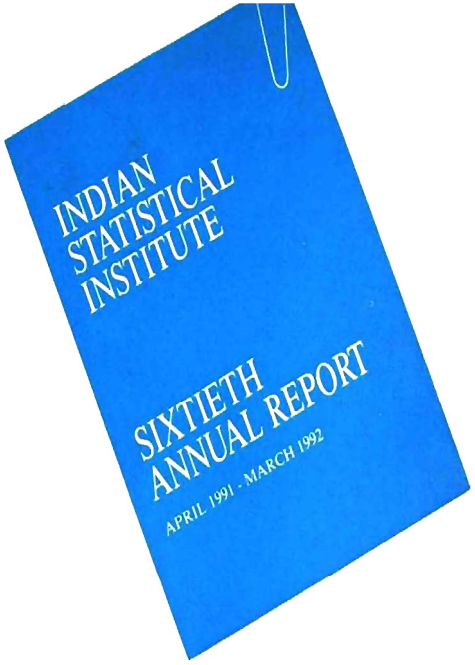

203 BARRACKPORE TRUNK ROAD
CALCUTTA - 700 035

INDIAN STATISTICAL INSTITUTE

SIXTIETH ANNUAL REPORT

April 1991—March 1992

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INDIAN STATISTICAL INSTITUTE

SIXTIETH ANNUAL REPORT

April 1991—March 1992

HISTORY OF THE INSTITUTE

Research in the theory and applications of the new discipline of statistics began in India in early twenties through the pioneering initiative and efforts of the late Professor P. C. Mahalanobis. For sometime after his return from England, Mahalanobis carried on statistical studies at his home. A chance meeting with Dr. Aneundale (the then Director of Anthropological survey of India and Zoological survey of India, Govt. of India) led to Mahalanobis's first systematic work on statistical methods. Later a small group of young scientists collected around him in the Department of Physics, Presidency College which came to be known as the Statistical Laboratory. On the 14th December, 1931 a notice was issued over the signatures of Prof. P. N. Banerjee, Prof. N. R. Sen, both of Calcutta University and Prof. Mahalanobis to convene a meeting on 17th December, 1931 to consider steps towards the establishment of an association for the advancement of statistics in India. At this meeting held on the 17th December, 1931 it was unanimously resolved that the Indian Statistical Institute be established and Sir R. N. Mookherjee be its first President and Prof. P. C. Mahalanobis be the first Secretary. Indian Statistical Institute was registered as a non-profit distributing learned society on 28th April, 1932 under Societies Registration Act XXI of 1860.

As the Institute expanded its research, teaching, training project activities and earned National and International recognition, the Parliament of India enacted the "Indian Statistical Institute Act no. 57" in 1959 declaring the Institute as an Institution of National Importance and empowering it to award degrees and diplomas. Significantly, Pandit Jawaharlal Nehru, the then Prime Minister of India himself piloted the bill in the Parliament. The already existing teaching programmes were then consolidated and expanded and courses for the degrees of Bachelor of Statistics (B. Stat.), Master of Statistics (M. Stat.) were initiated. The award of Ph.D./D.Sc. degree was undertaken at the same time. Later on, M.Tech. courses were started in Computer Science and in Quality, Reliability and Operations Research.

Recognition of the Institute by the Act of Parliament gave greater encouragement to research activities not only in statistics and mathematics but also in various areas of the natural and social sciences without whose live contact, it was believed that the methodology of statistics could not grow. The primary objective of the Institute is the advancement of learning statistics but in addition to emphasise the importance of statistics in relation to other disciplines. The Institute therefore maintains not only research groups in statistics and mathematics but also in the social, biological, physical and earth sciences. Other objectives of the Institute are to develop statistical theory and methods and their use in research and practical applications with special reference to the problems of planning national development and social welfare; to provide for and to undertake, the collection of information, investigations, projects and operational research for the purpose of planning and the improvement of the efficiency of management and production.

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INDIAN STATISTICAL INSTITUTE

Keeping the objectives in view, from the inception of the Institute, Prof. Mahalanobis and his associate Professors H. C. Sinha, S. S. Bose, R. C. Bose, S. N. Roy, C. R. Rao, FRS and others not only contributed to the developement of the of the theories and methods of statistics, but also made valuable applications of statistics through large sample surveys to numerous other disciplines. The technique and methods of the large scale sample surveys earned world reputation for the Institute and Prof. Mahalanobis himself. The late Sir R. A. Fisher, father of modern statistics, was a constant visitor to the Institute and the late Professor J. B. S. Haldane was a member of the faculty for several years beginning 1957. At the inspiration of these stalwarts and other world renowned scientists, the Institute began to undertake researches in several natural and social sciences with the hope that collaboration under the same roof would foster the mutual development of statistics and these disciplines. In fact, Fisher had named statistics as 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. Apart from research activities in statistics, probability and mathematics, which began since the inception, most of the other research groups which exist today started their activities in the fifties.

Research in economics, in particular, received great encouragement when Prime Minister Jawaharlal Nehru entrusted the preparation of the draft Second Five-Year Plan of the country to Professor Mahalanobis and the Institute. Since then many economists of the Institute, some of them very well known, have worked in Calcutta and Delhi 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.

The Institute has been one of the pioneering institutes in the country in the design of electronic computers. An analong computer was assembled as early as 1953 to solve certain differential equations. Soon after, in collaboration with the Jadavpur University, work on the design of a computer with solid state central processor named ISIJU-I, was commissioned in 1966 by Shri M. C. Chagla, the then Minister of Education, Government of India. Since then, the computer scientists have diversified their researches in other areas to a great extent including Fifth Generation Computing Systems.

The work of the Statistical Quality Control Unit was started following a visit of Dr. W. A. Shewhart, the father of SQC, to the Institute in 1948. SQC promotion work was gradually spread all over the Industrial Centres in India under a comprehensive programme covering education and training, applied research and consultancy services.

The Institute has, over the years, had the distinction of having on its roles and as associates very eminent scientists in different disciplines, some of whom have been mentioned above, who have won numerous national and international awards and honours.

A special feature of the scientific activities of the Institute is the collaboration, it receives from scientists from the world over, through their sustained visits. Institute has been enjoying the privilege to host the visit of a number of world famous scientists,

economists and Nobel laureates from time to time in different disciplines. Besides specialists in different fields, the Institute has always attracted the notice of dignitaries of the world. Our late Prime Minister, Pandit Jawaharlal Nehru made such visits several times and so did leaders from other countries.

The Institute is now on the verge of the Birth Centenary of the Founder, Professor P. C. Mahalanobis. During the year-long Celebrations, several conferences will be held and eminent personalities of the world in different spheres would come to this Institute and glimpses of the past would be reflected through their august presence.

The Institute has its headquarters at Calcutta and two other Centres at Delhi and Bangalore. It also has a network of service units of the Statistical Quality Control and Operations Research Division covering many major cities of India.

LIST CONTAINING THE NAMES OF PRESIDENT OF THE INSTITUTE, CHAIRMAN AND MEMBERS OF THE COUNCIL AS ON 31 MARCH, 1992

President : Shri M. G. K. Menon, F.R.S..

The Council

1. *Chairman :* Shri P. N. Haksar, M.Sc. Bar-at-Law, IFS (Retd.)

Representatives of Government of India (4)

2. Sri M. G. Sardana, (upto 31 October 91)/Dr. S. N. Roy, (from 1 November 91), Director General, Central Statistical Organisation/Ex-Officio Additional Secretary, Department of Statistics, Ministry of Planning, Government of India, Sardar Patel Bhavan, Parliament Street, New Delhi 110 001.

3. Shri S. Krishnamoorthy, Joint Secretary and Financial Adviser to the Govt. of India, Department of Statistics, Sardar Patel Bhavan, Parliament Street, New Delhi 110 001.

4. Shri T. R. Venkatachalam, Principal Adviser (up to 4 February 92)/Shri R. Nagraja Rao. Officer-in-charge (from 5 February 92) Department of Statistical Analysis & Computer Services, Reserve Bank of India, C-8/9, Bandra-Kurla Complex, Post Box No. 8182, Bandra (E), Bombay 400 051.

5. Dr. (Smt.) A. R. Rajeswari, Joint Adviser, Department of Science and Technology, New Mehrauli Road, Technology Bhavan, New Delhi 110 016.

Scientists not employed in the Institute (7)

Representative of ICSSR (1)

6. Prof. Amiya Kr. Bagchi, Director, Centre for Studies in Social Sciences 10, Lake Terrace, Calcutta 700 029.

Representatives of INSA (4)

7. Prof. M. G. Nandkarni, Head, Centre for Advanced Study in Mathematics, University of Bombay, Lokmanya Bal Gangadhar Tilak Bhavan, Vidyanagari, Vidyanagari Marg, Bombay 400 098.

8. Prof. R. P. Bambah, Vice-Chancellor, Punjab University, Chandigarh 160 014.

9. Prof. M. S. Kanungo, Department of Zoology, Banaras Hindu University Varanasi 221 005.

10. Prof. H. Y. Mohan Ram, Department of Botany, University of Delhi, Delhi 110 007.

Scientists Co-opted by the Council

11. Prof. B. K. Kale, Department of Statistics, University of Poona, Ganeshkhind, Pune 411 007.

12. Prof. P. V. S. Rao, Head, CSC Group, Tata Institute of Fundamental Research, Homi Bhabha Road, Bombay 400 005.

Elected representatives of the members of the Institute not employed in the Institute (2)

13. Dr. Deb Kumar Bose, 24, Mandeville Gardens, Flat A2/1, Calcutta 700 019.

14. Prof. Prabuddha Nath Roy, 1/525, Jodhpur Park, 4th floor (West), Calcutta 700 068.

Heads (2)

15. Dr. T. S. Arthanari, SQC & OR Division, Indian Statistical Institute, 143, Nungambakkam High Road, Madras 600 034.

16. Dr. Parkash Chander (up to 30 June 91)/
Dr. B. L. S. Prakasa Rao (from 1 July 91 to 31 December 91)/
Prof. Bhaskar Dutta (from 1 January 92),
Delhi Centre, Indian Statistical Institute,
7 S. J. S. Sansanwal Marg, New Delhi 110 016.

Elected representatives of the employees of the Institute (2)

17. Shri Dilip Sengupta, Population Studies Unit, Representative of the Scientific workers, Indian Statistical Institute, Calcutta 700 035.

18. Shri Apurba Guha, Dean's Office, Representative of the Non-Scientific workers, Indian Statistical Institute Calcutta 700 035.

Officers of the Institute (Ex-officio) (7)

19. Dr. J. K. Ghosh, Director (upto 12 July 91)/
Dr. N. Bhattacharya, Director (from 13 July 91),
Indian Statistical Institute, 203, B. T. Road, Calcutta 700 035.

20. Dr. Somesh Dasgupta, Professor-in-Charge, Theoretical Statistics and Mathematics Division.

21. Dr T. Krishnan, Professor-in-Charge, Applied Statistics, Surveys and Computing Division.

22. Dr. Chitta Ranjan Malakar, Professor-in-Charge, Social Sciences Division.

23. Dr. B. B. Chaudhuri, Professor-in-Charge, Physical and Earth Sciences Dvision.

24. Dr. Pranab Kr. Tapaswi, Professor-in-Charge, Biological Sciences Division.

25. Dr. Amulya Bhusan Gupta, Dean of Studies.
Shri P. K. Bandyopadhyay, Chief Administrative Officer, was non-member Secretary.

INDIAN STATISTICAL INSTITUTE

DIRECTOR'S REPORT

During the year under review the Institute organised a good number of national and international conferences, workshops and summer and winter schools at different centres. Particular mention may be made of a Winter Conference in Linear Algebra and Linear Models (at Calcutta), a Conference on Stochastic Differential Equations (at Bangalore, jointly with Indian Academy of Sciences); a mini-Conference on Harmonic Analysis (at Bangalore), a Symposium on Quantum Field Theory and Statistical Mechanics (at Calcutta, jointly with S. N. Bose Centre for Basic Sciences), the 45th Annual Conference of the Indian Society of Agricultural Statistics (at Delhi), a Seminar on Certain Aspects of Linear Cellular Automata and Applications (at Calcutta), a Winter School on Use of Statistical Software (at Calcutta), an International Workshop on Recent Trends in Speech, Music and Allied Signal Processing (at Delhi), a Workshop on Parallel Processing (at Calcutta, jointly with C-DAC, Pune), a Winter School on Quantitative Economics (at Bangalore, jointly with the Institute for Social and Economic Change and Bangalore University) and the Third International Conference on Informetrics (at Bangalore). In addition to the above, the different Units of the SQC & OR Division in various cities and the DRTC at Bangalore Centre organised a number of seminars during the year.

A UGC-sponsored Refresher Course in Statistics was organised at Calcutta for the training of university and college teachers.

Many faculty members from different centres, particularly from the Divisions of Theoretical Statistics and Mathematics, and Applied Statistics, Surveys and Computing, participated in the Statistics Section of the Indian Science Congress in which Professor K. R. Parthasarathy was the President and Professor B. K. Sinha, the Recorder. Three Research Fellows of the Institute won Young Scientist Awards at the Science Congress—Shri Shantanu Mukherjee of Population Studies Unit in Statistics and Shri Ashish Ghosh and Shri Debaprasad Mandal, both of ECSU, in Computer Science.

Mention may be made in this connection of Smt. Ketaki Das of AHGU who got the Young Scientist Award for 1991 from the Indian Society of Human Genetics and Dr. Bani Bandana Ganguly of Biochemistry Unit who was selected for the Dr. A. R. Gopal Ayengar Award of IARP at BARC, Bombay.

Senior members of the faculty won many honours and awards during the year. Professor J. K. Ghosh, who was Director for a five-year term ending 14 January 1992, was elected President of the International Statistical Institute for the years 1993-95. This is a great honour for him and for the Institute. Only two other Indians, Professors P. C. Mahalanobis and C. R. Rao, had received the honour before. Professor Sankar Pal received the prestigious Bhatnagar Award in Engineering Sciences in recognition of his fuzzy set theoretic work on pattern recognition, image processing etc. Professor B. L. S. Prakasa Rao and Professor V. S. Sunder were elected Fellows of the Indian Academy of Sciences. Professor Somesh Dasgupta, a leading mathematical statistican, became a Fellow of the Indian National Science Academy. Professor Bhaskar Dutta received the Mahalanobis Memorial Medal for the year 1990 from the Indian Econometric Society for outstanding contributions to quantitative economics. Shri B K. Pal became the first Indian member of the World Academy of Quality and Shri N. T. V. Ranga Rao got the Oshigawa Award from Japan second time for an essay on the "Modernization of small scale industries and business".

As regards teaching and training activities, the first batch of the new two-year M.Tech. programme in Quality, Reliability and Operations Research, started during 1989-90 at Calcutta, graduated during the year and they were well received by those employers who are quality conscious. All the regular courses of the Institute went on satisfactorily. During the academic session 1991-92, a total of 10,200 candidates applied for admission to the various degree and diploma courses and they were called for written selection tests which were conducted at 22 centres spread over the whole country. A total of 5,799 candidates appeared for these written tests and subsequently, 493 of them were called for interview. Finally, 271 candidates were offered admission to different courses like B.Stat. (Honours), M.Stat. (S-stream an M-stream), M.Tech. (Computer Science) and M.Tech. (Quality, Reliability and OR), besides Ph.D. programmes in various fields.

The Institute operates the International Statistical Education Centre (ISEC), which was established in 1950, jointly with the International Statistical Institute, under the auspices of the UNESCO and the Govt. of India. During the year under review, the Centre conducted the 10-month Regular course of the 43th Term with 11 trainees from 6 different countries in South and South-East Asia and commonwealth Africa. The Govt. of India awarded fellowships to 9 of these trainees—three under the TCS of the Colombo plan, 1 under SCAAP and 5 under AID to Sri Lanka. The remaining two were Indians and were supported by their sponsor (the Indian Air Force). In addition to the above, ISEC arranged a Special Course in sampling for one trainee from Uganda.

The printing and publication of Sankhyā, Series A and B, made satisfactory progress and all the parts of volume 53 were published besides Vol. 54, Series A, part 1.

The Institute pursued its various interests in fundamental and applied research, much of which has been multidisciplinary.

One piece of research done by two young scientists of the Bangalore Centre, Drs. Bhaskar Bagchi and Basudev Dutta, gives some idea of the activities of the Division of Theoretical Statistics and Mathematics. They presented a completely theoretical proof of the existence and uniqueness of the 9-vertex triangular of $Cl^{4,2}$. The original proof of existence, due to Kiihnel, as well as the orginal proof of uniqueness due to Kiihnel and LaÃmann, were based on extensive computer search.

The activities of the SQC & OR Division were being increasingly appreciated by industry as well as by Govt. A UNIDO proposal to provide training in Quality Management to candidates from neighbouring countries by ISI experts was under the consideration of Govt. of India. The Division has been helping industry in implementing ISO 9000 Quality Systems and has been trying to develop computer aids for such purposes.

Some work done in the ECSU attracted wide attention. A speech synthesizer for Bengali named *Bangabani* was developed by Professor Ashok Dutta and associates and this may be the first complete speech synthesis system in any given language. A related achievment was a system, called *Surobitan*, for automatic musical transcription for vocal songs. Computer based Natural Language processing was started for Bengali by Professor B. B. Chaudhuri and his team, probably for the first time in India.

The Centre for Knowledge Based Computing System (KBCS) Technology and Fifth Generation Computer System (FGCS) Development Project, sponsored by DoE/

UNDP, completed its first phase in March 1992 and its duration was later extended by a further period of one year.

Satisfactory progress was made on many of the interdisciplinary projects taken up at the request of different agencies by applied statisticians, economists, sociologists, biologists etc. Special mention may be made of the project on "Differential Impact of Modern Rice Technology", funded by the Rockefeller Fundation, the project on "Evaluation of Rainfed Farming', sponsored by the Overseas Development Administration, UK and carried out in collaboration with the Hindusthan Fertilizer Corporation Ltd. and the project on "Identification of Rural Poor" taken up at the instance of the Dept. of Statistics, Govt. of India. Significant progress was made by the anthropologists in their studies on human adaptability, on genetic epidemiology and on evolution and dermatoglyphics. Work was continued on mathematical and stochastic modelling of cellular growth, differentiation and morphogenesis.

A sample survey project had been undertaken for assessing the yield rates of the FFDA (Fish Farmers' Development Agency) and non-FFDA tanks and also the training programme under the FFDA and other related matters in several districts of West Bengal. The survey was completed and a report submitted to the Directorate of Fisheries, Govt. of West Bengal.

The Institute started preparations for celebrating the Birth Centenary of its founder, Professor Mahalanobis (born : 29 June 1893), in a befitting manner, during 1992-93 and 1993-94. An International Advisory Board was set up, with Shri P. V. Narasimha Rao (Prime Minister) as Chief Patron and Shri Pranab Mukherjee, Sri Sukh Ram and Shri Jyoti Basu as Patrons, for guiding these celebrations. Steps were initiated for holding several international conferences in different fields at different centres of ISI, for setting up an archive-cum-museum at Professor Mahalanobis's residence (Amrapali), and for bringing out a special volume of Sankhyā, among other things. The Institute would also celebrate during 1992 the birth centenary of the great savant, Professor J. B. S. Haldane, who had served on its faculty for several years. The programme includes an International Conference on Human Genetics to be held at Calcutta in December 1992, besides a series of special lectures. It may also be mentioned that the DRTC at Bangalore Centre organized the Third International Conference on Informetrics in August 1991 to commemorate the birth centenary of Professor S. R. Ranganathan, pioneer in library science in India, who started the DRTC.

John & Wiley Sons, Inc., NY, and Wiley Eastern Ltd. offered to create a Visiting Chair in Statistics and Probability at the Institute in honour of Mr. W. B. Wiley.

After prolonged negotiations with the Govt. of India, the Statistical Publishing Society (SPS), another creation of Professor Mahalanobis, was taken over by ISI with effect from August 1991.

On the administrative side, the decisions of the Govt. of India on the long pending issue of pay scales for non-faculty staff of the Institute were received in March 1992 after considerable delay which caused a lot of anxiety among the workers. The decisions nearly settled the matter for existing workers of the Institute in a satisfactory manner. But unfortunately, Govt. withheld their decisions on the pay scales of new entrants to the Institute and advised the Institute not to appoint persons from outside until these decisions are made.

Part I. Teaching, Training, Research, Projects and Publication

1. TEACHING AND TRAINING

Degree and Training Courses

A brief account of teaching and training activities during the period from April 1991 to March 1992 is given below :

During the academic session 1991-1992, 10,200 candidates applied for admission and were called for written selection tests for the various courses offered by the Institute, viz., B.Stat. (Hons.), M.Stat. (M-stream and S-stream), M.Tech. in Computer Science, M.Tech. in Quality, Reliability and Operations Research, Two year Part-time Post-Graduate Diploma in SQC and OR (Bombay and Madras), Research Fellowships in Statistics, Mathematics, Economics, Computer Science, Physics, Fluid Mechanics, Anthropology and Geology, One Year Part-time Course in Statistical Methods and Applications and the Course on Operation and Programming of Automatic Data Processing Equipment. Admission tests were conducted at 22 different centres all over the country. A total of 5,799 candidates finally appeared at admission tests and a total of 493 candidates who qualified in the written tests, were called for interviews. Based on the performance in the written tests and the interviews, 271 candidates were offered admission to various courses during the academic session 1991-92.

There were four foreign students who applied for admission to the courses. Admission tests were conducted for them through the Indian High Commissions in Kenya and Dhaka.

The annual examinations for all the regular courses were held in May/June 1991. The 1991-92 academic session commenced on 8 July 1991.

One hundred and three candidates received their degrees and diplomas at the Twenty-Sixth Convocation of the Indian Statistical Institute held on 6 March 1992 and one hundred five candidates who passed the various regular courses of varying duration (one-year or less), received the certificates during the year. Four candidates were awarded Ph.D. degree of the Indian Statistical Institute.

Eleven trainees in Engineering and Technology from various Universities (Jadavpur, Banaras Hindu University, Aligarh Muslim University) received a six-week practical training in the Electronics and Communication Sciences Unit and the Electronics Unit.

The number of candidates admitted to the different degree, diploma and training courses during 1990-91 and 1991-92 and the results of the examinations held during the period are as follows :

INDIAN STATISTICAL INSTITUTE

NUMBER Of STUDENTS ADMITTED AND PASSED IN DIFFERENT COURSES APRIL 1991—MARCH 1992

Course	Number of students		
	enrolled in 1990-91	enrolled in 1991-92	passed in annual examination in 1991
Degree			
1. Bachelor of Statistics with Honours [B. Stat. (Hons.)]			
1st. year	24	16	22
2n year	16	23	16
3r year	10	16	10
2. Master of Statistics (M. Stat.)			
1st year (M-stream)	9	9	9
1st year (S-stream)	20	13	18
2nd year	22	27	21
3. M. Tech. in Computer Science			
1st year	28	24	21
2nd year	14	21	15
4. M. Tech. in Quality, Reliability and Operations Research			
1st year	23	17	17
2nd year	16	17	14
Diploma/Certificate/Associateship			
5. Statistical Quality Control and Operations Research (1-year)	course discontinued		1
6. Course on Operation and Programming of Automatic Data Processing Equipment :			
1st year	18	13	14
2nd year	22	14	17
7. Part-time Certificate/Diploma in Statistical Quality Control and Operations Research (Bombay and Madras)			
Bombay—1st year	7	—	1
2nd year	—	1	—
Madras— 1st year	10	10	4
2nd year	8	4	6
8. Associateship in Documentation and Information Science			
1st year	6	8	9
2nd year	8	6	8
9. Part-time course in Statistical Methods and Applications			
(i) Calcutta	48	49	13
(ii) Delhi	18	—	5
(iii) Hyderabad	37	41	16
10. Six-month Part-time Course in Statistical Quality Control :			
Bangalore Jan-June	6	—	16
July-Dec.	10	—	9
Hyderabad Jan-June	28	7	4
July-Dec.	33	15	3
11. Intensive Course on Programming and Applications	17	15	15
12. Junior Certificate Course in Statistics (Jointly with C.S.O.)	11	6	5
Fellowship			
13. Junior and Senior Research Fellows, Visiting Fellows in different disciplines	107	135	—
14. SDP Fellows	18	18	—
Grand Total	587	534	306

Ph.D/D.Sc Degrees

(A) Ph.D./D.Sc. Degrees Awarded :

(a) The following is the list of Ph.D. degrees obtained by the Research Fellows, Research Associates and Project Assistants of the Institute.

(*i*) Dr. Chiranjib Medda	"Variation of muscle protein and lipid of some fishes", degree awarded by the Viswa Bharati University, Shantiniketan. Supervisor : Professor Biswanath Mitra.
(*ii*) Dr. D. P. Sengupta	"New Amphibians (Labyrinthodontia Temnospondyli) from the late Triassic Maleri Formation of Deccan, India : Their significance in geology and palaeontology", degree awarded by the University of Calcutta. Supervisor : Professor T. Roy Chowdhury.
(*iii*) Dr. Susmita Mukhopadhyay (née Bandopadhyay)	"Material working status and health of mother and child", degree awarded by the University of Calcutta. Supervisor : Professor A. Basu.
(*iv*) Dr. S. Pal	"Some low level image segmentation methods, algorithms and their analysis", degree awarded by the IIT, Kharagpur. Supervisor : Dr. P. Bhattacharya, IIT, Kharagpur.
(*v*) Dr. (Mrs.) Tilottoma Barua	"A study of Tai Phakes population in Assam", degree awarded by the Gauhati University, Assam. Supervisor : Professor B. N. Das and S. Guha Roy.

(b) The following is the list of Ph.D. degree obtained by the members of the staff of the Institute.

PHYSICAL AND EARTH SCIENCES DIVISION

Electronics and Communication Sciences Unit

(*i*) Dr. (Mrs.) Amita Pal	"On a class of stochastic Approximation Type parameter Learning Algorithms for pattern Recognition", degree awarded by the Indian Statistical Institute. Supervisor : Professor D. Dutta Majumder.

STATISTICAL QUALITY CONTROL AND OPERATIONS RESEARCH DIVISION

(*ii*) Dr. Aravind Sett	"Component Importance in a consecutive-k-out of n : F systems", degree awarded by the Indian Statistical Institute. Supervisor : Professor K. G. Rammurthy.

(c) The following is the list of Ph.D. degree obtained by the persons not engaged in Indian Statistical Institute but who had worked under the guidance of the faculty of the Institute.

(i) Dr. Sadhan Samar Maity	"Some contirbutions to Analysis of covariance structures", degree awarded by the Indian Statistical Institute. Supervisor : Dr. B. N. Mukherjee.
(ii) Dr. HO-Jan Chang	"Some optimal tests in Directional Data", degree awarded by the University of California, Santa Barbara. Supervisor : Professor Ashis Sengupta and S. R. Jammalamadaka.
(iii) Dr. Nabakumar Ghosh	"On some problems of unsteady motion in the theory of water waves at an inertial surface", degree awarded by the University of Calcutta. Supervisor : Professor B. N. Mondal.
(iv) Dr. Lalitha Sundarshan	"Some Aspects of Multi source satellite Image processing", degree awarded by the Indian Statistical Institute. Supervisor : Professor D. Dutta Majumder.
(v) Dr. (Mrs.) Sujata Diwale	"A Multivariate study of Androgyny in relation to Psychological Health and status of women", degree awarded by the University of Nagpur. Supervisor : Dr. B. N. Mukherjee.

(B) Thesis submitted for Ph.D./D.Sc. Degrees :

(a) The following is the list of Ph.D thesis submitted by the Research Fellows, Research Assistants and Project Assistants of the Institute.

(i) Mrs. Sudeshna Banerjee	"On some problems in the linearised theory of water waves", University of Calcutta. Supervisor : Professor B. N. Mondal.
(ii) Shri S. Sur-Kolay	"Studies on nonslicible floorplans in VLSI layout design", University of Calcutta. Supervisor : Dr. B. B. Bhattacharya.

(b) The following is the list of Ph.D. thesis submitted by members of the staff of the Institute.

Physical and Earth Sciences

Electronics

(*i*) Shri Malay Kumar Kundu — "On some problems of image Data compression and Related Preprocessing Techniques", University of Calcutta.
Supervisor : Professor D. Dutta Majumder.

Geological Studies

(*ii*) Shri T. Chakraborty — "Stratigraphy and sedimentation of the proterozoic Sullavai Group in the South Central part of Pranhita-Godavari Valley, Andhra Pradesh, India", Jadavpur University, Calcutta.
Supervisor : Professor A. K. Chaudhuri.

Physics

(*iii*) Shri S. Gangopadhyay — "Orthogonal Transformation in Linear System", IIT, Kharagpur.
Supervisor : Professor K. B. Dutta, IIT, Kharagpur.

(*C*) The following is the list of Ph.D. thesis submitted by the persons not engaged in Indian Statistical Institute but who worked under the guidance of the faculty of the Institute.

(*i*) Shri B. P. Vani — "Poverty, Inequality and Consumption pattern of the poor in rural India", Indian Statistical Institute.
Supervisor : Professor N. S. S. Narayana.

(*ii*) Mrs. Manisha Bhattacharya — "Some biophysical parameters of skin and skin characterisation", Indian Statistical Institute.
Supervisor : Professor A. B. Gupta.

(*iii*) Shri S. Pohit — "India's External Debt : Determinants and Impact", Indian Statistical Institute.
Supervisor : Dr. Atul Sharma

INDIAN STATISTICAL INSTITUTE

International Statistical Education Centre—Calcutta

A brief report on activities of the International Statistical Education Centre during the year 1991-1992 follows :

It may be recalled that the Centre was opened 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. The directors represent International Statistical Institute Indian Statistical Institute and the Government of India. Professor P. C. Mahalanobis was the Chairman of the Board of Directors since its inception in 1950 until his death in 1972. Since then National Professor C. R. Rao, F.R.S., has been the Chairman of the 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, sponsored by respective Governments. Major training programme of the Centre is a 10 month Regular Course. In addition, special Courses of varying duration are also organised. Since inception, the Centre has provided training to 1,176 trainees from 56 Countries.

A total of 61 candidates from 19 different Countries were nominated by respective Governments for admission to the 45th term of the Regular Course of this Centre. Of these 61 Candidates, 18 were offered admission and 11 participants from 6 Countries joined. Nine trainees were supported by Fellowships awarded by the Government of India under the Technical Cooperation Scheme of the Colombo plan, special Commonwealth African Assistance plan and Aid to Sri Lanka Scheme. The remaining 2, were from Indian Air Force and were supported by their employer.

Teachers of Calcutta and Delhi Centres of the Indian Statistical Institute and Officers of the Government of India participated in teaching the Regular Course during the year. 2 trainees went to Delhi Centre of ISI to undergo 8-week specialization in Economic Planning.

All the 11 Regular trainees were recommended for the award of Statistical Training Deploma.

A novel feature is that during this term, following a request from United Nations, special Courses of 5-month duration in the field of sample surveys for University teachers from African Countries who were being sponsored by the United Nations Department of Technical Cooperation for Development (UNDTCD) were organised with the approval of Professor J. K. Ghosh, erstwhile Director of Indian Statistical Institute, in collaboration with ISI. One trainee from Botswana already completed this course in December 1991 while another trainee from Uganda had started undergoing the same since January 1992 and likely to continue till Mid-June 1992. The Centre hopes to receive more such trainees in future.

Professional Examinations in Statistics

The Examinations Committee conducts professional examinations twice in every year for the award of the

1. Statistical Assistantship Certificate
2. Junior Diploma in Statistics, and
3. Senior Diploma in Statistics.

For the July 1991 term these examinations were held at Bangalore, Bombay, Calcutta, Delhi, Hyderabad, Lucknow and Madras Centres.

For the December 1991 term these examinations were held at Bombay, Calcutta, Delhi, Hyderabad, Lucknow and Madras Centres.

The details of the examinations for July 1991 and December 1991 terms are shown below.

Examinations	Number of candidates					
	registered		appeared		passed*	
	July	Dec.	July	Dec.	July	Dec.
1. Statistical Assistantship Certificate	17	11	7	7	4	5
2. Junior Diploma in Statistics	44	47	33	35	11	11
3. Senior Diploma in Statistics (New)	9	9	5	6	3	—
4. Senior Diploma in Statistics (Old)	1	2	1	2	1	1

*Passed in one or more papers only, not necessarily completed the examination.

The total number of candidates who have qualified for the award of the Certificates and Diplomas in the Professional Examinations in Statistics including the results of December 1991 term are 483 and 260 respectively.

RESEARCH WORK

The research activities of the Institute are grouped in the following Divisions : Theoretical Statistics and Mathematics ; Applied Statistics, Surveys and Computing ; Physical and Earth Sciences ; Biological Sciences ; Social Sciences ; Statistical Quality Control and Operations Research ; and Library, Documentation and Information Sciences. In addition, the Computer and Statistical Services Centre (CSSC) has the responsibilities of management of in house Computer System of the Institute and providing Computing and Statistical Services to Scientific workers.

A brief account of the progress of research in different Divisions and Units of the Institute during the year under review is given below :

Theoretical Statistics and Mathematics Division

The Division of Theoretical Statistics and Mathematics has Units at Calcutta, Delhi and Bangalore Centres, besides one Unit at Hyderabad. The Division is basically engaged in research in different areas in theoretical statistics, probability theory and mathematics, besides providing theoretical support for a number of applied problems that arise in different projects undertaken by ISI and other Institutions. One major responsibility of this Division is to provide instruction in theoretical statistics, probability and mathematics for the B.Stat. (Hons.), M.Stat., M.Tech. (Computer Science), M.Tech. (Quality, Reliability and OR) and various short-term training programmes of the Institute. The Division also conducts advanced courses in mathematics, probability and statistics for the Research Fellows. A strong feature

of the Division is to organise Summer/Winter Schools and Workshops in a variety of advanced and current topics in statistics, probability and mathematics. Besides, colloquium talks and seminar talks by faculty members and visitors are organised regularly.

During the period 1991-92, the members of this Division were engaged in research in the areas of Theoretical Statistics, Statistics and Probability, Probability and Stochastic processes, Mathematics, Applied Mathematics.

During the period, 91 papers were published by the members of this Division in leading International, National journals and books and many other papers have been accepted for publication. Four books have been authored by the members of this Division. Two International Conferences, one Summer/Winter School and many Workshops were organised by this Division in 1991-92. About 35 distinguished Scholars visited the Division and presented Seminars besides collaborating with the faculty.

Details of Research activities

Theoretical Statistics and Mathematics unit (Calcutta)

(*i*) *Statistics*

(*a*) Bayesian analysis, Decision theory, Statistical inference and Asymptotic theory of inference : Noninformative priors obtained by matching Bayesian and frequentist probability of HPD sets ; second order minimaxity ; Berry-Esseen bound for the least-squares estimates in autoregressive models ; Study of the maximum likelihood estimates in generalized regression models and least-squares estimates in nonlinear regression models ; partial unification of L- and R- estimates in linear model ; extensions of the usual kernel smoother for GLM type responses and a hydribization of the parametric and nonparametric regression techniques ; locally more accurate confidence sets ; Statistical modelling and related inference ; ranked sum statistics and related inference ; Asymptotic normality of the number of k-clusters ; bootstrap method ; Asymptotic comparison of fixed sample size and inverse sampling in multinomial selection procedures ; efficiency in semiparametric models ; evaluation of m.l.e. in common location scale problem ; selection of t-best multinomial cells.

(*b*) Sequential analysis : Stein estimation ; regret for sequential estimation of the difference of two means ; piecewise sequential estimation in a certain family of two-parameter exponential distribution and related second-order properties.

(*c*) Multivariate analysis : Study of multivariate median and estimation of the dispersion of multivariate L-median ; multivariate extension of sign test ; bivariate exponential model related to clean-up standards at superfund hazardous sites ; Study of multivariate dependence ; characterization of uniform distributions through order statistics.

(*d*) Sample surveys : Use of auxiliary information ; sample surveys appropriate to socio-economic research ; use of transformations for optimum estimation procedure; search for optimal sampling strategies under superpopulation model with nonlinear regression.

(*e*) Design of Experiments : Design of experiments under Bayesian set-up ; repeated measurement designs ; construction of balanced incomplete row-column design ; analysis of balanced incomplete multiresponse designs ; optimality of block designs ; row-column designs ; construction of treud-free factorial designs ; universal optimality and non-optimality of some row-column designs ; robustness of BIB and extended BIB designs for missing data ; E-optimality of block and row-column designs with unequal number of replicates.

(*ii*) *Probability and Stochastic Processes*

Strong law of large numbers ; sharper speed of convergence to normality for some *m*-dependent processes ; moment bounds for some stochastic processes.

Study of the theory of stochastic integrals in Frank Knight's predication process set-up ; study on the characterization of polynomials of a discrete martingale which are also martingales ; study of Hida-Cramer type representation of stochastic processes.

(*iii*) *Mathematics*

(*a*) Functional analysis : It has been shown that the projective tensor product of a two-dimensional ℓ^p-space with a two-dimensional ℓ^q-space never has the Mazur Intersection Property (MIP) for a large range of values of p and q ; study on the intrinsic characterization of the MIP in terms of farthest point phenomenon, extreme contraction in $L(\ell_\infty^2, \ell_1^2)$ and the MIP in $\ell_\infty^2 \otimes_\varepsilon \ell_1^2$.

(*b*) General topology and measure theory ; topological-cum-analytical aspects of function spaces.

(*c*) Measure-free proof of Birkhoff's ergodic theorems.

(*d*) Harmonic analysis.

(*e*) Descriptive set theory and automata theory : Additive cellular automata and matrices over finite fields ; restrictions of Boolean function and linearity ; complexity of winning strategies for Σ_2^0 games ; definable hereditary families in the projective hierarchy.

(*f*) Graph theory : Chordal graphs and specified elimination ordering ; a new characterization of *k*-trees ; totally supercompact graphs ; measurement of reciprocity in weighted social network.

(*iv*) *Applied Mathematics*

Study of the dispersion processes of solute or contaminate in steady and oscillatory currents ; Study of the processes of grain size sorting during the bedload and suspended load transportation ; navigation hydraulics.

Theoretical Statistics and Mathematics Unit (Delhi)

During the year the Centre worked on the following research areas :

(*i*) Statistics and Probability : Reliability Theory ; Survival Analysis ; Nonparametric Inference ; Quantum Stochastic Calculus ; Functional Equations in Probability Theory ; Spectral Theory ; Percolation Theory.

(*ii*) Theoretical Statistics : Estimation of a common location ; Cramer-Rao type integral inequalities ; Optimality of designs ; Robust designs.

(*iii*) Mathematics : Latin squares, Numbered Graphs ; Order Statistics, Linear Algebra ; Linear Algebra and its applications, Operator Theory ; Game Theory and Mathematical programming.

Theoretical Statistics and Mathematics Unit (Bangalore)

(*i*) Probability theory : Applications of large deviations to Information theory semi-stable measures and processes ; diffusion processes.

(*ii*) Statistics : Sample surveys, Large sample theory, Bayesian inference. Bayesian non-parametric statistics, Reliability theory, Optimality and construction of experimental designs.

(*iii*) Mathematics : Groups of exceptional Lie type, coxeter groups and the Monster group, Combinatorics (Bruck-Ryser type theorems for quasi-symmetric designs and strongly regular graphs), Functional Analysis, Geometry of Banach space, Ergodic theory, Operator algebras and Operator theory, Harmonic analysis, Differential Geometry and Topology, Spectra of Laplacians (especially on vector bundles), Spectral theory for partial differential operators, Finitely additive measures, G-inverses.

Applied Statistics, Surveys and Computing Division

The Applied Statistics, Surveys and Computing Division consists of two units : Computer Science Unit and Biometry Research Unit. Research activities in the Division include both theoretical investigation of methodology and application of existing methods to the solution of real life problems. A brief account of these research activities is given below :

Computer Science Unit

Sample Surveys : A UMV unbiased estimator for a finite population total based on randomized response (RR) surveys has been found for a class of sampling designs. Optimal strategies under linear models and generalized random permutation modelling for population variance under RR surveys have been characterised. Empirical investigations carried out to choose from several estimators of total based on Midzuno-sampling scheme and to find good strategies for variance estimation. Controlled sampling designs have been found to yield unbiased ratio estimators for variance. Performances of alternative unbiased ratio variance estimators have been studied. Gabler's nearest proportional to size (NPPS) sampling scheme has been found to yield optimal controlled sampling to protect the efficiency of Horvitz-Thompson (HT) estimator even on assigning zero selection-probabilities to nonpreferred samples. NPPS scheme is also known to protect efficiency of Basu's generalized difference estimator (GUE) under suitable super-population modelling.

Brewer's asymptotic approach has been employed to yield model-cum-design based alternative variance estimators for OR-predictors, assuming regression models and the approach is extended to cover HT estimator employing non-PPS sampling.

The approach is extended to find variance estimators for estimation of distribution functions based on survey populations. Ohlsson's competitor to Rao-Hartley-Cochran (RHC) variance estimator has been studied further in respect of stability, actual coverage probabilities achieved for the confidence intervals and related characteristics through intensive simulations. Substantial improvement in employing Gray predictor over HT estimator in small domain estimation has been demonstrated through simulation studies.

Design of Experiments : E-optimality of a certain class of PBIBU's with rectangular association scheme and of a new class of adjusted row column designs was established. Constructions were obtained of some new series of optimal block designs in non-orthogonal multiway set up and some new results were obtained in t-linearly independent sets in finite projective geometries. Investigations were carried out on latin squares with structural symmetry property.

Reliability :

Software Reliability : The problem of estimation of the number of bugs in a software programme was tackled using parametric and nonparametric approach. Inference : Studies were conducted on the Estimation of the component life time distributions nonparametrically based on life time data from a parallel system with two components.

Probability Models : Moment bounds on reliability of aging components were derived in a unified manner. Some problems related to the relative aging of two life distributions was studied.

Biostatistics :

Competing Risks : The two sample problem with missing failure type and the nonparametric estimation and testing for covariate effect with missing failure type were studied.

EM Algorithm : For the problem of estimating segregation ratio with different methods of ascertainment, the EM algorithm has been developed which is more elegant and computationally efficient than the conventional methods of computing maximum likelihood estimates.

Regression :

Nonparametric Regression : Likelihood based kernel smoothing and cross-validation procedures were developed.

Linear Regression : Effect of multiple row deletion when the estimation space is reduced and superadditivity of information in correlated linear experiments were studied.

Multivariate Analysis : Studies have been carried out on (*i*) construction of optimal invariant test in some applied multivariate mixture models with non-regularity problems. (*ii*) efficient estimation in wrapped stable distributions for directional data. (*iii*) characterizations of and estimation procedures for families admitting Cox's semi-parametric logistic discrimination and (*iv*) generalization of Bhattacharyya plot and Gibbs sampling procedure for multivariate mixture models.

Various iterative algorithms useful in ML estimation of parameters in covariance and correlation structure analysis have been compared with respect to their rate of convergence, algorithmic efficiency etc. The robustness of the Fisher-Scoring algorithm even with bad starting values has been numerically demonstrated.

Computer Sciences : Application of cellular arrays of processors in one and two dimensions with a view to utilize VLSI technology and to enhance the performance of computations by embedding different algorithms in arrays of processors. Test generation techniques implemented as BIST (Built In Self Test).

Development of a software package for data handling and summarisation to be used by trainees in microcomputers. Improvement and modification of EASE package.

The Unit also organised a winter school on use of statistical software in collaboration with the faculty members of Theoretical Statistics and Mathematics, Economic Research Unit and the Anthropometry and Human Genetics Unit from 9 to 28 December, 1991.

Externally funded project :

1. *Differential Impact of Modern Rice Cultivation*

The poject 'Differential Impact of Modern Rice Technology' across Production Environments was going on. Field work for both rounds of the intensive survey of households has been completed and the data been cleaned. The documentation has been prepared and the analysis of the data was going on.

2. *Fish Farmers' Development Agency Survey*

A sample survey project was completed and a report was submitted to the Directorate of Fisheries, Govt. of West Bengal for their views before final printing. The project was aimed to assess the yield rates of the FFDA (Fish Farmers' Development Agency)/non-FFDA tanks, training programme under the FFDA, and other related matters in four districts of the State.

The average output of FFDA tanks has not reached the anticipated target of 2500 kg per hactare. Yield rate varied from 350 kg to 1750 kg in the four districts. Nothing definitely can be said about the superiority of production rate of the FFDA tanks as compared to non-FFDA tanks. The FFDA programme seems to have increased the gross production of fish by enabling poor fish farmers to utilise derelict water areas for fish farming. Availability of inputs in time, as also the quality and the quantity of inputs, were some significant constraints towards higher yield rate. The FFDA training programme was found to be useful by all sections of fishermen but most of them would prefer training for a longer duration.

Biometry Research Unit

Biometry Research Unit is engaged in different Biomedical, Toxicological and Enviromental problems with their theoretical interpretation to predict the onset of diseases. Studies on genetic marker isozymes, immunological profiles, role of common medicinal plants on hypoglycemic activity, preparation of mathematical models to

mimic oral glucose tolerance and a possible connection between viscosity and early onset of diseases are being envisaged. Some of the research activities were :

(i) Immune response in young malnutrition related diabetes mellitus : It is found that in spite of the low graded socio-economic conditions there is a prevalence of hyperglycemia associated with hyperlipidaemia in the young insulin dependent diabetic subjects studied. The possible reasons at immunoglobulin levels are being studied.

(ii) Antihyperglycemic properties of certain medicinal plants : So far, the common medicinal plants, *Vinca rosea*, *Azairachta indica* and *Ocimum sanctum* have been subjected to investigation relating to their possible relevance with antidiabetic properties. Some interesting results are obtained with their applications (orally and i.p.) on rodents.

(iii) Modelling viscoelastic properties of blood : The structural viscosity of streptozotocin induced diabetic rats/rabbits has been monitored along with the investigation of plasma hematocrit values, the I : G ratio and blood glucose concentration. It is found that the diseased system has become more thixotropic by this stress.

(iv) Growth modelling of major Indian carps : The results obtained so far in this externally funded project reveals a prominent effect of source and space variation of nursery ponds on the future development of the species.

Project work :

1. Malnutrition related young IDDM and adult NIDDM patients : Young malnutrition related diabetes mellitus (MRDM) is a new addition to class of diabetes. It is a peculiar tropical disease, the etiology of which has not yet been established. Studies on biochemical, physiological and immunological aspects are undertaken to find out some causative factor of this disease. Biochemical studies revealed the high lipid value. Immunogenetic studies also revealed till now the high level of DR_4 and DR_7 on their HLA pattern. It is hoped that after the completion of this project a novel and significant contribution to this problem can be made which was not contemplated before.

2. Modelling viscoelastic properties of blood : Investigation on streptozotocin induced diabetic rats or rabbits in the level of plasma hematocrit values, I : G ratio and blood glucose concentration have been undertaken. It is revealed that the diseased system has become more thixotropic by the stress. Recently radiation stress on rabbits at a dose of 100 R/M using X-ray machine operating at 250 KVP with a 2mm Cu filter has also been induced. The result showed a clear indication of more aggregation of red blood corpuscles in the blood of exposed animals.

3. Antihyperglycemic properties of certain medicinal plants : A number of crude drugs extracted from plant sources, eg. *Azadirahta indica* (neem), *Ocimum sanctum* (Tulsi) and *Vinca rosea* (Nayantara) have been reported by us to possess hypoglycemic and antihyperglycemic activity. High LD_{50} values and general behavioural studies revealed that the extracts can be considered as safe substance to be used as a drug ordinarily. Hence the present methodical and scientific analysis of these extracts will be contemplated to investigate the active pure compound(s) responsible for this activity and whether these extracts have any other actions on the body system and thus an attempt will be made to develop hypoglycemic drugs from plant sources.

Externally funded project :

"Determination of Survival. Growth and Reproduction rates of fresh-water Indian Carps with particular reference to Bundh-bred, Hatchery and Riverine sources". (funded by Directorate of Fisheries, Govt of West Bengal) : The Unit has executed a pilot study on the investigation of the growth rate pattern of three major Indian Carps with particular reference to Hatchery, Bundh-bred and Riverine sources during the period July-October 1988. Based on the report submitted, the Unit was requested to continue further study with emphasis to reduce the lag phase of growth of carps by judicious selection of supplementary food and to trace the velocity and acceleration of growth in terms of physical biochemical and genetical parameters. Results so far obtained pinpoint the predominant role of the genetic isozyme, lactate dehydrogenase in combating an adverse ecosystem in a still unexpected manner. The study also suggests the existence of taxonomic distance among the three species belonging to the same Cyprinidae family.

Computer and Statistical Service Centre (CSSC)

Computer and Statistical Service Centre (CSSC) manages the central computational facilities of the Institute. It supports about 400 users including the students, research scholars and scientific workers of the Institute. There are some external users from other academic Institutions also. NSSO, Govt. of India and CSO (I-S wing) are also using the computational facilities available at the centre.

During the period of report, CSSC has provided statistical and computational consultancy services to 24 users, offered eight courses on programming languages and application packages. A special course on "Operation and Programming on Personal Computer" was organised for NSSO and Bidhan Chandra Krishi Viswavidyalaya.

The following Hardware/Software items have been acquired :

1. SHAZAM (For VAX/VMS) an Econometrics Analysis package
2. Spare Station 1 and Printer (Epson Ex-1000) SUN OS-4.1, NFS, FORTRAN PASCAL, C++
3. Four Wipro PC/XTs with LAN card to be connected to Spare Station 1 as end nodes in LAN
4. One Wipro PC/AT and Laser Printer (HP Laser Jet III)

Physical and Earth Sciences Division

The Division comprises the Chemistry Unit, the Electronics Unit, the Electronics and Communication Sciences Unit, the Geological Studies Unit and the Physics Unit. Faculty members of the Division are engaged in teaching and training, besides research and project work. Researches carried out in these units are described below :

Chemistry Unit

Main topics of Research : Two parallel though interacting lines for research are being persued. Surface reactions in colloid systems and their significance in several

natural processes is one of them. The second concerns active components of soil systems and their interaction. At present, distribution and characteristics of non-crystaline inorganic materials in soils of diverse origin and under widely differing usages are under investigation.

Over the years this unit did extensive work on the distribution and chemistry of organic matter of West Bengal soils and gathered a formidable amount of data. Valuable information on the accumulation, decay and development of humus material under widely differing agroclimatic conditions prvoided. Though important clue to soil management and soil amelioration could be suggested, the work prompted the unit to undertake similar investigation on other active components particularly the non-crystalling inorganic materials. Their importance has been fully realised only recenty and hence proved worth examining.

The members of the Unit have already examined some soils and have been able to characterise the amorphous materials, the so-called allophanes, present in them. This work will be when completed.

On-going Projects :

1. Distribution, Characteristics and Reaction of Allophanic Materials in West Bengal Soils : Fractionation of fifteen samples of three profiles have been completed so far. Non-crystalline residues in the fine and coarse fractions have been identified. Exchange capacity and surface areas have been determined. Gelling ability of these materials is under investigation.

2. Adsorption in solid solution interface : Adsorption and exchangeability of tris-ethylene diamine cobalt[III] complex by alkyl substituted ammonium cations on quartz, feldspar and slates have been carried out. Distribution coefficients and selectivity constants have been calculated. This helps to understand the nature of modification of the alumino-silicate surface by adsorption of organics.

3. Soil composition and Soil Physical properties : Work on this project has been started this year.

Electronics Unit

A. *Digital Systems Research*

1. Parallel Algorithms and Parallel Architectures :

The objective of this project includes the following :

(*i*) Design of efficient parallel algrorithms for various numeric, non-numeric and graph problems, problems on computational geometry and mapping them on suitable parallel architectures.

(*ii*) Design of fault-tolerant parallel architectures for different numeric and non-numeric problems.

(*iii*) Testing and Design for testability of systolic arrays.

(*iv*) Studies on tree-type architectures and their suitability for parallel processing. Performance of simple tree architecture is severely limited by the constraint imposed by the data communication bandwidth of the root processor. Our objective is to get rid-of this bottle-neck by suitable modification of the tree architecture.

2. Network Topology :

The objective of this study is to find suitable topologies for computing networks in order to have a network with small diameter, less number of communication links, incremental extensibility, fault-tolerance and ease of routing in both fault-free and faulty situations. Many of these requirements are mutually conflicting in nature. An optimal design is still called for.

An incrementally extensible network topology has been proposed. Properties of some dense trivalent graphs as network topologies have been studied. Studies have also been carried out on the quantification of network reliabilities. A stochastic model of fault in the network has been considered and an algorithm has been developed to compute the reliability of the network. Some optimality criteria have been proposed to minimize the diameter of loop networks. Algorithms has also been proposed to find the shortest path between any two nodes of a loop network, in fault-free case as well as under single fault. An algorithm has been proposed to find maximal subcubes in a residual hypercube.

3. Studies on Interconnection Networks :

Different properties of MIN's such as their permutation capability, routing, equivalence, fault-tolerance etc. constitute the subject matter of our study. The problem of partitioning a given permutation into an optimal number of subsets such that each subset is realizable is a single pass, has also been considered for investigation.

(i) A summary of work already done upto 31st March 1992 : From the analysis of conflict graphs an optimal graph coloring algorithm has been developed to find out the optimal number of passes for a set of permutations. This has been studied on baseline network and then generalised for other types of full-access unique path MIN's. It has been found that the set of all possible permutations can be partitioned into a number of equivalent classes. For each class, we define a seed-permutation. The conflict graph of any permutation is isomorphic with that of the seed-permutation belonging to the same equivalent class. Several self-routing techniques on rearrangeable networks (Bense network) have been studied. Work has been done towards the classification of the permutations according to different self-routable techniques.

4. VLSI Layout Design-phase II :

The objective of this project is to design efficient floorplans of VLSI chips. The rectangular dualization method of floorplanning is adopted and the novel concept of inherent nonslicibility is proposed. Graph-theoretic characterisation of inherent nonslicibility is being investigated, which will lead to a recognition algorithm. For a given topological neighbourhood graph, it will then be possible to design a slicible floorplan whenever it exists. A second issue under consideration is to investigate the transformation techniques for converting a nonslicing to a slicing with minimum violation of neighbourhood relations. This would greatly help the placement and routing in the latter phases of chip design.

Another area of our investigation includes the placement problem in the layout design cycle. Linear and circula placement of modules which minimizes the wire length being considered. We would like to study the problem of finding the largest area empty rectangle in a given VLSI layout, and designing efficient algorithms for doing so. Finally, the different aspects of routing will be studied as well.

Graph theoretic characterization of inherently nonslicing (INS) floorplans has been explored. An entirely new family of INS floorplans have been discovered. In the placement area, efficient algorithms for optimal linear placement of parallel graphs have been developed.

B. *Theoretical Physics*

Topological aspects of the internal symmetry of particles have been investigated. Topological field theory and its relationship with quantization and supersymmetry have been studied. The relationship of Berry phase with chiral anomaly has been demonstrated. Besides the topological features conformal anomaly and gravitational anomaly have been studied. Equivalence of different quantization procedures have been demonstrated. The role of topological aspects in quantum gravity as well as the cosmological constant problem in relation to this have been studied. The effect of non-zero Berry phase and Bose-Fermi transmutation the $3+1$ dimension and fractional statistics in $2+1$ dimension have been investigated in the field of condensed matter physics.

Relationship between different quantization procedures have been studied. Topological field theory, particularly the Chern-Somons topology and its role in quantum field theory, Bose-Fermi Transmutations in condensed matter physics have been investigated. With the help of fractional statistics in $2+1$ dimension underlying mechanism of superfluids in $3+1$ dimension has been explained. Stochastic quantization approach to field theory of a dissipative system has been studied. A possible geometrical interpretation of Energy-time uncertainty has been studied in developing quantum field theory from stochastic fields.

Supersymmetric Quantum Mechanics has been studied to find exact solutions of some important problems in Quantum Mechanics and also to study SUSY breaking.

Some hitherto unknown results for Coulomb-like potentials has been obtained. Also complete formulation for the application of $1/N$ expansion and algebraic method to Dirac equations has been achieved for the first time. This has been extended to constrained quantum mechanical system. In field theory Gaussian approach have been used to study spontaneous symmetry breaking in both flat and curved space. An important result has been obtained for R. W. space time with background charge. In plasma physics exact solution has been found for double layers in presence of intense relativistic electron beam. Extension of this study to magnetic plasma is undertaken.

An exhaustive and qualitative explanation for the anomalous high-multiplicity cosmic ray events at ultrahigh energies has been presented very recently and the quantitative checkup of the same is now under progress. This would have removed all the so-called anomalies. Furthermore, calculations for the prompt muon and neutron flux on the basis of the very uptodate accelerator and collider data will also be taken up in the near future.

1. Theory of Unsharp Measurement in Quantum Mechanics and the trajectory of a particle :

The classical nature of trajectory of a microparticle say the track of α-particle including chamber has been studied within the framework of unsharp measurement theory developed by Busch, Lahti and Mittlested. We have then considered the effect

of Gravitational noise on this trajectory and quasi-classical limit has also been discussed. The effect of stochastic forces on the nature of trajectory in general are under investigation.

2. Massive Photon hypothesis and non-dissipative nature of Quantum Fluctuation :

The photon looses its energy when it propagates through a Maxwell vacuum with the conductivity coefficient $\sigma \neq 0$. The mass of the photon can be related to σ and Hubble constant. This loss of energy can be related to the conformal fluctuation of the metric tensor of the space-time background. Under certain condition it has been shown that the fluctuation becomes nondissipative and the mass of the photon $m_\gamma \to 0$ in this limit. This is consistent with formalism of QED and Nelson's stochastic mechanism. However, the conditions for dissipative nature of fluctuations are also studied where the photon becomes massive. This might have relevance to explain redshift mechanism without considering expanding universe as pointed out by Narlikar, Pekkar and Vigier.

3. Stochastic Acceleration mechanism for high energy cosmic Ray particles

The acceleration mechanism for ultrabigh energy cosmic Ray particles seems to be one of the challenging problem in high energy Astrophysics. An investigation has started to build up a stochastic acceleration mechanism to accelerate the particle to the energy $\geq 10^{20}$ev has been initiated.

4. Anyons and super symmetry :

Anyons have been studied from the point of view of their symmetry behaviour. In particular we have studied if anyons can have supersymmetric interactions. Also it has been demonstrated that supersymmetric anyons can contact interact. Non invariance algebra of a number of anyonic systems have also determined.

A number of potential problems from the point of view of supersymmetry were studied. In particular, partial solutions have been found out for some of the problems. Semi-classical approach has also been used for a problem.

C. *Fluid Mechanics*

1. Scattering and radiation problems :

Within the framework of linearised theory of water waves further mathematical work concerning water wave scattering and radiation problems involving nearly vertical barriers nearly vertical wall, submerged nearly circular cylinder etc. have been studied. The first order correction to the amplitudes of the motion set up by the rolling of a nearly vertical partially immersed or submerged plate have been calculated by using a tailored version of Green's integral theorem. The problem of water wave diffraction by a bottom deformation has been considered and the first order corrections to the reflection and transmission coefficients have been evaluated. In all these problems a simplified perturbation analysis has been invoked.

2. Wavemaker problems :

Generation of waves due to prescribed normal velocity on vertical wavemakers in the form of plane, cylinder have been studied for both one-fluid and two-fluid media. The effect of surface tension at the free surface of an one-fluid medium and at the common interface of a two-fluid medium has also been considered.

3. Source potentials :

Problems of generation of water waves due to a line source in the presence of a nearly vertical cliff and in the presence of small bottom deformation have been considered. The concerned source potentials have been constructed approximately by invoking a perturbation method.

Recent experiments suggest that effects of helicity and rotation on different types of turbulent flows are highly important. As a part of the present programme deductive theory has been developed obtaining a closed set of equations and their solutions that exhibit the effects of helicity on a homogeneous turbulent flow. Correlation of acceleration fluctuations in such a flow has also been calculated. The determination of the structure of turbulent scalar field e.g. temperature field due to the presence of helicity is under progress. The structure of turbulent velocity field in a homogeneous turbulent shear flow has been determined using a rapid distortion theory (RDT). Work of developing a model for the homogeneous turbulent shear flow in a rotating frame-work, when non-linear terms are included, is in progress.

4. Flow of a Thin Film of Liquid on a Rotating Disk :

Works on the project of the 'Flow of a thin film of liquid on a rotating disk' has been started since 1989 and some remarkable progress has already been obtained. It is well known that this project is addressed to the problem of spin coatins. This coatins process is generally used to coat the photoresist on silicon wafers for integrated circuits. In this process, a thick layer of fluid is distributed initially over a horizontal disk, after containing concentric grooves, and the layer is subsequently thinned by spinning the disk at high angular velocities. At the start of the spinnigs, most of the fluid is ejected from the wafer leaving a thin film which flows slowly outward from the centre of the disk under the action of centrifugnal force. As the film thins the fluid evaporates causing the increase of fluid viscosity, which reduces the radial flow. Eventually, the viscosity increases to such an extent that the radial motion virtually ceases. After a while the spinner is stopped and the process is completed by evaporating the residual in an oven.

It is well known that the evaporation starts from the surface layer of the film and during the process of evaporation the latent heat is extracted from the film as a result of which a solid skin is formed on the surface layer which puts greater resistance to the remaining liquid for evaporation. During backing, the inner liquid starts evaporating as a result, there may appear undisirable cracks, waves etc. on the surface layer of the film. To supress these unwanted defects on the surface layer and at the same time to get the desired thinning of the film are has to mix up liquids of different volatility to obtain the right combination of the coating liquid mixture. These mixing of liquids are generally done by a trial and error process since our knowledge on spin coating mechanism is not sufficient till todate.

A unique approach has been devised by which one can avoid directly the appearence of undesirable waves and cracks etc. Moreover, it is hoped that specified axisymmetric cooling/heating mechanism will end the trial and error process of mixing the different coating liquid mixture. Partial success in understanding the formation of this film on a rotating disk for an uneven initial distribution has been achieved.

5. Blood Flow :

Under normal conditions, it is sometimes distributed by abnormal unnatural growth formed in the lumen of arteries resulting in arterial diseases. This abnormal growth develops at various locations of the human cardiovascular system and it is necessary to study its effect on the flow field of blood in the arteries.

One model has been considered for studying blood flow in a constricted artery. In this model the separation phenomenon of blood flow has been analysed.

It has been observed that the biological system, in general are greatly affected by the application of an external magnetic field. A model based on the magnetic field has been considered for studying its effect on the flow characteristics of blood in a single constricted artery.

In the present investigation the application of Decomposition Method has been considered. A decomposition method is such a mathematical tool which can provide analytical approximation to a wide class of nonlinear equations without linearization, perturbation, closure approximation, or discretization methods. The present investigation deals with the study of blood flow in a constricted artery by decomposition method.

D. Mathematical Methods :

1. *Integral Transformations*

Some Mehler-Fock type integral transforms have been developed. These involve the associated Legendre Functions as kernel, the superscript of the associated Legendre function appears as an integration variable in the inverse transformation formula while the subscript remains a fixed complex number. Integral expansion of some functions involving the associated Legendre functions have been obtained. These seem to have applications in wide class of problems of mathematical physics involving conical and toroidal regions.

2. *Integral Equations*

Explicit solution to a class of Fredholm integral equations has been found. Dual integral equations involving Associated Legendre functions as kernels and also inverse Associated Weber Orr transforms have been studied. These usually arise in certain appropriate mixed boundary value problems of elasticity. Function-theoretic method of solving a singular integral equation involving two disjoint intervals arising in theory of water waves have been considered. Also, the techniques of integral transforms and integral equations have been utilized in studying some water wave problems.

E. Operations Research

1. *Inventory models*

Some deterministic inventory models have been studied. These involve different demand rates during stock-in and stock-out periods, perishable items with discounts and linear trend in demand. Further work in this area is being continued.

2. *Queuing Models*

A pre-emptive priority queuing model with two classes of customers have been constructed and studied for time-dependent solution by using Laplace transform in time and the method of generating function.

Applications of function-theoretic method in the study of some queuing problems have been contemplated and work in this area is going on.

Externally funded projects

(a) *Ongoing Project :*

Title of the project : 'Integral transforms, integral equations and applications'.

Progress of work : This project in being sponsored by Council of Scientific and Industrial Research, New Delhi, and is being administered through the Calcutta Mathematical Society, since August 1988. The research work so far carried out under this scheme is concerned with establishment of integral transforms involving special functions like the Associated Legendre functions, solutions of integral equations including dual integral equation and application of integral transforms and integral equations to appropriate problems of mathematical physics. Some works on Mehler Fock type integral transforms have been carried out. Explicit solution to a class of Fredholm integral equations of second kind, solution of certain dual integral equations involving associated Legendre functions and function-theoretic method of solving a singular integral equation arising in the theory of water waves have been considered in some other works. As applications of integral transforms and integral equations, a substantial amount of work involving problems in the linearised theory of water waves have been carried out.

(b) *Completed project:*

Title of the project : 'On some problems in the linearised theory of water waves'.

Brief Summary of the work done : This project was sponsored by the Third World Academy of Sciences, International Centre for Theoretical Physics, Trieste for a period of one year from October 1990 to September 1991 and was being administered through Calcutta Mathematical Society. This research project is concerned with further mathematical work in the linearised theory of water waves. It involves a number of problems which can be broadly divided into three classes. One class is concerned with problems of water wave scattering and radiation by partially immersed or submerged bodies of various geometrical shapes. Another class deals with wave maker problems and the last class is concerned with generation of water waves due to sources in the presence of perturbed boundaries in the form of nearly vertical cliff or bottom with small deformation. A number of problems related to this project have been successfully handled.

INDIAN STATISTICAL INSTITUTE

Electronics and Communication Sciences Unit

Research

Investigations for the methodology and algorithms development of various problems related to the application area of computer science and communication technology with relevant software/instrumentation backing.

During the period under report, research activities were carried out in the following areas with satisfactory progress towards the set targets.

1. Studies on pattern Recognition, pattern Classification and Learning Algorithm.

(*i*) A computer-based parallel system for automatic recognition of printed Bengali alphanumerics using technique—(of mathematical morphology, pattern decomposition and skeletonization.) and involving only local processing have been implemented and tested with a CCD camera. Ultimate goal of this scheme is to contribute to a reading machine for the blind.

(*ii*) Algorithms have been developed for determining multiclass (fuzzy) boundary and shape of a pattern class from its sampled prototypes. This reduces and/or represents the uncertainties involved in the conventional crisp procedures. Successful implementation of a multivalued recognition system (developed in ECSU) in identifying ill-defined man-made objects such as air ports, sea ports, road maps and beaches has been demonstrated on IRS image data.

2. Development of methodologies for Analysis and Understanding of Image, Shape and Texture.

(*i*) Recoverable type of 2-tone parallel mode thinning algorithm for the extraction of 2-tone image have been developed and could be fruitfully utilized for data compression purpose besides the extraction of structural features. The data compression of binary contour images as well as extraction of contours from gray images have been completed.

(*ii*) Algorithms development for extrema detection and gray level ranking in moving window regarding texture analysis have been completed using statistical, fuzzy and deterministic methods. The application ranges from satellite imagery, microscopic image, and biomedical images. In another experiment from the intensity of multiple images regarding the depth of the physical surfaces, as for example human face detection, has been continuing.

(*iii*) Preprocessing part of the low cost parallel mode algorithms for image processing and analysis of fingerprint data have been completed.

(*iv*) A library of satellite image progressing routines on PC/AT based system was developed and implemented (at NCKBCS).

- enhancement for making linear features to be more clear.
- thinning for producing 1-pixel thick curvilinear patterns.
- inferencing from the representation of thinned output in the form of graph.

Directional masks have been used to enhance the linear structures like roads, small rivers etc. from gray level images and then certain segmentation techniques used to isolate these structures from the background and can be used in parallel machine for automatic preparation of road maps from the satellite images. The techniques developed will be of great use for civil/defence purposes.

(v) A Single-pass Pragmatic Thinning Algorithm (SPAT) for regeneration of pen motion in handprinted script has been developed and tested for both printed and handwritten script. The results have been reported to international conferences

(vi) New definition of classical entropy based on exponential behavior of gain, and the definitions of various image entropies have been introduced along with their properties. The image entropy measures include local, conditional, positional, hybrid and higher order fuzzy entropy. These information measures take care of the dependency of pixel intensities, probability and possibility distributions of pixel, collective pixel property and location of an object in the scene. Various algorithms for quantitative scene analysis and robot vision problems have been developed using these measures.

3. Signal Processing, Microwave Propagation, Atmospheric Studies with Appropriate Application.

(i) Detailed investigations of microwave signal propagation in beyond-the-horizon mode study and characteristic analysis of microwave signal (T.V. signal) transmitted from Khulna, Bangladesh 150 km away from Calcutta are being continued. Performance analysis of the received signals and correlational factor of those with the meteorological/climatological conditions of the lower atmosphere during that period are being considered.

(ii) Large volume of recorded radar data have been processed for different observations/analysis of lower atmospheric structures. Atmospheric modelling and detailed investigations on plume characteristic and stability/unstability criteria for the ABL are being continued. Computer analysis of those ABL structures using image processing and pattern recognition techniques have been employed with some encouraging results.

(iii) Procurement of laser unit and its accessories for setting up of constrained laboratory experiment on aerosol and other suspended particles sizes and their distribution in the atmosphere has been completed and plan program for this experiment is continued.

4. Speech Analysis and Synthesis, Music Analysis and ASR Research.

(i) Acoustic analysis of non-nasal vowels and nasal consonants, in Bengali language have been completed. Acoustic phonetic study of non-nasal consonants and diphthongs commenced for establishing a statistical data base speech synthesis, recognition and assistance for standardisation of phonetic quality.

(ii) Microprocessor-based text of speech synthesis for Bengali speech sounds, called BANGABANI has been completed using signal concatenation method. Work in introducing intonation patterns and prosoding are being continued for natural speech as communication aids for blind and dumb people.

(*iii*) Studies related to cues of nasality and their spectral characteristics of sung vowels in Hindusthani Shastriya Sangeet have been completed. Identification of Indian ragas is being continued. Extraction of notes from vocal songs have been completed and the software called SURUBITAN is ready for use.

(*iv*) Phonetic transcription of 20,000 Bengali words have entered into lexical tree regarding the development of Bengali lexicon for ASR system. A manner-directed ambiguity driven lexical tree for word hypothesis verification and disambiguation related to ASR is continued in collaboration with Universitat di Torino, Italy. An expert system for specific tasks in man-machine interaction like speech mode communication, script, and sketch for interaction and acquiring of a suitable knowledge engineering environment for the purpose is continued.

(*v*) A new hypothesis for production of stress and new cues for perception has been proposed and experimentally established. The findings were reported in an International Conference.

(*vi*) A new approach for time domain analysis for vowel sounds have been proposed, tested and a recognition score of 23% reported in an international Conference.

(*vii*) A project on task specific speech recognition for Reservation and Enquiry using Speech Mode Interaction (RESMI) has been started.

5. Research on Computational Geometry, Computer Vision Technology.

(*i*) Algorithms for normalizing the orientation and size of simple 3-D objects have been developed as a part of 3-D shape description and matching project. In another scheme, a computer vision algorithms based on concept of differential geometry on a set of local features of shapes has been developed to locate/recognise partially occluded 2-and 3-D rigid objects. Both the schemes have potential applications as computer vision system in industrial environment.

(*ii*) An algorithm has been developed to implement optimized error of fit for objects by fitting rectangles, ellipse and their 3-D version. A new fractal geometry based criteria was developed and was applied to the performance evaluation of digital image magnification techniques. The criteria will be applied in natural scene analysis and computer graphics.

(*iii*) Ultimate aim of preprocessing technique should be computer based vision system based on human visual system (HVS). An automatic thresholding of edge detector was developed and different effects and types of transformation used were studied on the quality of extracted edges.

6. Artificial Intelligence, Neural Networks and Expert System Methodologies.

(*i*) Creation of a large lexicon and some morphological/syntactic level of analysis of Bengali sentences were achieved in natural language processing (NLP) scheme, a major topic in AI.

(*ii*) Based on approximate reasoning, a linguistic recognition system has been formulated and tested with real type data. This has been found capable of handling various imprecise/uncertain input patterns and provides a natural decision system.

(*iii*) Artificial neural network —a massively parallel interconnection of simple, robust, fault-tolerant processing elements, has been successfully employed in PR and IP field. Fuzzy extension to the multilayer perception model and the self organising Kohonen's net model have been developed and found quite satisfactory to pattern classification problems as compared to Bayesian classifier.

Concept of fuzzy sets has been incorporated at various stages of Kohonen's network and multi-layered perceptron to handle imprecise, incomplete or linguistic input data and intractable pattern classes for recognition, rule generation and inferencing, and for extracting objects from noisy images. This shows how pattern description in terms of lingnistic properties and membership values can be processed by a neural net for fuzzy and crisp classification, and their merits over conventional networks and Bayes' classifier.

(*iv*) Neural networks (NN) have been used to find the maximum-a-posterior (MAP) estimate of a scene modelled as a Gibb's random field. The MAP estimation problem which is computationally prohibitive has been solved using a modified version of Hopfield's neural networks. Relaxation algorithms for object extraction have been developed which optimize objective functions that can be mapped as the energy function of a Hopfield type network and Kohonen's self-organizing network. These algorithms work well in noisy environment. A connectionist model is developed which can identify multiple object classes simultaneously from overlapped input features. Necessary learning techniques have also been formulated

7. Research on Fuzzy set theory and Applications.

(*i*) New fuzzy set theoretic operators developed include index of area coverage (IOAC), fuzzy medial axis transformation (FMAT), divergence between fuzzy sets, bounds for membership functions and spectral fuzzy sets. The bound functions and spectral fuzzy sets enable to reduce the uncertainties in assessing membership value and to make the fuzzy set theoretic approach enough flexible. FMAT is useful for both skeleton extraction and exact reconstruction/representation of images without committing ourselves to a specific hard thresholding.

Externally Funded/Collaborative Projects.

1. The National Nodal Centre for Knowledge Based Computing is engaged in active research and developmental work in the field of Pattern Recognition, Image Processing, Computer Vision and Artificial Intelligence, in connection with the Fifth Generation Computer Systems development (the FGCS/KBCS programme of DoE/UNDP). The main activities of the centre are—

(*i*) Application of pattern recognition, image processing, computer vision and expert system techniques in remote sensing and natural resources studies

(*ii*) Application of pattern recognition, image processing, computer vision and artificial intelligence techniques in industrial inspection for relevant Indian Industries.

(*iii*) Parallel architectures connectionist models and algorithms for image processing and computer vision.

(*iv*) Microprocessor-based expert system for mass screening/health care and related public health applications.

The following programmes in NCKBCS funded by UNDP Project have been undertaken during the year :

(*a*) Parallel architectures and algorithms for image processing, pattern recognition, and computer vision,

(*b*) Model studies for high level vision system (HLVS), and the application of HLVS in remote sensing studies,

(*c*) Simulation of lower level vision system (LLVS) for geological application, algorithms for middle level vision system (MLVS) for geology and natural resources management.

(*d*) Development of algorithm for industrial inspection system with special attention to occluded 2D 3D scene recognition.

(*e*) Acquisition of state-of-the-art computing resources and the setting up a well-equipped machine vision laboratory.

2. ECSU successfully shouldered the dedicated task of installation of a portable sound radar (Sodar) at BHU, Varanasi, in DST national programme on 'Monsoon Through Boundary Layer Experiment (MONTBLEX) funded by DST. The specially designed, developed, and fabricated sodar system has been utilised for monitoring ABL dynamics and to relate those parameters with an aim to predicting the behavioural pattern of monsoon activities in northern India.

3. A new project was commenced from 23 March 1992 for a period of one year titled "Procedures for spectral characterization that has physical Meaning". Analysis of Spectral bands of certain classes corresponding to physical entities of defence interest is the aim and objective of this project which has been funded by Defence Electronics Applications Laboratory (DEAL) Dehradun.

4. An Indo-German collaborative project (with CSF Institute, Munich) on Biomedical Image Analysis has been going on for more than five years. Topics of research include (*i*) automatic detection of malignant cells and automatic grading of histological sections using image processing and pattern recognition techniques, (*ii*) 3-D medical image analysis, (*iii*) Expert systems for clinical diagnosis. We received computers/related equipments and software packages worth Rs. 6.00 lakhs from the German side within the frame work of this project.

Teaching and Training

Faculty members of ECSU are also engaged in teaching and training in some of the regular courses in ISI like the M.Stat., M.Tech. (Computer Science) and M. Tech. (Quality, Reliability and Operation Research) programmes, and also in supervision of M.Tech. projects/dissertations besides supervision of Ph.D work. A number of external undergraduate/post-graduate students of Computer Science, Electronics and Telecommunication, Electrical Engineering and also of Master in Computer Application (MCA) from different Universities and IIT's undergo their vocational/semestral training under the supervision of faculty members of this Unit.

Geological Studies Unit

During 1991-92, research was undertaken in the following broad areas :

Tectono-stratigraphy of the Delhi Supergroup of Central Rajasthan ; Proterozoic stratigraphy, tectonics and sedimentation in the Pranhita-Godavari Valley ; Stratigraphy and palaeontology of the Gondwana sequence of the Pranhita-Godavari Valley ; Amphibians of the Satpura Gondwanas ; Jabalpur-Lameta stratigraphy and sedimentation of Jabalpur ; Some aspects of Quantitative Geology and Computer Applications ; Physico-chemical studies of microemulsions in relation to its application in biology and oil exploration.

The important developments in the research are stated below :

1. *Proterozoic stratigraphy, tectonics and sedimentation in the Pranhita-Godavari Valley :*

A large area exposing the Proterozoic sequence of rocks around Adilabad, Andhra Pradesh, has been mapped. A number of large faults has been recognised. This finding necessitates a major revision of the stratigraphy of the Precambrian Penganga Group. Numerous deep water debris flow conglomerates have also been located within the Penganga Group of rocks and their presence indicates a deep water sedimentation.

Braid bar sequences and interbedded aqueous-aeolian deposits of the floodplain have been recognised within the Proterozoic Mancherial Quartzite. Reconstruction of fluvial bars from the Precambrian sediments is rather rare, and hence the detailed reconstruction of the midchannel bars in the Mancherial Quartzite is likely to provide important information about the palaeohydrology of the fluvial system. The identification of significant amount of aeolian deposit in the floodplain has thrown new light on an under-emphasized aspect of interacting fluvial-aeolian system.

The work on the Proterozoic rocks exposed at Rajul Gutta and Mancherial, Adilabad District, Andhra Pradesh, shows that these rocks are not only disturbed by faults as was previously believed but are also considerably folded.

The experimental work showed that stationary vortex could produce layered fillings within cylindrical scours. However, unlike the concentric layers found in the cylindrical structures in the rock record, the laboratory produced layers (laminae) are horizontal in attitude. Barring the shape of the laminae in some instances, all other essential details of these 'enigmatic' structures have been simultated in the laboratory.

2. *Stratigraphy and Palaeontology of the Gondwanas of the Pranhita-Godavari Valley :*

The most significant development includes completion of the detailed study of two new middle Triassic archosauromorph reptiles along with the stratigraphy of the middle Triassic Yerrapalli Formation. A composite stratotype of the Yerrapalli Formation has been erected.

Laboratory preparation is now underway of a nearly complete skull and some post-cranial material of a rare crocodile collected from the Lower Jurassic Kota limestone.

3. *Lameta Beds of Jabalpur :*

The stratigraphic and sedimentologic work of the Lameta Beds exposed in and around Jabalpur has been almost completed. The most significant finding in the stratigraphic work is that there are evidences strong enough to establish the Lameta Beds to be the upward continuation, without any stratigraphic break, of the immediately underlying Jabalpur sequence. If this is really the fact, then there is going to be a major revision in the understanding of the Jabalpur-Lameta sequence that is prevalent till now in the Indian stratigraphy.

Excavations carried out in the equivalent rocks of the Lameta Beds at Ariyalur (Tamil Nadu) and Kheda (Gujarat) have yielded some interesting fossil remains of Maestrichtian age. At Ariyalur, a pond turtle and at Kheda, a neck vertebra of a dinosaur have been discovered ; the latter may yield much information about the nature of 'Gondwana-land ; which was in a condition of total break-up in the Meastrichtian time.

4. *Quantitative Geology and Computer Applications :*

An interactive graphic programme is being developed for the computation of tectonic strain ratio and the initial shape factor from the shape of deformed particles.

A computer program named ROSE-C has been developed. It is written in 'C' to draw Rose diagrams of high quality using 24-pin dot-matrix printers. It can handle both unidirectional and bidirectional (axial) data, and also compute and print various statistical parameters like the direction of the resultant, the circular variance, consistency ratio, and the mean angular deviation. The diagrams produced are scalable up to a maximum size of 9.3 cm. A number of options, including a choice of 9 different patterns to shade the Rose diagram, have been provided. One of them allows the user to control the pattern. The program is designed to run up to 20 datafiles in a batch, each with its own choice of options.

Physics Unit

During the period under review, the research activities of the Physics Unit have been on

(*a*) Problems of 'Bioengineering and Dermatophysics'

(*b*) Development of Control System Theory, and

(*c*) Quantum probability.

Under (*a*) above, the Unit worked during the year mainly on 'Skin Characterisation' by a quantitative and objective evaluation of such skin parameters as skin pH, hydration state, sebum level, high frequency electrical conductance, hygroscopicity and water holding capacity, skin friction and skin elasticity. The above project has just been completed.

Under (*b*) a number of algorithms for identification, realisation and decoupling of linear multivariable systems have been developed. The proposed algorithms are expected to be helpful in practical design of Control systems.

Under (*c*), the work has been mainly on quantum flow.

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, Anthropometry and Human Genetics Unit, Biochemistry Unit, Embryology Unit, Entomology and Leaf Protein Unit. Laboratory Research activities carried out in these Units are described below.

Agricultural Sciences Unit

Research Activities

With a focal theme on 'Cropping Systems under Rainfed Farming' condition evaluation studies on farm based trials and village surveys in Giridih, Bihar, were undertaken during the period under review. Out of 8 research projects of the Unit 6 projects are ongoing and 2 projects new. 5 projects are related to sustainable productivity improvement in different cropping systems of Bihar plateau at Giridih experimental farm. Other 3 projects are related to studies on adaptation of Coconut and oil palm, numerical anatomy and morphology of the family palmae (Arecaceae), as also investigations on mangroves in the saline tracts of Sundarbans region. Brief details of the ongoing projects are as follows :

1. *Improvement of Cropping System :*

Field trials on up and medium lands with Paddy, Maize and groundnut as Kharif crops followed by 6 winter crops were undertaken. Progressive soil moisture and evapotranspiration studies are in Progress cropping Sequence Studies in medium land with residual soil moisture indicated successful rice based double cropping system with higher yield potential through organic nutrient management and mulching. Rainfall data analysis is in progress to correlate paddy growth and yield related to critical dry spells as observed in the region.

2. *Intercropping studies*

In intercropping studies under upland situation promising combinations in maize, Pigeonpea and paddy based systems were on trials with different row arrangement to find out the optimum combination with maximum production potential. Nitrogen uptake and soil fertility changes are noted. Plant and soil data analysis is in progress.

3. *Studies on the performence of different potential crops for eastern region of Bihar plateau*

To find out the crops/varieties suitable for growing in different land situation under resource constraint, mainly water, some improved varieties of draught resistant cereals, legumes and oilseeds were cultivated and their performence are being analysed.

The third and fourth generations of rice induced by different levels of X-ray and EMS treatments respectively were raised and harvested and the data are under process.

4. *Exploratory work on palmae*

This study deals with the various morphological and anatomical aspects of palms. In order to see whether there is any anatomical variation between left-spiralled (FSL) and right-spiralled (FSR) areca palm, leaf samples from ten seedlings each of FSL and FSR were collected. Data were taken in respect to number of stomata, epidermal cells and trichomes per unit area, and their size. These data were analysed through computer. It revealed statistically significant variation between FSL and FSR plants. However, variation between successive leaves are yet to be found out.

5. *Oil palm introduction and coconut improvement in Sundarbans*

The seedlings of oil palm and 8 cultivars of coconut were transplanted in June 1987 at the 24 Parganas (S) District Seed Farm, Manmathanagar. A few plants of oil palm and coconut have started flowering. Recommended doses of fertilizers have been applied twice in a year. Growth data in regard to height of plant, number of leaves and data of flowering are being collected at regular intervals. The leaf anatomy in the eight varieties of coconut revealed statistically significant variation in respect of stomatal frequency, number of epidermal cells and number of trichomes per unit area. However, the variation in length and breadth of stomata, epidermal cells and trichomes are insignificant.

6. *Eco-floristic and anatomical investigations on mangroves of Sundarbans*

In the anatomical investigations, the structure, shape and size of leaves of 28 mangrove plants have been studied during this period and the studies on general anatomy of roots and stems are in progress.

7. *Agrosociological constraints of technological adaptation in subsistence farming of Bihar plateau*

In a collaborative work with S.R.U. of I.S.I. with the objective of assessing agro-sociological aspects of farming. 24 villages on Usri watershed of Giridhi District were extensively surveyed to get the data on various aspects affecting farming pattern. Initial data collection in follow up studies are being undertaken.

8. *Studies on weed-crop interaction*

Initial trials on cropweed interactions in paddy and wheat have been conducted. Data are under analysis.

Externally funded project

(*i*) In I.C.S.S.R. funded agroecological studies data collection and tabulation work in the sampled villages of Usri river watershed of Giridih District is in rapid progress. Report will be submitted in this year.

(*ii*) In H.P.C.L. sponsored Rainfed farming project, where multidisciplinary evaluation work is carried out by I.S.I., survey in sampled households in six cluster villages of Bihar, West Bengal and Orissa is in progress.

Teaching

B.Stat. II year students were taught a part of Biology I course by Dr. M. Ghose of this unit during the period July to October 1991. Two class tests and one semestral examination were also conducted. Dr. D. K. Bagchi, as honorary Reader in University College of Agriculture, Calcutta University, took classes in part II course of M.Sc. (Agriculture).

Anthropometry and Human Genetics Units

Research Activities

1. Human Adaptability Programme : Under this programme several common notions were questioned. (*a*) It is generally believed that a laborer's work output is positively related to his/her health status. Study on the tea plantation labourers failed to corroborate this notion. (*b*) It is generally believed that the working women's dual role of domestic as well as external worlds generates role conflict and thereby adversely affects physical and mental health. Study on middle class Calcutta women does not corroborate this notion.

This multidisciplinary programme was initiated in 1976 with the general objectives of (*a*) evaluating the nutritional and health status of populations exposed to diverse environmental conditions ; (*b*) identifying and measuring the impacts of these environmental factors on health ; (*c*) detecting the effects of human health and activity patterns on the environment ; (*d*) delineating the states of, and strategies for, survival, and perceptions of well-being, under the given environments ; and (*e*) eventually, determining the limits to human adaptation. Following projects were conducted within the general framework of this Programme.

(i) *Health status and labour productivity :* Demographic data were collected from about 200 Oraon households, engaged in agricultural practices. Further analyses of data on diet, anthropometry, haematology, lung function etc. collected earlier were continued.

(ii) *Effects of micro-environmental factors on health in rural populations, Phase II :* A KAP Survey on immunization, health, hygiene and child care has been conducted on about 450 Mahishya individuals ; blood pressures were measured on about 1000 Mahishya individuals of both sexes, data on socioeconomic status and physical ailment symptoms from about 50 Poundra-Kshatriya households as well as data on cultural aspects of food and household food intakes (qualitative and quantitative) were collected from 235 Kayastha, Poundra-Kshatriya and Oraon households during both lean and peak agricultural season. Further analyses on extant data were continued.

(iii) *Psychological stress and health of mother and child, Phase II :* Data on anxiety scores are being collected among the working and non-working mothers of Calcutta city, as a part of resurvey. Further analyses on extant data were continued.

(iv) *A study on the determinants of fertility and mortality in an urban setting. An anthropological perspective :* Data on health and hygienic practices and socioeconomic status were collected from 400 slum-dwelling Muslim households ; data on demographic aspects and socioeconomic status from 400 slum-dwelling Hindu household were also collected. Analyses of demographic data were continued

(*v*) *Human biology of Himalayan populations :* Data on demographic aspects were collected from 70 Lepcha households; anthropometric, haematological and physiological data were also collected from about 100 Lepchas inhabiting Dzongu area of North Sikkim.

2. Joint Management of Forests (JMF) in West Bengal : The main results of various studies undertaken in West Bengal are : (*i*) There are presently over 2000 Forest Protection Committees (FPC) in West Bengal protecting over 50% of all the forest lands, (*ii*) the functioning status of various FPCs was greatly influenced by ethnicity, number of villages involved, proportion of families in a FPC participating in the project, and whether the protected area is plantation or natural regeneration, (*iii*) natural regenerating forest provides a wide range of bio-diversity and meets various subsistence needs of the local communities, and (*iv*) the biomass gathered contributes over 20% to the local family income.

3. Evolution and Dermatoglyphics : Dermatoglyphics studies among the Chimpanzee, Gorilla, Orangutan and humans show that this morphological adaptation on hands and feet played a very significant role in the evolution of primates including humans. Studies further show that without this specialization humans would not have been able to develop present levels of technological civilization.

4. Man-Environment Interactions in Coastal Ecosystem : Marine fisherman on the Indian coast are chiracterised by frequent migrations because of the uncertainty of their environmental conditions. The patterns of their movement and settlement along the coast will be reflected in the way these populations are distributed on the coast. Orissa coast offers an interesting case in this context, as almost all the fishermen here are migrants, mostly from Andhra Pradesh in the south or from West Bengal in the north. we have been studying distributional patterns of migrants on the Orissa coast in relation to the ecological parameters both in the present habitat and in their parental places.

5. Genetic Load : Theory and Empirical Experience : The studies of inbreeding effects on reproductive outcome have been reviewed and genetic load computations were made for about 50 Indian populations. The magnitudes of genetic load observed among the Indian populations are compared with those among the Western and Japanese, populations with different magnitudes of inbreeding histories to test Sanghvi's hypothesis on long-term effects of inbreeding and to empirically assess if inbreeding has harmful effects as has been generally believed.

6. Studies in the area of Dermatoglyphics : The results obtained in population variation confirm that (i) the dermatoglyphic traits, in general, and palmar, character, in particular, do help in understanding the biologic/ethnic affinities among different ethnic groups; (ii) the different types of traits which are influenced by different genetic and environmental factors give rise to different clustering patterns; and (iii) recent interest in the study of asymmetry has been focussed for better understanding of the hypothesis of developmental homeostasis.

7. Growth study on the Bengali children and their families : Collection of anthropometric data on height, weight, skin folds etc. from school children of Baranagar area was in progress. Some preliminary analysis on the boys show economic differences with respect to the traits of body composition.

Analysis of intrafamilial correlations and estimates of heritabilities for 28 anthropometric traits is complete. Results show sex difference in correlational value with respect to biacromial and bi-iliocrital diameter.

8. Genetic Epidemiology : A survey to study genetic and environmental determinations of blood pressure and lipid levels has been completed. Data on 100 Marwari families have been gathered. Laboratory determinations of lipid profiles have also been completed. Statistical analyses were in progress.

A family study on Vitiligo has been completed. Recessive genes at three or four loci seemed to be jointly responsible for this disorder.

In collaboration with the University of Pittsburgh, a family study revealed that the mode of inheritance of abdominal aortic aneurysm—an important vascular disease—has a recessive mode of inheritance. Studies on localization of this gene were in progress.

Data collection and blood sample analysis of individuals with rheumatoid arthritis progressed well. This project was in collaboration with the National Institute for the Orthopaedically Handicapped.

Out of 5,000 families—designed statistically, nearly 4,000 families were completed. After screening the blood samples of the patient in the laboratory the following salient points were noted :

(*i*) The number of female patients is much higher than that of male patients.

(*ii*) ESR value is high in the Active-phase of rheumatoid disease.

(*iii*) ESR value is moderate in the Burnt-out case of rheumatoid disease.

(*iv*) In case of rheumatoid arthritis the globulin level is high, especially the gama globulin of serum protein.

(*v*) Immunoglobulin level Ig^G, Ig^A, Ig^M are also high.

The results of the project would be helpful in formulating possible preventive measure of this disease and rehabilitation programme taken up by NIOH (Govt. of India).

9. Population Variation Programme : The human variation programme was initiated with an idea how and why contemporary human populations differ in physical or biological characteristics, i.e., frequencies of biological traits, both visible and invisible, for which genes are mainly responsible. It is interesting to study the micro-evolutionary dynamics of human population in the Indian sub-continent, where thousands of endogamous groups exist having a wide range of social, cultural and biological variation. A project entitled "Genetic Survey of some endogamous groups of Northern India" was carried out under this programme with the following specific objectives :

(*i*) to examine the nature of distribution of various biochemical and serological markers in blood amongst different castes like Brahmin, Kaystha, Rastogi, (Vaisya), Chamar, Muslim in Lucknow city and village.

(*ii*) to study various Immunoglobulin level (Ig^G, Ig^A, Ig^M) in the population groups;

(*iii*) to examine genetic variation within and across population groups;

(*iv*) to measure the distance between population groups and to build up phylogenetic trees;

(*v*) to study the relationship, genetic proximity and geographic distance of the populations.

About 500 blood samples were screened from the above population. After screening some variants of biochemical markers were detected. (Variants: G-6-PD slow, PGM_1 new type, LDH and Al_1 and HbA_2).

10. Genetic Variation in Indian Populations: High prevalence of a haemoglobin variant (HbE) has been detected in some populations of north West Bengal. Further studies are continuing in populations of North West Bengal.

Biochemistry Unit

The Unit has been currently pursuing research mostly in the area of Biochemical Epidemiology. Research activities done by the unit are described below:

1. Genetic Epidemiology of blood pressure: An investigation of both genetic and environmental factors with special reference to the lipid profile of blood/serum was taken up in an aim to understand the etiology of blood pressure. The study consists of impaired metabolism of fats in individuals in a population; finding out the receptor/repressor blocking effect of enzymes; low density cholesterols along with the total cholesterol with a known "Proband" of hypertensive patient in the same family. The dietary intake pattern is also noted.

2. Epidemiological study on Rheumatoid Arthritis: This is a collaborative project taken up by I.S.I. and National Institute of Orthopaedically Handicapped (NIOH) (under the Ministry of Welfare, Government of India). The project is designed to throw light on the following aspects:

(*a*) to find the prevalence of the disease;

(*b*) to study the nature of inheritance;

(*c*) to study the risk factor(s);

(*d*) to study the environmental factors and

(*e*) to confirm the RA cases through laboratory investigation (haematological, serological, biochemical and immunological examinations) to locate proper probands.

3. Cancer Chemoprevention : An approach towards cancer control. In order to identify the dietary risk factor(s) and its association with cervical preneoplastic and neoplastic diseases following studies are persued :

(a) Hospital based study : 459 subjects have been screened for their Pap smears between 1989 and 1991. Detailed epidemiologic informations were obtained on these subjects. Of 459, 238 showed some degrees of dysplasia. 25 had repeated Pap smear for one or more times, 16 of them showed persistent dysplasia. Analysis of several epidemiologic variables were done on 308 subjects. Inclusive of these were current age, age at the consummation of marriage, sexual exposure period, parity, spontaneous abortion, medically terminated pregnancy, cervical erosion, menstrual irregularities, other gynaecologic problems as independent variables. The indicator variable was dysplasia (Ds). The overall net contribution explanation of Ds is $R = 0.4428$ i.e. $100\ R^2 = 19.59\%$, where current age (Age) and cervical erosion (CE) contribute to the following

$$R_{Ds.\ Age,\ CE} = 0.4173$$

$$100\ R^2_{Ds.\ Age,\ CE} = 17.41\%$$

A second hospital based study was initiated at the Southern part of Calcutta, Bagha Jatin State Hospital. This was done in collaboration with the Govt. of West Bengal.

(b) Population based study : 500 women have been screened at Domjur, Howrah in different Villages. The population include Muslim (n=50), Schedule Caste (n = 50) and rest Hindu. Subjects were between ages 17–80, all married and mostly having parity 3 +. Incidence of dysplasia was more than 3%.

(c) Thirty subjects of high risk group (in sex profession) were under extensive investigation for an in depth study. In addition to the other investigations, they are all investigated for STD and treated (if needed). The in depth study included investigation for HPV in their cervical lavage.

(d) A study was in progress to raise an antibody against folic acid. Cationized BSA is conjugated with folic acid and injected into a rabbit. An antibody which recognizes folic acid was identified. Its specificity was also under investigation.

4. Externally Funded (CSIR) project :

Cytotoxicity of heavy metal :

Prevalent occurrence of heavy metals in earth's crust is responsible for spontaneous existence of metal compounds in different plants and plant parts which is exclusive food material for animals and human beings. Environmental and industrial mutagens as well as carcinogens interact with the genetic material of the living cell (DNA, chromosomes). The project dealt with the evaluation of cytotoxicity of heavy metal-tin in its inorganic and organic form on the somatic and meiotic chromosomes of plant and animal considering, cell division, numerical and structural chromosomes aberration, sister chromalid exchanges and cell cycle kinetics as endpoints.

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Embryology Unit

Research Activities :

During the period under review further analysis were made of the free fatty acids, Chemical signals in Tiger. The very difficult question of whether these chemical signalling molecules reflect the individuality of the animal was tackled and preliminary support for the theory was obtained by using Professor Mahalanobis's D^2 Statistic and multivariate analysis techniques applied on the quantitative data of certain signalling molecules.

The synthesis of the molecule that is responsible for both the aroma of fragrant rice and tiger marking fluid was accomplished in the laboratory, though with a poor yield.

In the studies of Mathematical and Stochastic modelling of Cellular growth, differentiation and Morphogenesis it was found that the negative cross-diffusion of a morphogenetic substance is essential in our model of the epigenetic process for spontaneous emergence of ordered structure. It was also observed that Turing systems are far more general than chemical networks with explicit activation/inhibition and all two component Turing systems are mathematically equivalent to a broad extent. The generality of Turing systems suggests that computer results won by using a generalised Chemical network carry over to all types of Turing systems so far investigated. Global stabilities of Patterns have been studied with the help of Liapunov's functions.

In the studies of Carcinogenesis and Tumour growth it was observed that spatially variable diffusion coefficients coupled with spatial variation of a reaction kinetics can explain malignant tumour growth. The evidence of morphogen is still the source of controversy to the experimental biologist. As such it was considered cell–chemotaxis model for complex spatial pattern formation. Model analysis demonstrates that the chemoattracting parameter plays an important role for achieving the complex spatial patterns.

In the studies of inter-crop interaction it was observed that the roots of some varieties/crops excrete both activator and inhibitor of growth of other varieties/crops. These activators and inhibitors diffuse through the soil and undergo chromatographic separation in soil. Plants growing at the position of accumulated activators show increased rate of growth and yield whereas plants growing at the inhibitor accumulation sites show a decreased rate of growth and yield. Some mathematical epidemiological models of Japanese Encephalities (J.E.) were constructed. The nature of J. E. spread was analysed from these models and prediction of the occurrences of J. E. in the next years were successfully made. Some measures of control of these disease were also proposed.

Projects :

1. *Filming of embryological and natural history subjects.*

Two such films have been made into video form. A micromanipulator and system for injecting in embryonic cells has been set up with the help of an indigeneous device.

2. *Chemical communication in mammals.*

The important results have been described in Research Activities.

3. *Mathematical and Stochastic modelling of Cellular growth, differentiation and Morphogenesis during embryonic development and of the mechanism of Carcinogenesis.*

The mechanism of controlled Cellular growth during embryonic development involving pattern formation and morphogenesis is a very important and fascinating subject of investigation in both experimental and mathematical fields. Mathematical investigation of cellular differentiation, morphogenesis and self-organization in biological systems have been carried out using bifurcation analysis, Control theory, Catastrophe theory, Liapunov function construction etc. Consistency of the mathematical models and the predicted behaviour of the system from these models have been established by comparing the results with real life data.

Spontaneous emergence of order and spatially dissipative structure in the non-equilibrium biological systems has been observed in a reaction-diffusion model of the epigenetic system. Emergence of order through fluctuation far from the thermodynamic equilibrium has been observed in stochastic reaction-diffusion model of gene activation and protein synthesis.

Since the evidence of morphogens is still the source of controversy, the unit considered a simple cell-chemotaxis model for complex spatial pattern formation and observed that the chemoattracting parameter plays an important role for achieving the stable complex spatial patterns. The most remarkable point was that chemotaxis had a destabiliging effect on the pattern formation, reflecting the real biological situations.

New methods have been explored to analyse the multiple loop negative feedback control network models of the epigenetic system. The formation of the primary layers of differentiation, e.g. Ectoderm, Mesoderm and Endoderm has been mathematically exhibited in the three dimensional geometry i.e. in the cylindrical and spherical shaped embryo with the help of non-linear reaction-diffusion models.

Since carcinogenic growth of tumours have a lot of semblances with that of embryonic growth with the exceptions that the former is unregulated whereas the later is perfectly regulated, these studies may lead to important observations of cytokinesis of tumour cells.

Reaction-diffusion model of tumour tissue with spatially variable diffusion coefficient of the mitotic inhibitor (chalone) has been constructed. This model has been analysed on one, two and three dimensional coordinate systems and has been observed to explain tumour growth with its characteristic mitotically active peripheral zone surrounding quiescent (mitotically inactive) central layers.

Cycline-chalone interaction and diffusion models have been proposed to investigate the roles of cycline (mitotic activator and chalone (mitotic inhibitor) during cellular development and tumour growth.

Some mathematical epidemiological models of Japanese Encephalitis (J. E.) have been constructed. The nature of J. E. spread has been analysed from these

models and prediction for the occurrences of J. E. in the next years have been successfully made. Some measures of control of these disease have also been proposed.

4. *Intercrop interaction—a mathematical study on agricultural ecology.*

Field experiments on intervarietal interaction between different varieties of wheats (for example, Sonalika versus NP710 ; UP262 versus Sonalika etc.) and different varieties of rice (for example, Subrana versus Pankaj ; Patnai versus Pankaj, etc.) were conducted with repetition each year for the last four years. Intercrop interaction experiments between mustard and wheat were also conducted. Both in the intervarietal and intercrop interaction studies significant differential effects at different spacings were observed showing thereby that the roots of some varieties/crops excrete both activator and inhibitor of growth of other varieties/crops. These activators and inhibitors diffuse through the soil and undergo chromatographic separation in the soil. The plants of a different variety/crop which grow at the location of accumulation of activators show increased growth and yields whereas those growing at the location of inhibitors accumulation show a decreased growth and yields. Soil samples from different spacing where allelopathic effects were observed were collected and experiments on germination of seeds on these samples were conducted. Enhancement of germination followed by increased growth of seedlings were noted in the soil samples collected from the spacings where increased allelopathic (activating) effects were observed.

Entomology Unit

Research was carried out in the following project :

Situation in Mosquito—Japanese Encephalitis research in India : In India, the most important study in JE (Japanese Encephalitis) virus solation was made jointly by Rockfeller Foundation, U.S.A. and Virus Research Centre, Poona. The workers of that team faced a lot of difficulties in identifying the vector mosquito. They first identified that the vector mosquito as *Culex vishnui*. Later it was discovered that they had identified three different species as *Culex vishnui*. To avoid confusion, a new term *Culex vishnui complex* (or group) was used to designate these three species of mosquitoes which are as follows : *Culex tritaeniorhynchus*, *Culex vishnui* and *Culex pseudovishnui*. Of them the first one (i.e. *C. tritaeniorhynchus*) is a vector of JE virus in India. This event shows how wrong identification of mosquitoes could lead us to anomalous situation and supports our contention that the magnitude of mosquito research is not understood in India (Daschaudhrury 1978).

In Japan, JE virus circulates in the bird-mosquito-bird cycle. In India, it circulates in pig-mosquito-pig cycle. The existance of JE virus in India was established in 1952. It was first recorded from Tamil Nadu. Later this virus has been isolated from Tirunevelli, Vellore, certain Villages in Krishna District, Bhopal, Gorakhpor, Asansol, Bankura and Dibrugarh in 1973 there was an epidemic of JE in Bankura and Burdwan Districts of West Bengal. The overall morbidity rate was 0.1590 per thousand population. In India JE is likely to continue as a menace.

Leaf Protein Research Unit

Research was conducted on the following areas during the year :

1. *Studies on tree leaves*—The leaves of *Ailanthus excelsa* a fodder tree, was found to be a promising source of leaf proteins. Trials were being conducted where chicks are being fed standard diets supplemented with leaf protein at 25, 50 and 75% levels to study the efficiency of this leaf protein as a protein substitute.

2. *Utilization potential of fibrous residues :* Encouraging results were obtained on utilization of fibrous residues from tree leaves, left after leaf protein production, for the following mushroom cultivation—*Pleurotus sajor-caju*, *P. flabellatus*, *P. florida* and *Volvariella volvacea*, *Agaricus bisporus*, a variety of button mushroom, was also found to form a good number of fruit bodies on compost made from fibrous residue of *A. excelsa* and maize leaves.

3. *Studies on aquatic weeds :* Amino acid compostition of leaf protein prepared from five promising aquatic weed species were studied to gain an insight into their nutritive potential.

4. *Studies on sugar beet crop*—Studies have been conducted for the last four years on various aspects of sugar beet (*Beta vulgaris* L.) crop as an alternative source of sugar, alcohol leaf protein as a by-product. This crop has proved its efficiency and potentialities in this agro-climatic region. Varietal trials have now been conducted on twenty cultivars Virtus, Raspoly, Magnamono, Maribomonova, LS-6 and LS-7 were found to be the most promising ones.

5. *Cellulolytic enzymes from Soil streptomyces*—Nine promising species of exocellular cellulose producing soil streptomyces were isolated. Experiments on extraction, purification and actual specific activity are in progress.

6. *Technical feasibility and economic evaluation of leaf protein at rural sites*—

(*a*) Phase—I of the DST sponsored project on "Production and economic evaluation of leaf protein at village level" was completed and the report submitted in three parts on 10 May, 1991. Phase—II of the project has been submitted for financial support.

(*b*) A baseline survey on anthropological, demographic, economic, nutritional and clinical aspects has been completed on a project entitled "Improvement of health and economic status of two communities by intervention programme using leaf concentrate (LC)". A contract worth £ 122, 135 has been signed for this with Find Your Feet, London. The project is awaiting clearance from the Union Government.

Social Sciences Division

The Social Sciences Division includes the following Units : Economic Research Unit, Economic Analysis Unit, Planning Unit, Population Studies Unit, Linguistic Research Unit, Psychometric Research and Service Unit and the Sociological Research Unit. The Economic Analysis Unit is located at Bangalore, the Planning Unit is located at Delhi, while the remaining five Units are located at Calcutta. Faculty

members of this Division were engaged 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

This Unit continued its teaching and training activities at various levels and research work covering different areas of theoretical and applied economics and econometrics. Members of the scientific staff shouldered the responsibilities of teaching economics, economic statistics and econometrics in the degree and research course in economics as well as in other training courses conducted at ISI, Calcutta. Several faculty members participated in the teaching programme of other universities also. There were, in addition, a number of Research Fellows working for the Ph.D. Degree under the supervision of faculty members of the Unit. The research activities of the Unit during the period under review covered fields like economic theory, economic planning and policy, industrial organization, welfare economics, demand analysis, income distribution, level of living and poverty in India, agriculture, economics of informal sector, economic development etc., besides other investigations in applied economics and methodological studies in econometrics.

Projects :

1. *Identification of Rural Poor :* The field work of this survey-based project was completed and data editing and processing on computer was taken up.

2. *Study on reliability of income data collected by different approaches :* Analysis of data collected by the NSSO through a Pilot Survey on Income, Consumption and Savings was continued in collaboration with the Computer Science Unit of ISI and some statisticians of the NSSO. The final report may be submitted in the first quarter of 1992-93.

3. *Statistical-linguistic analysis of selected prose works of Rabindranath Tagore based on complete counts :* The first report on the statistical-linguistic analysis of Tagore's works, based on *Gitanjali*, was sent to press. Similar work was initiated on several prose works of Tagore in collaboration with ILCAA, Tokyo.

4. *Location Pattern of Indian Industries :* On the basis of the inter-regional distance matrix and the updated norm of varied 'Wagon Kilometers' requirement for transporting one crore of various merchandise commodities available from 'Indian Railway Statistics', an attempt was made to obtain inter-regional transport coefficients for various commodities. Simultaneous determination of optimum location of industries and the interregional flow was the objective of the exercise.

Economic Analysis Unit (Bangalore)

The Unit continued to have fruitful research collaborations with the Reserve Bank of India and Indira Gandhi Institute of Development Research, Bombay. Other important activities were :

1. *Winter Programme in Quantitative Economics :* The Unit organised its third successful training programme in quantitative economics for university and college teachers at Bangalore during 2-30 December 1991, jointly with the Institute for Social

and Economic Change and the Bangalore University. The Winter School was inaugurated at ISEC on 2 December 1991 by noted economist and former Dy. Governor of Reserve Bank of India, Dr. K. S. Krishna Swamy. Twentythree teachers from all over India attended the course. The faculty was drawn mainly from ISI (Bangalore and Delhi Centres), ISEC, Bangalore University, University of Bombay, and the Indira Gandhi Institute of Development Research. Dr. G. V. K. Rao, former member of the Planning Commission and retired Chief Secretary to Government of Karnataka, gave away the attendance certificates and delivered the valedictory address on 27 December 1991 at the ISI campus.

2. *Socio-economic Survey of Sericulture* : In August 1991, the Central Silk Board, Ministry of Textiles, Government of India, entrusted the work of Socio-economic survey of sericulture, to the Unit. ISI has accepted to undertake/co-ordinate the survey work in all 17 National Sericulture Project states. ISI has assumed direct responsibility for conducting the proposed socio-economic survey in the two states, West Bengal and Karnataka and will co-ordinate the work of other states. This project is funded by the Central Silk Board.

3. *Summer Courses in quantitative economics* : The summer courses organised by the unit during the year enjoyed wide recognition from Government, UGC and many Indian Universities.

Planning Unit (Delhi)

The members of the Unit continued research in a number of fields in both applied as well as theoretical economics, regional planning and analysis of social movements and study of rural labour. Research in applied economics included diverse topics such as planning, problems in estimation of poverty, estimates of labour force and unemployment, foreign trade and economic development internal organization of firms, of the public sector, as well as problems of enforcement of laws and regulations by the government, health and family planning and income tax enforcement system amongst others. Work was continued on the development and application of macro-economic models for analysing policy issues. A project on the Disparity in Income and Level of Living among private medical practitioners was completed. Research in economic theory revolved around game theory and its applications, economic inequality, industrial organization, theory of mechanism designs, models of unemployment and the design of organizational structure, incentives and implementation of plans.

Projects

1. *Dilip Mookherjee*

(*a*) *Theoretical Research* :

(*i*) "Aspiration based Adaptive Learning in Repeated Games", with Jonathan Bender and Debraj Ray

(*ii*) "A model of Transfer Pricing", with Stefan Reichelstein.

(*iii*) "Authority, Responsibility and Incentives in Hierarchies", with Stefan Reichelstein.

(*b*) *Empirical Research*

"Income Tax Compliance in India, A Time Series Analysis 1971-90", with Arindam Dasgupta and Radhika Lahiri.

2. *P. N. Mukherjee*

(*i*) "Agrarian Conflicts and Rural Labour" sponsored by ICSSR, New Delhi.

(*ii*) "Social Mobility and Development", Indo-Soviet Joint Research Collaboration, ICSSR, Delhi (1991-93).

Linguistic Research Unit

During the period under review, the Linguistic Research Unit continued its programme of research in the areas of Fundamental and Applied Linguistics. There are five main headings under which the Unit's research projects may be grouped, namely

Studies on the phonetic stuctures of major Indian languages and application of the results in the areas of

(*a*) Speech Pathology; (*b*) Second Language Acquisition and (*c*) Cultivation of Mother-tongue.

1. Sociolinguistic aspects of Convergence.
2. Language, Class and Cognition
3. Bengali Semantax
4. Application of Statistics in Linguistic problems
5. Stylistic studies on the works of major Indian authors.

A brief account of research work done during the year is presented below :

Fundamental Research : A survey of the articulatory and acoustic structure of the Tamil language was in progress. Fundamental research on the Suprasegmentals of Bengali, Hindi, Oriya and Telugu was in progress.

Applied Research : Studies were in progress on :

(*a*) Articulatory status of speech sounds during the fourth stage (2—5 years) of speech and language development in the pre-school age child.

(*b*) Factors leading to convergence between the numerous major and minor languages belonging to the three major language families in India, namely Indo-Aryan, Dravidian and Munda, from a sociolinguistic perspective.

Studies were continuing on the academic achievement of hearing impaired children attending general schools with normal hearing children.

Studies were continuing on the comparative intonation patterns of Indo-Aryan and Dravidian languages as well as between languages within the broad Indo-European group. Studies on pitch and intensity were being carried out, utilising the Visi-Pitch.

Indepth statistical studies, initiated almost five decades ago by Professor P. C. Mahalanobis on the vocabulary of Tagore's short stories, and stylistic studies on other contemporary Bengali authors is in progress.

Research has been initiated in the areas of language and cognition in the context of class, code, control and also in Bengali syntax.

On-going Projects :

(*i*) Study of Suprasegmentals of the Hindi Language : Syllable stress in words, sentence melody and intonation patterns have been studied and some preliminary analysis have been carried out with the help of the Visi-Pitch. Further data was collected for indepth studies on sentence melody in relation to semantic codes.

(*ii*) Study of the Suprasegmentals of the Telugu Language : Analyses of syllable stress in monosyllabic, disyllabic and polysyllabic words was continued and some preliminary analysis has been carried out on the Visi-Pitch.

(*iii*) Comparative Suprasegmentals of the Slavic, Indo-Aryan and Dravidian languages : Some preliminary field work has been carried out in Delhi, Ahmedabad, Baroda, Hyderabad and in Belgrade. Further analysis will depend on availability of necessary equipment.

(*iv*) Statistical studies of the vocabulary of Tagore's short stories : After the completion of the analysis of the short stories of Tagore, Verse Libre in Tagore's 'Lipika' is in the process of analysis from the view point of stylistics

(*v*) Study of the phonetic structure of the Tamil language : Consultation with experts in the language took place and the phonemes of Tamil identified by them according to previously published literature.

(*vi*) Survey of the articulatory norms in Bengali speaking children of Pre-school age : Further data was collected from pre-school children. Special test for articulatory evaluation of children (2—5) years have been complied and will be used.

(*vii*) Educational problems of hearing impaired children attending schools for normal children : Compilation of data was continued and some analysis of collected data was carried out. Special programmes regarding social awareness amongst parents of hearing impaired children were organised.

(*viii*) Sociolinguistic aspects of convergence : A quantitative study : Some preliminary surveys have already been conducted in Hyderabad-Secunderabad and in some border areas between Orissa and Andhra Pradesh.

(*ix*) Semantax of Bangla Verb : Valency of Bangla Verbs has been established on the basis of number of participating entities involved in a sentences and semantic features of each verb like volitionality, kinesis, affectedness of agent or patients etc. This valency will trigger the structure of compound verbs and composite verbs and lexicalised compound Verbs. This is a pioneering work as far as Bangla verb is concerned.

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Population Studies Unit

Research :

A. *Externally Funded Project*

Attainment level of primary school children at the end of Class IV in West Bengal, 1991-92.

The Project, funded by the Government of West Bengal, was undertaken in Collaboration with the State Council of Education Research and Training. The object was to evalute the level of learning of the students completing Class IV in Bengali medium schools. A random sample of more than 1,000 primary schools from all the 17 districts was drawn. Administration of tests in various subjects, such as language, mathematics, environmental studies and other subjects, had been completed. The scoring, coding and data entry into computer were being simultaneously done.

B. *Other Projects*

1. *Effects of socio-cultural and behavioural factors on proximate determinants of fertility.*

This is a socio-psychological study undertaken in Nadia district of West Bengal. The sample consists of 4,000 households. A household Schedule and two schedules for couples, one for male and the other for female, were canvassed. An enquiry on opinion on marriage was also instituted among the head of the sample household as well as each spouse of the eldest eligible couples. The number of units from which data were collected upto March 1992 :

Households	= 3941
Male respondents	= 3700
Female respondents	= 4291
Marriage Opinion schedule	= 7004

2. *Micro-regional statistical surveys in India upto 1875 : An evaluation.*

The purpose of the study is to analyse the statistical materials on land and people of 19th Century. National archives and state archives are the sources of the data collected in this regard.

3. *A study on infant mortality and its major components in a health centre in Singur.*

The study is an attempt to utilize information relating to infant mortality as available in the registers of the Singur Health Centre and establish the linkages of the neo-natal and post-neonatal mortality with factors at individual and family levels. Birth order emerges as an important determinant of infant mortality. About 40 per cent of infant deaths were recorded for whom birth interval was less than two years. Prematurity or low birth weight was the major cause of infant mortality in the area. Acute respiratory infection, birth injury and asphyxia are the other important causes of death. Neo-natal mortality is found to be the major component of infant mortality. Immunization of infants in terms of timing and type is not found effective in controlling such mortality. Special education is called for improvement in pre-natal and peri-natal care.

4. *Study on the incidence of Nepali migrants to India and to West Bengal in particular.*

Using data from the census series, the study examines the settlement pattern of the Nepali migrants, their in—and out—movements, occupation and other available characteristics during 1951-81.

Psychometric Research and Services Unit

The research work done in this unit during the period is briefly summarised below :

1. *Potential Entrepreneur School-leavers :* The objective of the project is to identify potential entrepreneur among the school students who are fit to start business or manufacturing unit independently. Certain personality characteristics viz., need for achievement, risk taking ability, independence, leadership and innovative activities influence the behaviour of the entrepreneur. In India family background plays an important role. Taking all these points into account, a suitable instrument will be developed which can be profitably utilised. Preliminary investigation and pilot study were in progress.

2. *Motivation to work for primary level workers :* The objective of the study is to develop a scale to measure 'Motivation to work' for the primary level workers. The sample group for this study will be Clerk, Typist, Factory Workers, etc. Literature review and construction of the primary form of the scale were completed.

3. *Personality pattern of different occupational groups :* The objective of the study was to develop the personality profiles of different occupational groups viz., teachers, doctors, executives, artists, with the help of 16 PF, a standardised personality inventory.

Data were collected from different parts of India and some more cases were yet to be obtained. Preliminary analysis of the data revealed that (*a*) the profiles of differnt professional groups vary widely ; (*b*) not all the 16 Factors are equally important in discriminating the professional groups.

4. *Consequences of Social and Economical Deprivation on Academic Achievement :* The objective of the study was to investigate the effect of prolonged socio-economic deprivation upon the scholastic achievement of school-going children. Subjects were students reading in Class-X in different schools of West Bengal. Data collection was complete and analysis of the data was also over. Report writing was in progress. The important findings are as follows : (*a*) prolonged deprivation adversely affects academic achievement, development of intelligence, etc. ; (*b*) the nature of this relation varies across sex and region.

5. *Assessment of minimum learning in Primary education :* The scoring and analysis of the data collected during the previous years are in progress.

6. *Creativity in school Children :* The Unit in collaboration with Language Research Unit, ISI conducted research on creativety in school children on 21.8.91.

7. Orientation programme to the SDPs and Technical Officers of SQC & OR Unit on some skills and personality traits required to play their roles in client organi zations at SQC & OR Unit. Indian Statistical Institute, Bangalore on 10 September, 1991. D. Dutta Roy organised this programme.

External projects :

(*i*) *Attainment level of primary students at the end of Class IV :* The project was taken in collaboration with SCERT, Govt. of West Bengal, to cover all the aspects of primary syllabus, viz. Language, Mathematics, Environmental Studies, Creative, Productive and Physical education. The study was held during the years 1990-91 & 91-92, covering all the 17 districts of West Bengal. Scoring & evaluation of the data collected were yet to start.

(*ii*) *Social impact study of mass literacy programme in Midnapore district :* This study was undertaken on the request of the Vice-Chancellor of Rabindra Bharati University to the Director, Indian Statistical Institute, to give them technical assistance & expert guidance for this study. The field study has been done in collaboration with the Literacy cell of Rabindra Bharati University, Calcutta, in the district of Midnapore from 27th January to 14th February, 1992. Evaluation — analysis of data are going on for a report to be published soon.

(*iii*) *Study on Man-power Management* : This study was undertaken in collaboration with Eden Hospital of Medical College, Calcutta on Man-power Management on 3.3.91. A questionnaire was developed to study organizational health of the Hospital.

Under the service projects, the Unit had undertaken the selection tests for admission of students in B.Lib (Sc.) and M. Lib (Sc.) courses under Calcutta University.

The Unit organised a Team building training programme for SQC & OR Division of Indian Statistical Institute, Calcutta on 30 May, 1991.

The Unit also prepared syllabus or organizational Behaviour for M.Tech courses in SQC & OR Division.

Sociological Research Unit

Research Activities

1. (*a*) Following collaborative researches with the scientists of Bio-Science Division and Statisticians of Statistics-Mathematics and Applied Statistics Divisions have been undertaken : (*i*) Studying farmer's perception and response to rain-fed farming system (including potential and constraints) in East Indian plateau region ; (*ii*) Vulnerability of rain-fed farmers and their strategies of risk management ; (*iii*) Conditions of development of sustainable agriculture in monocrop rice producing villages of Eastern India including explorations of endogenous sources of change and development in local cropping practices ; and, (*iv*) evolving methodology of assessing quality of degrees of impact of exogenous inputs for induced development.

(*b*) Collaboration also made with scientists of Statistics-Mathematics Division of ISI on : (*i*) Identifying boundaries of social interaction by graph-theoretic method ; (*ii*) Decomposition of reciprocity in a social network among the villagers by their

various primordial and new characteristics like caste, community affiliation, class, etc. ; and (*iii*) obtaining measures of reciprocity in weighted di-graph of a social and economic network as in case of volume/value of flow of goods between rural/urban regions within a country/between various countries like in international trade, or, frequencies or rates of intensities of interaction among villagers in different dimensions.

2. "Social ecology of the minority/marginal groups" is the emergence of social polarization over and above the economic differentiation between castes of different strata.

3. The analysis of case-study materials of rural elderly of a West Bengal village shows that inter-personal relationship is not a major problem since strong oriental values still persists in rural society. It is only among the poor and ritually lower segments of society that the old age conflicts tend to get a momentum.

4. (*a*) Evaluation of development in tribal areas and the distribution of development input among tribal families of different economic strata through TTDP and other poverty alleviation programme in last two decades.

(*b*) Increasing inequality among tribal households through development.

5. (*a*) Collection and analysis of data related to continuity in peasant uprisings in Bengal since the introduction of the colonial rule ;

(*b*) Explication of the impact of popular upsurges during the terminal years (1945-47) of British rule, leading to the transfer of power in the subcontinent.

(*c*) Stress and strains in the communal situation in contemporary India—their variations and the process of historical evaluation of these variations.

6. Study of people's perception about risk and development, carrying capacity of land in terms of human population and grasping the on-going changes in the grass-root level are the central areas of the enquiry.

The faculty members of the Unit as usual took part in the teaching and training programme (sociology and Sociometry) of B.Stat. (Hons.) Course. Field work was also arranged to give the students practical training.

Project Works : Externally Funded Projects

1. *Evaluation of Rainfed Farming Project.*

Sponsored by the Overseas Development Administration (ODA) of Government of U.K., the Hindustan Fertiliser Corporation Ltd. (HFCL) in consultation with the Overseas Development Group (ODG) of the University of East Anglia at Norwich, U. K., has undertaken a project to explore the possibilities of low cost sustainable agricultural development under farmers' own rainfed conditions in East Indian plateau region in 6 districts of three states—West Bengal, Bihar and Orissa. The special features of the project are : farmers participatory system-evolutive nature with poverty focus.

As requested by HFCL and ODA, ISI is evaluating the impact of these activities since 1989. Besides, an objective is also to evolve an appropriate methodology of evaluation for this purpose. Social scientists, agronomists, bio-chemists and statisticians of ISI are working collaboratively in this work.

Reports of evaluation for the first two years—1989-90 and 1990-91 have been submitted to HFCL and third year's is under preparation. A team of 3 consultants (one social anthropologist, one nutritionist and one agricultural economist) of ODG, U. K., visited ISI during 16-24 November 1991. They had intensive discussions with ISI researchers and visited some villages with them. In connection with the project, ODA has offered to provide financial support and arrange study tours for three researchers of ISI at University of East Anglia, Norwich, UK, for 3 months which depend upon sanctions by Government of India.

2. *Perception, performance and potential of development in Usri water-shed area of Bihar plateau—An eco-systemic approach* (ICSSR funded project)

The study was taken up in the water-shed of Usri flowing through Giridih district in south Bihar plateau. This study intended to explore linkages between human ecology and system ecology in socially and economically backward area with an objective to suggest ways and means for improving upon man-environment relationships in accordance with perception of the people inhabiting the area and their participation.

Field work, tabulation and analysis of data were completed. Final report was under preparation.

3. *Guidance and Consultancy Services in Data Processing* (funded by ICSSR).

Since 1988, the Sociological Research Unit of ISI has undertaken a programme, "Guidance and Consultancy Services in Data Processing" under the auspices of Indian Council of Social Science Research (ICSSR), New Delhi. The faculty staff of SRU have been providing guidance to Ph.D. scholars from different Universities in eastern India. Services were provided to scholars from various universities of Orissa, Bihar and West Bengal.

4. *ICSSR Post-doctoral Fellowship Programme*

A Post-doctoral Fellow of ICSSR (New Delhi), Dr. Anil Kr. Chowdhury worked in the project of ICSSR, "Socio-economic mechanism for the survival of landless agricultural labour in rice areas of West Bengal : The case studies", under the guidance of Dr. Suraj Bandyopadhyay of the Unit. Field work, tabulation and analysis of data has been completed. Final report was under preparation.

5. *Cancer Chemoprevention : Cancer Screening Programme for the poor females in the southern fringe of Calcutta* (Government of West Bengal sponsored)

This is a collaborative research project of Sociological Research Unit and Biochemistry Research Unit, Indian Statistical Institute at Bagha Jatin State General Hospital, Bejoygarh State General Hospital and Moore Avenue Polyclinic sanctioned by Government of West Bengal. Government of West Bengal arranged to provide infra-structural facilities at the above hospitals for this purpose.

6. *Computer-based documentation, cataloguing and classification system for art objects and archaeological artifacts.*

This was a collaborative research with the Computer and Statistical Service Centre of ISI. This project was accepted by the Government of West Bengal for consideration of financial support.

7. *Study of situation assessment of presumed highrisk behaviour practising groups in Calcutta and other towns in West Bengal.*

This Unit and the Biochemistry Research Unit of ISI, collaboratively provided consultancy services to the Department of Virology, School of Tropical Medicine, Goverent of West Bengal, on the requests made by the Government of West Bengal and the World Health Organisation (WHO).

Other Research Projects :

1. *Social ecology of the minority/marginal groups of eastern India.*

Listing of 13 villages out of 44 having artisan groups completed. Also some preliminary enquiries were done in respect to several cases.

2. *Pressure from below : A study of the impact of the popular movements in the 1940s.*

To find out the data base of the Tebhaga movement in Birbhum five types of source materials, most of which so far remained untapped, were explored : (*i*) the records of the District Courts, (*ii*) the files on FIR shelved in the relevant Police Stations, (*iii*) the old journals of the district, like *Birbhum Barta*, (*iv*) the organisational reports of the *Krishak Sabha* and (*v*) the tape-recorded interviews of the leaders and participants in the Tebhaga uprisings in Birbhum.

A report was under preparation in order to put together the information gathered so far.

3. *Haldia : A study in the linkage of population and development in an industrial complex.*

Chloride India was kind enough to supply a list of workers belonging to different categories. These categories were considered as strata and 20% of workers from each of these categories was selected randomly. 87 out of 468 employees have been surveyed using questionnaire-schedules and personal interviews. Some key persons of different industries in Haldia were also contacted to make the research feasible.

4. *Agro-sociological constraints of technological adaptation in subsistence farming of Bihar plateau region*

Data collection and literature review being undertaken.

5. *Inequality and distribution of gains in tribal societies : A pilot study*

Two villages of south Bengal were completely enumerated. Data transcription is continuing.

6. *The aged : Study of the contemporary conditions of the rural elderly persons in eastern India*

Field work for the pilot survey has been completed. A report based on the exploratory survey was prepared. A technical report on the feasibility study relating to the project was also prepared.

7. *Application of reciprocity measure as an indicator of balance in international trade by countries and commodities*

A technical paper, in collaboration with the scientists of Statistics-Mathematics Division of ISI, was under preparation.

8. *Agro-Sociological exploratory Study in South Bihar plateau*

Scientists of this Unit were also engaged in this inter-disciplinary research activities. This was a collaborative research project with the Agricultural Science Unit in three tribal villages near Giridih town in order to explore local farmers' indigenous knowledge, technology and rational as well as their risk management and coping strategies.

Statistical Quality Control and Operations Research Division

Introduction

The QM and OR Division is primarily devoted to Professional Work in the field of Quality Management, Operations Research, Reliability and Software development for Quality Assurance.

It renders assistance and expert advice to manufacturing industries, takes up project assignments in the field of Quality, Operations Research and other related areas. The main thrust of the division is to promote and propagate SQC and other quantitative techniques, helpful in enhancing quality and productivity. These are carried out through plant visits, organising Seminars and by organising training programmes at the plant level from operators to the top management. Training programmes are mostly directed towards motivating the work force and getting support from the top management in carrying out quality activities as a routine exercise. In addition, special programmes on SPC, Taguchi methods, Design of Experiments are given from time to time.

The countrywide awareness for quality systems implementation, arising out of ISO 9000 Quality System requirements has opened up a new opportunity for the division to use its experience in the Quality Management area.

The new activities currently pursued by the Division include : (*i*) Consolidation of expertise available within the division in the area of TQM and ISO 9000 Quality Systems. (*ii*) Initiating work for the Quality Mission project during the 8th plan

period. (*iii*) Design and development of software for computer aided quality control, computer aided open learning system for quality related topics and (*iv*) Equipping all SQC and OR Units with personal computers, and other peripherials like laser printers etc.

UNIDO has approached ISI to draw up a plan for training in Quality Management. The proposal has been submitted to the Government of India for approval. The Division continued liaison with various academic and technical institutions, societies, productivity councils and professional bodies.

Service

During the period under review 20 plants joined the SQC service, about 90 technical reports were sent to factories and 6 factories discontinued. A total of 95 factories took consultative services as on March 1992.

Projects involving SQC and OR methods were carried out in various organisations involving various types of problems. Some of the areas of work are, computer application in Quality Management, general purpose computer software on simple statistical tools, design and analysis of minute experiments, an utility package for discscreen management, optimal control of conductor dimension for telecommunication cables, sampling scheme for carrier detonator, evaluation of outgoing quality and development of system of control for foils, control of cabinet shrinkage in PU foam process, energy conservation in plant.

Education and Training

There was a long felt need by the SQC and OR Division to give a structured approach to the training of the Specialist Development Programme Fellows. A centre for Specialist Development was set up at Bangalore. A two weeks' additional inputs programme to SDPs' was organised at Bangalore during September 1991.

In plant training programmes for Executives, technologists and other production personnel including operators were continued during the period under review. The training programmes for Vendors of BHEL at various centres continued.

During the period under review. 1605 managers and technologists were trained in various inplant, general and other courses, 34 trainees undergoing M.Tech. in Quality, Reliability and Operations Research, 95 trainees underwent professional training in SQC and OR at Post Graduate level and in part time courses in Calcutta, Bombay, Delhi, Madras and Bangalore. In all, the Division organised 79 Inplant Courses, 13 General Courses and 8 Other Courses at different places in India during the year.

Research

During the period 14 papers were published, 21 sent for publication, 85 manuals and technical reports etc, prepared by the specialists of the division. Some of the areas of work were : Bayesian three decision acceptance sampling plans, continuous sampling plans, sampling plan under stratified random sampling schemes for inprocess inspection, Fuzzy goal programming in acceptance sampling, Optimum investment in Drilling, approximations of doubly non-central Z distribution, strongly balanced uniform measurement design, Life testing experiment and minute analysis, parametric

design and global optimisation, trimloss problem, optimization of fuel injection system, Linear complimentarity problem with N and No matrices, characterisation of P-matrices, optimum allocation of parallel-series and series-parallel systems, optimisation of bicriteria quasiconcave function, control of rotor-stator gap.

Software Development Team

A Software Development Team (SDT) has been set up at Calcutta to persue the possibility of developing software for statistical process control, Quality System and other Quality related methodologies. The programme to develop computer aids for ISO 9000 Quality Systems has been launched.

Promotional Activities

The specialists from the Division delivered 393 lectures, talks etc., to various institutions and organisations. The Division also arranged 55 seminars and the specialists from various units attended 33 seminars. Introductory visits were paid to 61 factories. 16 surveys and pilot projects were carried out and 85 reports sent.

Quality Mission 1992-1997 Project

Though over 80,000 managers and engineers have been trained by QM and OR Division in the short term and specialised courses, there has not been much noticeable impact on our economic growth or exports simply because of lack of sufficient incentives or pressures on the part of our managements to seek competitive strength and quantum jump improvement in the business operations and the services. However, the benefits have accrued over the years to the limited 'islands of excellence' from the expertise of the quality specialists of the Institute.

With the new industrial policy of the Government and the liberalisation, globalisation of Indian trade and industries, there has been justifiable thrust on quality and productivity in the Indian industries. To meet such increased demand of trained quality man power, QM and OR Division proposed the Quality Mission 1992-1997 project as a part of the 8th Five Year Plan activities. This project has been welcomed by the Government and the first year of this project namely 1992-93 will lay the necessary infrastructural foundations and approach for the rest of the project. In this project it is planned to train over a lakh of executives in industries.

The project will be led by the Project Leader with the advice of a Committee of Advisers comprising of the senior faculty of QM and OR Division. The Implementation Committee chaired by the Director and convened by the Project Leader will plan, implement and monitor the project.

Since the present strength of the QM and OR Division will be inadequate to launch such a laudable programme, along with the existing pressure on TQM and ISO 9000 implementation exercises, it was decided that 60 to 80 project linked appointments will be made in different levels as trainers. Recruitment of these project linked personnel, orientation training for these personnel and subsequent announcement of training programmes for executives in the areas of TQM and ISO 9000 quality systems have to be specified, planned and executed.

Besides above, keeping in view the Birth Centenary of Professor P. C. Mahalanobis in the coming year, the Division has already started it's work to organise an Indo-US-Japan conference during 11—14 January, 1993. Competitiveness in world markets is an essential element of national economic development. Focussing on advanced materials and parts manufacture, this conference will foster understanding and collaboration among scientists and engineers from India, Japan and North America in the fields of engineering design, computational approaches in design, statistical design and analysis, reliability and quality control. The preliminary work regarding this conference including the selection of papers for inclusion in the proceedings of the conference to be published in U.S.A. by ELSEVIER was undertaken during this year.

Library, Documentation and Information Sciences Division

Documentation Research and Training Centre (DRTC), Bangalore

1. *Objectives and Programmes of Activity :*

Objectives : The Documentation Research and Training Centre was established as an integral part of the Indian Statistical Institute in 1962. The primary objectives of DRTC are :

(*a*) To contribute the development of the different branches of the discipline "Information Sciences" including "Documentation" and "Library Science", by carrying out, guiding and supporting research and development activities in the concerned fields, aiming at developing expertise and excellence in the different branches of Information Sciences.

(*b*) To help development of "Information Centres" including Libraries, Documentation Centres, Data Centres, Information Clearing Houses, Information Analysis and Consolidation Centres, Archives etc. by offering advisory services in designing specific development plans ; professional tools ; professional techniques, methods and procedures ; information service products etc. as a particular situation warrants it and admits of, specially in response to specific formal requests.

(*c*) To disseminate results of research, information, analysis and consolidation, advisory services, and of compilations in the different branches of "Information Sciences" including "Documentation" and "Library Science" through publications and extension services, as the case may be.

(*d*) To develop manpower equipped with appropriate professional knowledge, understanding and skills that is capable of participating efficiently and effectively in the (i) Management, i.e. design, development, organisation, implementation, operation, control, evaluation, etc. of information service systems, centres, programs and projects ; (ii) In the advanced teaching and research in the field of "Information Sciences" including "Documentation" and "Library Science" by conducting appropriate professional educational and training programmes.

(*e*) To help professionally educated and trained persons in finding appropriate job opportunities after successful completion of the courses conducted by DRTC by establishing contact between them and the prospective employers.

(*f*) To ensure and promote the professional advancement of the educated and trained manpower by organising and conducting continuing educational and training programmes on professional topics and disciplines.

(*g*) To ensure and promote the professional advancement of the members of the DRTC Faculty by providing them opportunities (*i*) to participate with responsibility in each and every programme of activities of DRTC, and (*ii*) to participate in the professional advancement programme organized internationally, nationally, regionally or locally, by agencies other than DRTC.

Programmes of Activities:

To achieve the objectives as mentioned above, the activities of DRTC have been organised into several programmes, such as the following :

(*a*) Research Programme ;

(*b*) Advisory service Programme ;

(*c*) (*i*) Extension Programme ;

(*ii*) Publication Programme ;

(*d*) Educational and Training Programme ;

(*e*) Employment Information Programme ;

(*f*) Continuing Educational and Training Programme ; and

(*g*) Faculty Development Programme.

Each of these programmes corresponds to each of the objectives as mentioned earlier.

2. *Training in Documentation and Information Science*

Course leading to "ADIS" Award :

Under its Education and Training Programme, DRTC conducts a course of 24-month duration leading to the award "Associateship in Documentation and Information Science" (ADIS). This award is recognized by the Govt. of India as equivalent to a Master's Degree in Information Science. Normally, the entry qualification for ADIS course is a Post-graduate Degree in "Library and Information Science" (BLIS or its equivalent). Not more than ten students are admitted in each academic session of 24-month duration. This is to avoid the problems of unemployment and under employment in the field of Secondary Information Work and Service in India.

Admission is based on Merit as determined by an All India Admission Test and Interview. Applicants are selected for the admission test on the basis of their respective performances in their highest academic professional courses. There were eight students selected for the academic session 1989-91 (24-months). They appeared at the final examination in 1990 after completing their formal residential part of the course of 12 months.

After that, they were engaged in their respective guided research projects. They submitted their dissertations in August 1991. The results of their course performances were declared in September 1991. All of them were declared passed. Seven students obtained First Class and one student got Second Class. Of the 8 students, two were women and six were men.

For the academic session 1990-92 (24 months), six students were admitted. They joined the course on 1 September 1990. All the six students completed their formal residential part of the course in August 1991. All of them appeared in the final examination held in 1991. They are now engaged in their respective guided research projects. They have to submit their respective disseratations by August 1992. The list of the students of 1990-92 batch was furnished in the DRTC Annual Report for 1990-91.

The academic session, 1991-1993 (24 months) commenced on 1 September 1991. There were eight students selected for this session. All the eight students joined the course and 7 students are still continuing with it. All of them were men. One student discontinued in December 1991.

Short Term Course on Computerized Information Work and Service.

Under the sponsorship of the National Information System for Science and Technology (NISSAT) forming part of the Department of Science and Industrial Research (DSIR), Government of India, New Delhi, DRTC has been conducting a six-week course on "Computer Applications to Library and Information Work" since 1986. This is considered to be an externally funded project. Normally, two such courses are conducted during each financial year. During the period April 1991 to March 1992, two courses i.e. 10th and 11th series, were conducted. The candidates seeking admission to the short term course is required to be a person carrying out professional information work and service in some information centre. According to the stipulation of the sponsoring agency, such a candidate has to pay the course fee of Rs. 3000/- for 6 week course.

10th Course, 1991.

The 10th course was conducted during the period 12 June to 26 July 1991. Fifteen candidates were selected for the course. All the candidates completed the course by meeting all the requirements.

11th Course, 1992.

The 11th Course was conducted from 20 January to 29 February 1992. Seventeen candidates attended the same.

INDIAN STATISTICAL INSTITUTE

Educational Study Tour by ADIS Students, 1990-92 and 1991-93 :

The students of the ADIS Course 1990-92 and 1991-93 sessions went for their educational tour to Madras. It was primarily arranged for them to attend the 37th All India Library Conference held at IIT, Madras during December 4-7, 1991. The theme of the Conference was "National Information Policies and Programmes". Prof. M. A. Gopinath conducted the tour.

3. *Research Activities :*

The main areas of research in which the different members of the DRTC Faculty were engaged during the period of the report (1991-92) are furnished below :

(*i*) The preparation of a Manual for the Construction of a Classaurus ;

(*ii*) The designing of a "Classaurus for the Depth Indexing of micro subjects going with the base", "Agriculture and related Sciences and Technologies".

(*iii*) The demonstration of the use of the above mentioned classaurus ;

(*iv*) The application of the "Colon Classification, ED 7", for the purpose of (*a*) arranging documents ; and for (*b*) documentation work and service ;

(*v*) The designing of a "Multi-Access Thesaurus" ;

(*vi*) The study of the varieties of "Thesaurus-Structure/Formats" from the point of view of their impacts on information retrieval.

(*vii*) The study of various methods of knowledge representation, such as, semantic nets, frames, and predicate calculus ; and of their related features to ascertain their co-relation with the classificatory language of colon classification ;

(*viii*) The designing and development of notational Depth Classification Schemes, Thesauri and Classauri for the depth indexing of micro subjects going with various recognized disciplines ;

(*ix*) The application of the "Modern Scientific Management Techniques" to the Planning and Management of Information Systems, Centres and Services ;

(*x*) The study of the methodologies of information analysis and consolidation ;

(*xi*) The preparation of a State-of-the art report on Performance Standards in the field of Secondary Information work and Service ;

(*xii*) The development of bibliometric measures for evaluating the use of library and information services ;

(*xiii*) The preparation of guidelines for developing software and application packages for house keeping operations of information centres, such as, circulation control, serial control, and acquisition control ;

(*xiv*) The development of a computerised manpower planning model for Information Centres ;

(*xv*) Restructuring of curricula and syllabi specially for the advanced courses on "Information Science" including "Documentation" and "Library Science" with a view to accommodate essential contents pertaining to the use of the machines and equipment which are all results of advances in information technologies.

(*xiv*) The development of a computerized Tutorial for CDS/ISIS (Mini-Micro Version).

Central Library (Calcutta)

The Institute maintains a Central Library at Calcutta. With the addition of 1720 books and 35 new journals to the stock, the total collection of the Library rose to 1,94,132.

Acquisition Unit : The Unit accessioned 1720 books during the period under report, out of which 1503 were purchased, 205 received as gift and 12 were received on exchange basis. It also acquired 390 books for the Statistical Workers' Circulating Library.

Periodicals Unit : The Unit received 1,316 periodicals out of which 244 were received as gift, 592 against subscription and 480 on exchange arrangement with national and international organizations. The Unit also acquired 35 new journals. 13 journals were subscribed under NBHM grant. It accessioned 2603 journals and completed the technical processing of 2009 journals.

Circulation and Stack Maintenance Unit : The Unit issued 51,138 books and journals to the users on loan and reference. The total membership of the Library was 2197 (after the introduction of New Library Rules from May 2, 1988) out of which 157 memberships were withdrawn. The total membership includes ISI, staff, research scholars, project assistants, B.Stat. & M.Stat. students, ISEC trainees etc. as well as outside students and institute members. 572 readers were given special permission to use the Library for a short period. 48 books and journals were borrowed from other libraries and 20 books and journals were loaned to other libraries under the interlibrary loan arrangement.

Reports & Records Unit : The Unit accessioned 475 titles and processed 208 titles. 1452 titles were issued to the borrowers during the period.

Circulating Library : The Workers' Circulating Library acquired 390 new titles bringing the total collection to 34,721. It issued 24,574 books to the members.

Technical Processing Unit : The Unit classified 998 books and catalogued 1142 books.

Documentation Unit : The Unit has launched Current Contents List Services on the following group of subjects :

(*a*) Statistics and Mathematics

(*b*) Electronics and Computer Science

(*c*) Geology and Earth Sciences and

(*d*) Life Sciences and Anthropology.

Reprography and Photography Unit : The Unit provided 7,42,359 xerox prints for the users during the period under report.

395 frames of photographs of different natures, 4,384 prints of photographic enlargements, 50 frames of lecture slides were made during the period under report.

Bangalore Centre Library

Book Acquisition : During the above period 350 books were added to the library by purchase. 30 books were received gratis.

Stock position : The total stock position as on 31st March 1992 is as follows :

Books—11,958 ; Books on gratis—663 ; Bound volumes of periodicals—4,980 ; Number of periodical titles subscribed—271 ; Number of periodicals received gratis—26.

Technical Processing : About 750 books were classified and catalogued during the year. Nearly 3,750 catalogue cards were filed.

Circulation Statistics : During the year, library facilities were enjoyed by 160 readers. 100 of them availed the lending facilities. 6 visiting Professors from different Units of ISI were also provided with the lending facilities. A total of about 11,000, books and periodicals (including loose issues) were circulated by the library. The inhouse use of books and periodicals were around 30,000. About 205 inter library loan transactions were registered.

The membership includes ISI Staff, Research Scholars, Project Assistants, M.Stat. Students, M.Tech. Students, SDI' Fellows, D.R.T.C. Students, Trainees of D.R.T.C. Short-term computer course etc.

Inter-Library Loan Service : Users of the Library availed of the Inter-Library loan facilities from the local libraries in Bangalore like Indian Institute of Science, Tata Institute of Fundamental Research, Indian Institute of Management and British Library. Similarly, the library extended inter-library loan facilities to Indian Institute of Science and Tata Institute of Fundamental Research, Bangalore.

Reprographic Service : The library provided 2,99,210 xerox copies to the users during the academic year 1991-1992.

Documentation Service : The following publications were brought out regularly from the library :

1. Bimonthly additions list of books,
2. Monthly list of current periodicals,
3. Current contents of journals.

Delhi Centre Library

Acquisition : Due to budget constraints, only 149 new books could be purchased and added to the stock. Received 257 publications as gift from various sources and agencies. 514 sets of loose issues of periodicals duly bound has been added to the stock, thus raising the stock to 30,484 volumes. 40 publications were also procured

by the acquisition section for personal use of the students and researchers of the Institute. About 175 Technical reports/Discussion Papers/Reprints etc. were received during the period from different Institutions of India and abroad. Standing order for the series "Lectures on Mathematics and Physics (TIFR)" were renewed during the period.

Periodicals : 248 titles of journals, both Foreign as well as Indian were subscribed during the year. In addition 29 titles of journals were received as complimentary and against exchange programme. 514 sets of loose issues of journals duly bound were added to the stock. Some new titles of the journals were subscribed for the first time during the period while some other titles were discontinued. In addition following publications were donated by ISI, faculty members :

(I) Pramana.

(II) Indian journal of History of Science.

(III) Proceedings of the Indian Academy of Sciences.

(IV) Probability Theory and related fields.

(V) Indian journal of Pure and Applied Mathematics.

(VI) Journal of Theoretical Probability.

Circulation : During the period April 1, 1991 to March 31, 1992, 144 members availed the lending facilities as permanent members. Approximately 10,659 publications were circulated during the period among its members. Under the inter-library program, about 101 publications were lent out to the neighbouring Institutes and libraries and 54 publications were borrowed from them for use by Delhi Centre Library members.

Reprographic Services : 29,507 photocopies were made during the period on the request of users of library. Reprographic facilities have also been provided to researchers of other institutes on a nominal payment of Rs. 0.50p. per page.

Other Activities : Like every year this year too Library Trainees with remuneration were appointed. At the end of their training, each trainee was given an experience certificate.

3. EXTERNALLY FUNDED PROJECTS

(A) On going Projects :

Applied Statistics, Surveys and Computing Division

Computer Science Unit

(i) Name of the Project : Differential Impact of Modern Rice Cultivation.

Chairman : Professor N. Bhattacharyya.

Project Co-ordinator : Mrs. Rama Chowdhury.

Funded By : Rockefeller Foundation.

(*iii*) Name of the Project : Fish Farmer's Development Agency Survey.

Name of the Project Leader : Professor Shibdas Bandopadhyay.

Funded By : Department of Fisheries, Government of West Bengal.

Biometry Research Unit

(*iv*) Name of the Project : Determination of Survival, Growth and reproduction rates of fresh water Indian carps with particular reference to Bundh-bred, Hatchery and Riverine Sources.

Name of the Project Leader : Dr. T. K. Basu.

Funded By : Directorate of Fisheries, Government of West Bengal.

Physical and Earth Sciences Division

Electronics Unit

(*v*) Name of the Project : Integral transforms, integral equations and applications.

Name of the Project Leader : Dr. B. N. Mondal.

Funded By : CSIR, New Delhi.

Electronic and Communication Sciences Unit

(*vi*) Name of the Project : Fifth generation computer system and knowledge based computing system (FGCS/KBCS).

Name of the Project Leader : Professor D. Dutta Majumder.

Funded By : Department of Electronics, Government of India and UNDP.

(*vii*) Name of the Project : Monsoon through boundary layer experiment (MONTBLEX)

Name of the Project Leader : Professor J. Das.

Chief Adviser : Professor D. Dutta Majumder.

Funded By : Department of Science and Technology, Government of India.

(*viii*) Name of the Project : Procedures for spectral characterization that has physical meaning.

Chief Investigator : Dr. S. K. Parui.

Chief Adviser : Professor D. Dutta Majumder.

Funded By : Defence Electronics Applications Laboratory, (DEAL), Dehradun, Ministry of Defence.

Biological Sciences Division

Agriculture Sciences Unit

(*ix*) Name of the Project : Agroecological studies data collection and tabulation work in the sampled village of Giridih District.

Name of the Project Leader : Dr. Dipak Kumar Bagchi.

Funded By : I.C.S.S.R.

(*x*) Name of the Project : Rain fed farming.

Name of the Project Leader : Dr. A. Maiti.

Funded By : H.F.C.L. and ODA (U.K.)

Biochemistry Unit

(*xi*) Name of the Project : Cytotoxicity of heavy metal.

Name of the Project Leader : Dr. (Mrs.) C. Duttagupta.

Funded By : CSIR.

Social Sciences Division

Psychometric Research and Services Unit

(*xii*) Name of the Project : Attainment of primary students at the end of class IV.

Name of the Project Leader : Dr. S. Guha Roy.

Funded By : SCERT, Government of West Bengal.

(*xiii*) Name of the Project : Social impact study on mass literacy programme in Midnapore District.

Name of the Project Leader : Dr. S. Guha Roy.

Funded By : Rabindra Bharati University, Calcutta.

(*xiv*) Name of the Project : Study on man-power management.

Name of the Project Leader : Dr. D. Dutta Roy.

Funded By : Eden Hospital, Calcutta Medical College, Government of West Bengal.

Sociology Unit

(*xv*) Name of the Project : Evaluation of rainfed farming project.

Name of the Project Leaders : Dr. Suraj Bandopadhyay, Dr. D. K. Bagchi and Dr. A. Maity.

Funded By : Overseas Development Administration (ODA), Government of U.K. and Hindusthan Fertilizer Company Limited. (HFCL).

(*xvi*) Name of the Project : Perception, performance and potential of development in Usri watershed area of Bihar plateau—an ecosystemic approach.

Name of the Project Leaders : Dr. A. Maity and Dr. D. K. Bagchi.

Funded By : I.C.S.S.R., New Delhi.

(*xvii*) Name of the Project : Guidance and Consultancy Services in Data Processing.

Name of the Project Leader : Dr. P. Chakraborty.

Funded By : I.C.S.S.R., New Delhi.

(*xviii*) Name of the Project : Cancer chemoprevention : Cancer screening programme for the poor females in the Southern fringes of Calcutta.

Name of the Project Leaders : Dr. Suraj Bandopadhyay and Dr. (Mrs.) Chandralekha Duttagupta.

Funded By : Government of West Bengal.

(*xix*) Name of the Project : Computer based documentation, cataloguing and classification system for art objects and archaeological artifacts.

Name of the Project Leaders : Dr. Suraj Bandopadhyay and Dr. Aditya Bagchi.

Funded By : Government of West Bengal.

(*xx*) Name of the Project : Study of situation assessment of presumed highrisk behaviour practicing groups in Calcutta and other towns in West Bengal.

Name of the Project Leader : Dr. Suraj Bandopadhyay.

Funded By : Requested by School of Tropical Medicine, Government of West Bengal.

Library, Documentation and Information Sciences Division

DRTC (Bangalore)

(*xxi*) Name of the Project : Short term training programme of computer applications to library and information work.

Name of the Project Leader : Professor M. A. Gopinath.

Funded By : National Information systems for science and Technology, (NISSAT) CSIR.

(B) Completed Projects :

Physical and Earth Sciences Division

Electronics Unit

(*i*) Name of the Project : On some problems in the linearised theory of water waves.

Name of the Project Leader : Dr. B. N. Mondal.

Funded By : Third world academy of sciences International Centre for Theoretical Physics, Trieste.

Electronics and Communication Sciences

(ii) Name of the Project : Systems and Algorithm for pattern Recognition and Shape Analysis for object of Defence Interest.

Name of the Project Leader : Professor D. Dutta Majumder.

Funded By : Defence Electronics Applications Laboratory, (DEAL), Dehradun, Ministry of Defence.

Social Sciences Division

Sociological Research Unit

(iii) Name of the Project : Social-economic mechanism for the survival of landless agricultural labour in rice areas of West Bengal : Two case studies.

Name of the Project Leader : Dr. Suraj Bandopadhyay.

Funded By : I.C.S.S.R., New Delhi.

4. SYMPOSIA, SEMINARS, LECTURES AND CONFERENCES

Among different Conferences, Symposia, Seminars, Workshop and Lectures organised by the Institute during the year 1991-92 mention may be made of the following :

Symposia, Conferences, Workshop etc.

A winter Conference on Linear Algebra and Linear Models was held during 23-24 December, 1991 at Calcutta under auspices of the Theoretical Statistics and Mathematics (Stat-Math) Division, Calcutta.

A "Refresher Course in Statistics" was organised by Dr. T. J. Rao and Dr. G. M. Saha, Stat-Math-Division, Calcutta during 2—20 December, 1991 Under the Sponsorship of UGC.

A Symposium on "Quality of scientific journals in India" was organised by Professor B. L. S. Prakasa Rao, Stat-Math Division, Delhi on 8 April 1991 with the presence of fifty participants at Indian National Science Academy, New Delhi.

A Conference on 'Stochastic Differential Equations" was organised in June '91 jointly by Indian Institute of Science and State-Math Division, ISI, Bangalore. Professor S. Ramasubramanian (ISI, Bangalore), Professor K. R. Parthasarathy (ISI, Delhi), Professor V. S. Borkar and Professor N. Mukunda (both from I. I. Sc. Bangalore) discussed on the subject.

A Conference on "Harmonic Analysis" was organised in March '92 under the joint sponsorship of Indian Academy of Sciences and Stat-Math Division, Bangalore with the participation of Professor Alladi Sitaram, Professor Gadadhar Misra, Professor V. S. Sunder (all from ISI, Bangalore) and Vittal Rao (I.I.Sc. Bangalore).

A Symposia on "Certain aspects of Linear Cellular Automata and applications" was organised by Professor Pabitra Pal Chowdhury of Applied Statistics, Surveys and Computing Division on 11 July '91 at Institute of Mathematical Sciences.

A winter school on "use of statistical software" was organised at Computer Science Unit, ISI, Calcutta by Shri Debasis Sengupta during 9-26 December '91.

A Conference on "On optimality of the Horvitz-Thompson estimator a Markov process model" was organised by Professor A. K. Adhikary, ISI, Calcutta at the Indian Science Congress held at Baroda during 3-8 June '92.

A Conference on "Diurnal variation in blood pressure" was organised by Professor T. Krishnan, ISI, Calcutta at the IX Annual Conference of the Indian Society for Medical Statistics held in New Delhi during 26-28 December '91.

A Conference on "Additive Cellular Automata and Linearity" was organised jointly by Professor Pabitra Pal Chowdhury and R. Barua, ISI, Calcutta at the National Seminar on theoretical computer science held in Madras during 4-6 July '91.

An international workshop on "Recent Trends in speech, music and allied signal processing" was held at ISI, Delhi during 9-11 December '91.

A joint workshop on "Parallel processing" was arranged by NCKBC, ISI and C-DAC, Pune at the Calcutta Nodal Centre during 24-25, October '91.

Seminar of the Technical Session III (Ecosystem and Enviroment and Problem area Management) on "Science and Technology for the development of West Bengal" was held at Electronics and Communication Science Unit, ISI, Calcutta on 14 November '92.

7th Conference on "Economic Theory and Related Quantitive Methods" was organised by Professor Dilip Mukherjee at ISI, Delhi during January '92.

A Seminar on "Common Articulatory Disorders in school going children" was conducted by Dr. Alokananda Mitter of Linguistics Research Unit, ISI, Calcutta on 9 December '92.

A Seminar on "The story of North Kolkata dialect and Kolkata standard" was organised by Debaprasad Bandopadhyay of Linguistic Research Unit, ISI, Calcutta on 31 January '92.

A Seminar on "Kostić Methodology for Evalution of speech sounds with special reference to hearing-impaired children" was arranged by Mrs. Monsumi Majumder of Linguistic Research Unit, ISI, Calcutta on 24 February '92.

A Workshop on "Behaviour Modification" was organised by Psychometry Research Unit, ISI, Calcutta during 11-13 November '91. Dr. V. Ganesan, Reader in Psychology, Bharathiar University, Coimbatore was invited as resource person of the Workshop.

A Workshop on "staff development programme" was held at Calcutta during 21-23 May '91. About 40 staff members participated in the Workshop.

A Workshop on "TQM and ISO 9000 standards" was organised at Bangalore. About 25 senior members took part in the Workshop.