cereus*.

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 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.

Research Activities

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 relating 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.

Projects Undertaken

The Unit had a number of I.S.I. plan research projects during the period: The two projects entitled Price Seasonality, Storage and Speculation' and 'Identification of the Causes of Sickness of Small Industrial Units' had started in the previous year. Field work components of these two projects have been completed and data analysis components of the project are in the stage of completion. However the North-East extension component of the first project started in November, 2000. Other projects, which started in October-November, 2000, were the following: (i) Economic Problems of Illiteracy (ii) Decentralization, Democracy and Development in India (iii) Economic Growth, Capital Formation and Regional Disparity in India with special emphasis on North Eastern states. The investigators have started field work/data collection in these projects.

Economic Analysis Unit

Research Activities

The Unit 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 worldwide 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 behavior. A number of other studies have been initiated using Bayesian approach and methods.

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.

The Unit has been working in Information Economics as well as Statistical Forecasting.

Linguistic Research Unit

Research Activities

The main areas of research were: (i) SEMANTAX (valency-based natural language processing, fuzzy logical expressions in Bangla, problem of conceptual tense and aspect vis-a-vis grammatical tense in Bangla discourse), (ii) Methods in Quantitative Linguistics, (iii) Studies on the phonetic and phonological structures of major Indian languages and application of the results in various areas of (e.g., speech pathology, second language acquisition, cultivation of mother-tongue, language standardization and comparative supra-segmental studies on Indo-Aryan, Dravidian and Slavic languages), (vi) Socio-linguistics (study of language attitudes, language maintenance and shift and measurement of bilingualism, linguistic subalternity and decentralized language planning in a plural society and analysis of folklore and folklanguage), (v) Clinical Linguistics (aetological and diagnostic approaches to hearing impaired children), (vi) Psycholinguistics (relationship between "empty linguistic organism" and "social malleability": Psi-properties), (vii) Post-Structuralism (post-formal approach to Linguistics, archaeology of Bangla grammar).

Projects Undertaken

Glottopolitics of Linguistic Subalternity in Multilingual India

The project solely devotes to the problems of heterogeneous 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 The main objectives of the projects are; (a) to understand the nature of the language movements as either cohesive or divisive forces, or as self-deterministic forces aiming at socio-economic decentralization, and (b) to understand the characteristics of movement-prone zones and linguistically deprived Area. The following movement-prone linguistic zones have already been covered: Rajbansi, Pahari, Gorkhali, Santali, Bundelkhandi, Chhattisgarhi, Assamese and Bodo.

Interference of L1 (Bangla) in the Learning of L2 (English)

An Item Response Theoretic approach is used. Since the geniuses of the two languages, Bangla and English are primarily under review and are structurally and functionally different and English is still important as

the Indian context, mainly as a window language for higher studies, trade, commerce etc., the project aims to gauge the extent to which L1, i.e. Mother tongue or Bangla interferes with the learning of English.

Whatever may be theoretically projected as linguistic human right, the practice of English as a medium of instruction or as a subject in the school curriculum enjoys a dominant status in the Indian context. It is part of our colonial inheritance, which has bound us to follow the English order of things. The mythical values ascribed to English make it as an H code, in which periphery l code is bound to communicate to achieve the Eurocentric development or Formal Elaboration of Social Hierarchy (FESH, Dasgupta, 1993). Thus periphery collaborates with Linguistic Imperialism to sustain the process of upward mobilization. And in this way a diglossic situation arises in the context of a plural society in India. The planners who believe in a monolingual option to solve the problems of multilingualism often advise to switch over to H/ Foreign code and some of them opt for H/ Archaic code. The earlier method of teaching English via L1 (i.e. indirect access to Universal Grammar or UG) has been discarded in West Bengal and instead of this the (a) Anglo-Vernacular or Grammar-Translation method, (b) Monolingual Functional-Communicative method (i.e. Direct access to UG) has been introduced from Class V. This project seeks to find out 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 is explored from the standpoints of markedness hypothesis. The items like passivization, wh- and yes-no questions, word order, tense, etc. are arranged to understand interference of L1 in L2. Apart from this syntactic investigation, the lexical level marked derivational and inflectional affixes are also arranged to meet the same goal. Thus almost eight parametric differences are to be arranged in fifty questions according to the supposed English knowledge base of students from each class. The responses of about 500 students are to be analyzed using the discrete point system. Then the achievement level of L2 is to be 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. Moreover the effect of interference can be identified and gauged if the Rasch model is employed. The consequences of this L2 policy is to be 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). A preliminary pilot survey has been carried out on 800 students from Bengali medium schools.

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 indigenous and integrated method for Statistical-Linguistic analysis appropriate to the Indian situation. In this way one can break the so-called "administrative divisions" (as Karl Popper called it) in-between subjects. For this basic need, the aim was to develop a methodology covering different fields of linguistics, Computer Science and Statistics. The areas covered are Lexicology, Semantics, Sociolinguistics and Text Analysis. Academic institutions where specialisation in linguistics is offered were urged 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.

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 is done on Bengali by preparing a list of Bengali words and concepts utilising text analysis of curricula language. A pilot video is slated for production with the help of Audio-Visual Unit.

Planning Unit

Research Activities

Members of the Planning Unit carried on a wide range of research activities. Some of the areas in which research was undertaken are: (i) Food policy in India with special reference to the efficiency of existing food subsidies, (ii) Theoretical and empirical analysis of the difference in performance levels of private and cooperative plants in the Indian sugar industry, (iii) Theoretical and Empirical work on the link between poverty, local governance and deforestation in U ttar Pradesh and Himachal Pradesh, (iv) Analysis of the impact of piped water on the health status of chilren in rural India, (v) Empirical Tesing of the impact of HYV seeds on household welfare, (vi) Analysis of home-ownership patterns across communities in the US and its impact on the provision of local public goods, (vii) Analysis of charitable fund-raising schemes employed by 19th century Indian guilds, (viii) Fiscal reforms in India, (ix) Theoretical analysis of predatory practices employed by dominant firms under bilateral asymmetric information, (x) Trade and foreign investment policy and their impact on personal distribution of wealth and income (in particular how a free trade or free direct investment policy would affect the skilled-unskilled wage differential in developed and developing countries), (xi) Political economy, endogenous growth and distribution, (xii) Agricultural insurance, (xiii) Bankruptcy and debt recovery procedures with special reference to India, (xiv) Auction theory with special reference to revenue maximizing multi-unit auctions, (xv) Axiomatization of cost allocation procedures, (xvi) The structure of strategy-proof social choice functions under domain restrictions, (xvii) Equity in voting models.

Population Studies Unit

Research Activities/Projects Undertaken

A Method of Finding Out Probabilistic Measures for Public Health System Effectiveness

The Indian health system is a very complex one having a good number of health and family welfare programme components forming different subsystems. Ensuring integrated functioning of various subsystems of the total health system needs evaluation of various operating health and family welfare programmes to total system perspectives with due recognition of different interacting subsystems. This study attempts at finding out a probabilistic measure for effectiveness of a public health programme or a subsystem.

An Historical Estimation of Population of the Province of Bengal : 1751 - 1801

In this paper, a decennial series of population has been estimated for the province of Bengal from 1751 to 1801 using some appropriate growth rates of the later periods. The Bengal famine of 1769 - 70 affected the growth of population to a large extent and had a long term effect. Famine mortality has also been estimated with special attention to reach a plausible figure of population for 1801.

Study of the Knowledge, Attitude and Behaviour of the Elected Members and Municipalities on Health and Family Welfare Programme in West Bengal

To increase the acceptance and awareness of the Health and Family Welfare Programme, people's elected representatives have been involved in disseminating the health and family welfare programme among masses. This study focusses on (i) the prevalence rate of KAP of health and family welfare among elected representatives, (ii) the level of knowledge, attitude and awareness regarding National Health & Family Welfare Programme and (iii) the policy prescription.The survey questionnaire has been developed and survey work completed in March 2001. Data processing and analysis are going on.

Mother and Child Health Care Practices Among Santals in the Medinipur District of West Bengal, INDIA

An attempt has been made to determine the nature of health care practices among santal mothers for themselves and their children in the district of Medinipur in West Bengal by analysing Survey Data. A general observation is that due to very low literacy level and poor economic and social background, Santal mothers have not yet been conscious about the health care and the immunisation programme for self and children in spite of the governmental intervention in implementing the mother and child health (MCH) programme.

Status of Obstetrics and Gynaecological Morbidity in W. B.

An attempt was made to estimate the prevalence of various symptoms which could roughly be used to estimate the gynaegological disease burden among weaker sections in Kolkata Metropolitan Area through a survey of self-reported morbidity among women.

This study reveals that the gynaecological morbidity in this study area is perceptibly high. A major percentage of the cases either do not seek health care at all or health care seeking behaviour is such that it does not help in redressing the ailment. Due to lack of awareness and perception of disease, most women do not avail the facilities provided, though in meagre scale. Women, in low socio-economic group, feel shy and consider the gynaecologic problems as part of their problems to be suffered. Good communication skills as well as rapport among grass root level workers are essential to generate adequate awareness on the morbid condition and long term sequally along with the preventive measure for different types of reproductive tract infections. Provisions for service facilities for gynaecological examination by doctors or senior nurses should be included as a part of MCH care to promote family planning.

Psychology Research Unit

Research and Other Scientific Activities

Organisational Health and QWL

How to improve Quality of working life of employees in banking organisation by manipulating organisational health variables is a major problem in organisational design. Organisational health refers to relatively but quasi-enduring state of physical, mental, social and spiritual wellbeing of the organisation and not merely an absence of strike and lockout. Current study is an attempt to relate organisational health and QWL of employees of rural banks. A questionnaire was developed to assess organisational health of bank employees. 200 data records were randomly collected from different rural banks of Midnapore, Howrah and 24 parganas.

Short-Term Information Processing

How much information could be stored in the hypothetical short-term memory storage in the brain system with the gradual decrease in stimulus presentation time is a major problem in short-term information processing researches. Current study is an attempt to determine the pattern of change in memory span with the change in stimulus presentation time. Literature survey is going on.

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

There is a gap in understanding about the intrinsic and extrinsic factors of reading and writing motivation in the literature. Content analysis of interview data from the class teachers, from high and low achieving students revealed that student perception differed from the teacher perception in identifying motivating factors. A list of intrinsic and extrinsic motivating factors was identified from the content analysis. Currently a questionnaire is under preparation following pair comparison scaling technique.

Study of Invariance of Item Parameters Across Social Groups of Likert Type Scale

During the current period a set of 215 observations using Semantic Differential Scale has been computerised. Fitting of data into two parameter logistic model under IRT is being attempted. But this model requires some modification of Graded Response Algorithm. As a result a number of softwares needed to be developed and tried out. At present attempts are being made to develop suitable software.

Entrepreneurial Behaviour and Individualism-Collectivism

The objective of the study is to identify the personality characteristics of entrepreneurs and their individualistic-collectivistic orientation. It also tries to find out whether the entrepreneurial behaviour is important in determining the success or failure of an entrepreneur. Data from small scale entrepreneurs from one district of West Bengal and one North-Eastern state viz., Tripura, have been collected. Analysis so far done indicates that success rate is significantly related with task motivation, individualistic orientation and locus of control of an entrepreneur.

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

There is a gap in the understanding of relative importance of computer programming aptitudes for success in programming profession. Prior studies on programming aptitude test development concerned clerical aptitudes. Data collected from experienced computer programmers revealed the importance of creativity aptitude for success in programming. Currently, test development is in progress to assess the creative aptitudes of computer programmer.

Analysis of the Results of Madhyamik Examination in West Bengal

Preliminary analysis of the content of evaluation has been completed. Detailed marks of 15,000 students of 197 sampled schools have been collected and computerised. Initial distributions of marks, means, standard deviations etc. have been computed. Marks obtained with respect to each question by examining marked answer scripts of about 1200 students for Mathematics and English have been collected from the Secondary Board. Field work concerning selected schools and biographical information from four districts has been completed.

Sociological Research Unit

Research Activities

Compiling an Annotated Bibliography of Raja Rammohan Roy (1772-1833)

The approach of the compilation would be to study and analyse the works of Raja Rammohan Roy in the light of his views on the condition of India. As is widely known, Rammohan was an activist for religious reform, social reform and educational reform. For these goals he wrote essays, treatises, books, and also pulished magazines and newspapers. The annotated bibliography can be prepared in three parts: in first phase primary works, manuscript and record collections; second phase - published and secondary works of Raja Rammohan Roy's writings and his letters; and, in third phase - bibliography and other scholarly works on Raja Rammohan Roy.

The first phase of the work is in progress.

Editing the Letters of Edward Thompson and Rabindranath Tagore (1913-1941)

The main objective is to study the views of "Rabindranath on culture and education in late colonial India". The researcher approaches it by writing an institutional history of Santiniketan and Sriniketan during 1901-1941, by exploring some relationship between Rabindranath and his circle. In the context of this relationship, the researcher is editing the correspondence of Rabindranath and Edward Thompson during the years 1913-1941. Data collection from different archives and libraries is in progress.

Lab-Land Interaction

This is a modest atempt at understanding the impact of the limited supply of seeds grown in the agricultural experimental farm at Giridih (on various land characteristics like upland, medium, semi-low and low with varied input combinations of water, manure, chemical fertilisers etc) to the local cultivators of this rainfed, monocrop area characterised by highly irregular rainfall distribution. The study also envisages to look at the extent of reciprocity of the experience of such cultivators, if any, in modulating the research programme of the farm.

Data on the recipients of the seeds and their response in adoption of the varieties including their perception of the impact in the context of the socio-economic, eco-geological, motivational or capability factors (for providing required supplementary inputs) are being processed. The extent of investigation, as envisaged, had to be limited in view of the seed-stock, budgetary and other constraints.

The programme is being conducted in collaboration and co-operation with colleagues of the Agricultural Science Unit at Calcutta and Giridih.

Appraisal of Achievement of Women Members of Gram Panchayats in West Bengal since 1993

In order to evaluate women's political activities, it is necessary to look at women's role in a holistic manner. Could women Panchayat members, through their participation earn their different rights from the society? Are the women in general and the leaders in particular aware of their own problems which the male leaders did not take into account? The project started in November 2000. Six gram Panchayats in West Bengal were selected for field work: three from each of the districts of Birbhum and Midnapore. Field data have already been collected. Data processing is going on.

Identity Crisis Among the Saraks and the Dakshinatya Brahmins: A study on Ethnicity and Boundary Maintenance of Two Little-Known Communities of Purulia, West Bengal

The present study seeks to examine the ethnicity and boundary maintenance of the Saraks and the Dakshinatya Brahmins of Purulia, West Bengal. The main objective is to show how these two ethnic groups exhibit similarity and differences in their socio-cultural and ideological behaviours and adopt strategies to maintain their identity (vis-à-vis other communities).

However, there can be no denying the fact that the little known communities should be protected against any kind of domination by greater or stronger communities if integration of the people is important for our nation. The study would therefore enable us to gain an insight into the actual situation of life and living and their aspirations for quality of life. This would have implications towards ethnic policies followed by the State and the nation.

The first phase of field work for collecting source materials as well as survey of the households of two communities have been completed.

Service and Supply to the Ceiling-Surplus Allotees in West Bengal

The abolition of intermediaries under West Bengal Estate Acquisition Act (1953) marked the beginning of the "Land Reforms" which is an on-going and arduous process of ensuring the control of ownership of land at the hands of the actual tillers. The Ceiling-laws amended from time to time enabled the Government for acquisition of excess land which became vested and could be distributed among the land-poor tillers of the soil. Experience showed that these struck at the root of feudal domination on land and swelled the ranks of poor peasantry. The project seek to find out whether the productivity of land has also increased due to intensive labour by the tillers owning small plots of land (size class) due to adoption of new technology of agriculture in case of higher-size class of peasants.

It is also relevant to ask whether such distribution of land, often inferior land and that too in very small parcels, was counter-productive. Whether supply system to the owners of vested land was adequate for enabling the new owners to exercise the control over the means of production and whether reverse tenancy was the result of such distribution are also relevant questions now, especially when ceiling on land had been abolished in certain cases.

The objective of this enquiry would be to go into the above questions and issues related to land reforms, on the one hand, and distribution of gains of land reforms among the classes of people living in the rural areas, on the other hand. Collection, compilation and analysis of data are in progress.

Survival Strategies and People's Perception: A Study on a Cross-Section of Rural Masses in West Bengal

The study intends to investigate how the rural people, belonging to different cross-sections, manage to earn their livelihood in the changing socio-economic and political environment. The main point of empirical investigation would be people's perceptions and decision making with respect to earning livelihood. Field data have already been collected from two areas of West Bengal - Purulia and Darjeeling. Data processing is going on.

North-East Projects:

Participation of Women in Gram Panchayat: A Study of their Achievement in Tripura

This study aims to assess the performance of women members of Gram Panchayats since 1993, when their representation in Gram Panchayats increased due to reservation of seats as a result of 73rd Amendment to the Constitution.

This would also involve evaluation of their awareness, participation in different activities and their ability to take decision in different affairs of public life.

Therefore, the proposed study aims to investigate the status, role and achievement of the elected women Panchayat members in Tripura.

The central point of enquiry would be as to whether the women members of Gram Panchayats would now be able to make decisions independently.

Six Gram Panchayats have been selected for the study: three from each district of West and South Tripura. Collection, compilation and analysis of data are in progress.

Impact of Total Literacy Campaign of National Literacy Mission in Tripura

Both National Literacy Mission (NLM) and Government of West Bengal had entrusted ISI with the work of carrying out evaluation of Total Literacy Campaign (TLC) as well as socio-economic impact of TLC in several districts of West Bengal. These reports were well received both by the NLM and the by the State Government. It would be worthwhile to compare a district of Tripura with the ISI findings in one district of West Bengal regarding performance in TLC, which has also been successfully undertaken in Tripura in a difficult situation created due to the threat of armed insurgency in certain parts of the state.

The field work has already been initiated in West Tripura District. The project is expected to be completed by October, 2001.

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

The study was undertaken in collaboration with Stat. Math Unit, 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 had broken down in the village, where the political and economic changes have occurred to a considerable extent. It has been replaced by mini-pyramidal structures emerging from the group 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 interaction in rural life, inter-caste and inter-class relationship in Giridih and surrounding villages, controlled measurement of fertility, application of Mahalanobis's D2 to social science data of intergroup relations, appraisal of households stocks of handicraft and machine-made products in the villages, exploration in Palamau area to measure the impact of development plans on the rural population, ecosystemic programme of work and agro-sociological collaborative study on rain-fed farming. Some of these investigations were taken up by SRU as TAC-DCSW proposed 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 Government of India.

A special initiative has been taken recently 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 Ramkrishna Mukherjee, involving more than 1 lakh filled-in questionnaire schedules. The task was recommended by the ISI Council's Committee on Giridih, which was unanimously accepted by the ISI Council. After a long period, two lecturers have been recruited and posted in Giridih and they have submitted their research proposals, entitled, "Patterns of social relations – An exploratory social network analysis in two villages in Bihar" and, "Gender and Labour: A study of mica industries of Giridih"' which have been approved by the TAC-DCSW of Social Sciences Division for the coming financial year, i.e., 2001-2002.

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 and reliability, enhancing productivity, reduce manufacturing cost and losses in

industries. This is realised through academic programmes, consultancy services, project work, inplant and general training programmes for industrial personnel, systems and software development, conferences, workshops, and seminars, research in the methods and procedures of quality control/management, operations research and allied techniques. The Institute is a permanent member of the *Quality Council of India* in recognition of its pioneering role and rich contributions towards countrywide quality movement. The Institute is also represented in the National Accreditation Board for Auditing and Training (NABAT).

The Division runs a two-year professional programme, called M.Tech (QR - OR) at ISI ,Kolkata and Part-time Certificate courses in SQC at Bangalore,and Hyderabad . The curriculum of the M.Tech (QR-OR) programme for both Statistics and Engineering streams was revised in detail by restructuring the semesters,introducing new courses,and updating the syllabi of the courses retained. The revised syllabi had been made operative from August,2000. The Division also provides faculty support for the SQC & OR specialisation in the IInd year of the M.Stat. course run by ISI. Besides,the faculty members of the Division participates in the teaching for B.Stat,B.Math. (at Bangalore) ,M.Stat I year ,part-time evening course in Statistical Methods and Applications at New Delhi and Kolkata and training programme conducted by International Statistical Education Centre at Kolkata. The Division also assists other Institutes and Universities for conducting their academic programmes. The division also offers a Specialist Development Programme 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 .In the current year 133 organisations throughout the country availed the services of the Division for training and consultancy .The Division has assisted 32 organisations including three in Iran for developing and implementing quality systems based on ISO 9000 & QS 9000 standards.and ISO 14000 environmental management standard. The Division carried out quality system audit for a number of organisations in India and abroad. Promotional visits were paid to 41 organisations in the country.

As part of the Divisions programme on promoting Quality management and related services in the neighbouring countries, promotional visits were undertaken from the export promotion cell in Mauritius. Besides conducting training for participants of 19 organisations, business contacts were made with Mauritius Export Processing Zone (MEPZA) and MADCO group of industries. Promotional visits were also made to Bangladesh at the invitation of Rapport Bangladesh,who have confirmed the work proposals to work for one organisation for implementation of ISO 9000 and to conduct a training programme. Correspondence with organisations of Thailand, Columbia, and Singapore are being made.

Projects Undertaken

The Division carried out 57 projects (plan as well as externally funded). Some of them are listed below.

A project on "Physical Verification of Foodgrains in FCI godowns"was entrusted to the Division by the Food Corporation of India (FCI) in the previous year.The Divisions specialists located in different centres worked alongwith experts from Math.Stat.and Applied Statistics Division worked for the project .In Phase I of this project pilot survey was carried out to find out the scope of this study and in Phase II,a detailed survey was carried out to develop a cost effective,simple and statistically sound sampling scheme and related procedure for adoption by FCI.Report has been submitted and feasibility of the methodology suggested has been demonstrated .

Recently National Accreditation Board for Testing and Calibration (NABL) received a proposal from Asia pacific Laboratory Accreditation Cooperation (APLAC) to organise proficiency testing programme on behalf of APLAC.As a part of the programme, NABL received proficiency testing data from 125 laboratories covering 30 countries. The task of data analysis was assigned to the Division.The work has been done and final report has been submitted.

The projects on "Estimation of warranty costs " sponsored by Hero Motors Ltd, Dujana, Ghaziabad, and a plan project on "Quality Status of Service sector " were completed by SQC & OR Unit, Delhi.

The project on "Developing a Model for Application of Statistical Methodology for Quality Improvement in Small Scale Industries through Survey " ,and a survey project "To assess Quality Improvement practices in Local software Industries continued during the year in SQC & OR Unit,Hyderabad.

A project on "Reducing throughput time of production of pressed components"sponsored by Panse Autocomps Pvt.Ltd., Pune was carried out by SQC & OR Unit,Pune.

A project on "Failure rate of Critical Components of Spinning Industries " sponsored by Sambandam Spg.Mills was studied by SQC & OR Unit, Coimbatore.

A project on "Study on characterisation of ceramic and grindability of special grade Aluminia in the operable region of important controllable process variably", sponsored by Indian Aluminium Co. Ltd., Belgamm (Karnataka) was successfully completed.

Training Programmes

156 tailor-made in-house training programmes were organised for different organisations during the year 17 short term general training programmes on Six Sigma, TQM, ISO 9000,Statistical Techniques for ISO 9000,SPC, Design of Experiments & Taguchi Methods,FMEA ,and QS 9000 were organised. The first batch of Six month's correspondence course on "SQC in Manufacturing"initiated by SQC & OR Unit, Baroda, with 25 participants completed the course. Two more correspondence courses on " Quality with Statistics" (one-year) and " Statistical Process Control"(six months) have been started at Baroda during the year.New course manuals have been prepared on Vendor Quality Management,Advanced concepts in Quality Management,Basic Statistics in Research & Development,and Time Series Analysis and Forecasting.

The extent of consultancy, inplant and general training programmes is summarised as follows.

(i)	Number of industrial units served	133
(ii)	General programmes	
	Number of programmes	17
	Number of participants	236
(iii)	Inplant programmes	
	Number of programmes	156
	Number of participants	2980
(iv)	Seminars/workshops	
	Number of programmes	8
	Number of participants	200
(v)	Number of talks	6

Inplant Training Programmes

A partial list of inplant training programmes organised by the Division for Top Management, Senior managers and Executives,Junior Managers,QC,R & D and Production personnel,Supervisory staff and operators are given below.

Sl No.	Title of the programme	Period/dates	Name of the organisation	No.of participants
1	Six Sigma-black belt programme	July-Oct 20 4 phases (1 week each)	Thermax	40
2	Statistical Techniques	June-3 days	Suretex	15

3	Housekeeping (2 batches)	Oct.-1day each	Lincoln	20
Sl. No.	Title of the programme	Period/dates	Name of the organisation	No.of participants
4	Refresher prg.for internal auditors	Nov.-1 day	Mormugao Port Trust	30
5	FMEA & Control plan	Aug.-1 day	Stumpp,Schuele & Somappa	20
6	QC Tools (2 batches)	April- 1 day each	Motorola	40
7	Design of experiments	May-3 days	Wipro peripherals	25
8	Statistics for Engineers	Jun-3 days	MICO	18
9	SPC	Jun- 1 day	IFB	20
10	Measurement System Analysis	Jul- 1 day	Lincol	10
11	Cost of poor Quality	Jul-half day	Otto Bilz	20
12	ISO 14000-EMS	Aug.- ½ day	IFB	20
13	Production Part Approval Process	Apr.- 3 days	Autoliv IFB	20
14	QS 9000 orientation programme	May- 1 day	Autoliv IFB	25
15	Team Oriented problem Solving-8D approach	May- 1 day	IFB	20
16	Process FMEA	May- 1 day	IFB	20
17	Design FMEA	Jun- 1 day	IFB	20
18	Advanced Product Quality Planning	Jul- 1 day	IFB	20
19	Regression Analysis	Nov- 1 day	RHW	20
20	Robust Engineering	Dec-2 days	Autoliv	20
21	Reliability Engineering	Dec-1 day	Autoliv	20
22	Top Mgmt.Prg.on ISO-9001:2000	Mar- 1 day	KAP India	15
23	Application of Statistical Techniques	Jan-Feb:8 days	ASPECT	15
24	Prg.for Champions of Six Sigma Implementation	Jan-Mar:5 days	L & T	30
25	Basic Statistics in Research	Aug-42 hrs	ORG-MARG,Baroda	15
26	SQC	Aug 14 hrs	Eicher Motors, Indore	20
27	Quality Function Deployment	1 day	Hindustan Motors,Tiruvallore	20
28	Simulation	1 day	- do -	6
29	Internal Quality Audit		Divyar Group	10
30	5S Concepts	½ day	DeeCee Exports,APR Textiles,Here fashions,Sakthi Exports	20
31	Quality Mgmt. Systems	½ day	-do -	20
32	Product Quality Certification		Sri Amman Mineral Water	5
33	Statistical Tools for R & D Applications	Jun- 3 days	Indian Oil Corporation,Faridabad	27
34	First wave of Bluck Belt (Six Sigma) for nonmanufacturing executives	Nov-3 days	- do -	14

35	Black Belt (Six Sigma)-II nd module	Jan-3 days	- do -	14
36	Black Belt (Six Sigma)-IIIrd module	Mar-3 days	- do -	14
37	Green Belt (Six Sigma)	Feb-3 days	- do -	15
38	Time Series Analysis and Forecasting	Feb-2 days	National Engg.Industries,Jaipur	10
39	Problem Solving using Statistical Methodology	3 days	Infosys Technologies Ltd.	18
40	Concepts of Process Planning	4 hrs.	Balmer Lawrie	10
41	Trainer's training	2 days	Technova Graphics	9
42	Quality System Effectiveness Measurement & improvement	2 days	CIRT	20
43	SQC on-line tools	2 days	Eicher Consultancy Services	10
44	Top Mgmt.Appreciation programme on SQC	1 day	Tata Metaliks	30
45	Statistical Forecasting Techniques for Sales Managers	2 days	Tata Steel,Calcutta	25

General Training Programmes

A partial list of the training programmes is as under.

Sl. No.	Title of the programme	Duration	Place	No. of Participants
1	Understanding and implementation of Six-Sigma	3 days	Bangalore	48
2	ISO 9001:2000 QMS	2 days	Bangalore	28
3	Total Quality Management	2 days	North – East Region	50
4	SPC -part time	20 days	Chennai	17
5	FMEA	1 day	Chennai	21
6	QS 9000 – part time	32 days	Chennai	14
7	Statistical Techniques for ISO 9000	3 days	Mumbai	4

Clients Served

A partial list of the clients serviced is as under:

Motorola,Mormugao Port Trust,Wipro,IFB,Otto Bilz,Godrej,Reliance,L & T, TVS Electronics,Sambandam Spg.,Salem,Medallion Knitwear,Coimbatore,Divyar Garments,Palladam,DecCee Exports,Food Corporation of India,New Delhi,Hindustan Latex,Bannari sugars,Shiva Textiles,State Bank of India,Coimbatore,Hindustan Motors,Tiruvallore,Madras Cements,Britannia Industries,High Explosives Factory,Pune, Technova Graphics, Pirangut Paranjape MetalShapers, Shirwal, WIMCO,ECIL,Hyderabad,Satyam Computers, Dr.Reddy's Labs,Hyderabad, Eicher Group of Industries, Tata Steel,Eicher Consultancy Services,Mumbai,India Foils ,Indian Aluminium,GAPP Industries,OSRAM India,Samtel Group,Indian Oil,GE,Coates India, ITD,ITC,Balmer Lawrie, NTPC,Peerless Hospital.Ganges Valley food,Coal India, ORG – MARG,Kalpataru Power Transmission,Gandhinagar,Apollo Tyres,Gujarat Cycles,,Hindustan Packaging, Banco products,Baroda

Research Activities

The research activities of the Division covered areas like Reliability Analysis (with reference to warranty cost estimation), Process Capability indices (including non-normal processes), Order Statistics, Generalized Stochastic Games, Linear Complementarity Problem (LCP),Assignment and Scheduling problems,Study of non-smooth functions,Regularisation of PO functions, Special classes of matrices useful in LCP,Construction of Designs,Fuzzy sets applications,Group Testing, Measurement System Analysis, Problem solving Techniques and Taguchi Methods, Gauge R & R studies .During the year 9 papers were published,10 papers have been accepted for publication, 10 papers have been sent for publication,and 6 papers have been presented in conferences / seminars.In addition 5 technical reports have been brought out and 1 book has been published .

One scientific worker received Ph.D.degree.

Other Activities

Conferences and Seminars

Ninth Internatioinal Workshop on Matrices and Statistics was organised by ISI in collaboration with Society for Development of Statistics,Birla Science Centre,University of Hyderabad and Osmania University in honour of Prof.C.R.Rao in celebration of his eightieth birthday during 9-13 December,2000.About 40 international participants and 80 participants from India attended the sessions.50 papers were presented during the workshop.

Two seminars on Quality management were organised by the Division for the entrepreneurs and academics in the North-East region.There were 102 participants in the two seminars.

In addition 5 awareness/promotional workshops were organised on Quality case studies, Environmental Mnagement Systems,and Six-Sigma.

Winter School

A winter school on "Multivariate Data Analysis"was organised during 7-25 February.26 participants from different academic Institutions and Industries attended the programme.

Newsletter

The Division is publishing a quarterly Newsletter covering important events events and activities of the Division.It publishes articles in Quality Management and related areas,book reviews and significant contributions in the field of Quality.

Staff Development Programme

In all 5 special lectures on Total Productivity Maintenance , Data Envelopment Analysis,Quality Improvement Activity,Achieving Process Excellence, and Analysis of Categorical Data were arranged for the participating staff during the last DCSW meetings.These were delivered by the senior faculty members of the SQC & OR and Applied Statistics Division.

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 programme and (v) Faculty development programme.

Research Activities

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

Library (Calcutta)

With the addition of 1511 books and 941 bound volume of journals to the stock, the total collection of the Library rose to 2,15,710.

Acquisition Unit

The Unit accessioned 1511 books during the period under report, out of which 1286 books were purchased and 225 books were received on complimentary basis. Of the 1511 purchased books, 342 books were funded by NBHM. The Unit also accessioned 668 books of various projects undertaken by the Institute.

Periodicals Unit

The Unit received more than 3200 loose issues of various journals. Nine hundred and fortyone journals were accessioned. Orders were placed for 460 journal titles in 2001-2001.

The Unit prepared 48 lists/bulletins and sent reminders for non-receipt of journals, invoices etc. Ordering, billing and other jobs had been taken up using computer.

Circulation & Stack Maintenance Unit

The Unit issued 64,128 books and other documents to the users on loan and reference. The total membership of the Library was 1,782, which included ISI staff, Research Scholars, Project Assistants, students, ISEC Trainee etc. as well as outside students and institute members. Eight hundred and fiftyeight readers were given special permission to use the Library for a short period.

Inter-Library Loan

Thirty six books and journals were borrowed from other libraries and 45 books and journals were loaned to other libraries under the inter-library loan arrangement.

The Unit processed 582 books for binding and 16 books for lamination and de-acidification from the rare collection, photocopied 13 out of print rare and mutilated books, fumigated 480 books and Bar-coded 4,940 books, during the period under report. Bar-coded membership cards were issued to 1,782 members of the Library.

Reports & Records Unit

The Unit processed 107 titles and 400 titles were issued to users on reference.

Circulating Library

The Workers' Circulating Library acquired 140 new titles bringing the total collection to 37,199, and issued 2,400 books to the members.

Technical Processing Unit

The Unit classified and catalogued 1737 new books and added to the LIBSYS database. The Unit issued 12 issues of current additions to the Library. The Unit had printed 12,149 computer cards using Libsys, and these cards had been filed.

Documentation Unit

The Unit had issued current contents list services to the users on the following group of subjects: a) Statistics and Mathematics, (b) Electronics and Communications Science, (c) Geology, (d) Life Science, (e) Economics, (f) Recent additions of books to the ISI Library. A total number of 41 requests for photocopies were sent against specific request across the country.

Reprography & Photography Unit

The Unit provided 6,39,804 Xerox prints to the users. 3,708 photographic enlargements were made during the period. 2,37,268 pages of offset prints and 1,201 frames of lecture slides and Computer output colour printed 4,431 pages were made during the period.

Projects Undertaken

Bar coding of Library documents started on December 2000 and completed generating and pasting of Bar-code labels to 67,000 books.

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 had also been formed with the Universities and Institutions of the North-Eastern Region access for providing on-line access to database of the Mathematical Review (Math Sci net). The Chief Librarian had acted as the Coordinator to the Consortium.

Electronic Library

During the current financial year, the library had subscribed Econlit on-line services. Steps had also been taken to develop electronic collection in CD-ROMs.