INDIAN STATISTICAL INSTITUTE

THIRTY-SIXTH ANNUAL REPORT
April 1967—March 1968

203 BARRACKPORE TRUNK ROAD
CALCUTTA-35

'IAN STATISTICAL INSTITUTE

ssor S. N. Bose, F.R.S., D.Sc., F.N.I., National Professor.

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Government nominees on the Council (Rule 6.1(b) (I)) : 1. Cabinet Secretary (Shri D. S. Joshi) or his representative; 2. Joint Secretary, Ministry of Finance, Department of Expenditure, Government of India, (Shri A. P. V. Krishnan); 3. Director, Central Statistical Organisation and ex-officio Joint Secretary, Department of Statistics (Dr. Uttam Chand).

Co-opted Members (Rule 6.1(c)) : Dr. T. R. Seshadri, F.R.S.; 2. Dr. Atma Ram, D.Sc.; 3. Shri Arun Kumar Dutt.

Ex-officio Members (Rule 6.1(d)) : Secretary of each local branch :* 1. *Bombay Branch :* Shri P. K. Bhaumick (1967-68); 2. *Kerala Branch :* Dr. (Miss) A. George (1967-68); 3. *Mysore State Branch :* Professor Srinagabhushana (1967-68).

Branch Chairmen's names shown under Additional Vice-Chairmen.

INDIAN STATISTICAL INSTITUTE

THIRTY-SIXTH ANNUAL REPORT

April 1967—March 1968

CONTENTS

Annexures

INDIAN STATISTICAL INSTITUTE

THIRTY-SIXTH ANNUAL REPORT

April 1967—March 1968

1. Introduction

1.1. *Genesis:* The idea of starting the Indian Statistical Institute was conceived by Professor P. C. Mahalanobis and a group of young men who had gathered round him in the nineteen twenties (1920-31), being interested in applying statistical methods to the solution of practical problems. There was already a workshop, so to say, for this purpose in what came to be known as the Statistical Laboratory, which was located in the room of Professor Mahalanobis, then professor of physics in the Presidency College, Calcutta. A public meeting, called over the signatures of Pramatha Nath Banerjee (Minto Professor of Economics), Nikhil Ranjan Sen (Khaira Professor of Applied Mathematics) and P. C. Mahalanobis, was held on 17 December 1931, with the late Sir R. N. Mookerjee in the chair. This meeting adopted a resolution which led to the establishment of the Indian Statistical Institute which was registered on 28 April 1932 as a non-profit distributing learned society under the Societies Registration Act XXI of 1860. A part-time computer was the only worker the Institute had in the first year of its existence, the total expenditure being Rs. 238. The Indian Statistical Institute Act of 1959 recognized the Institute as an institution of national importance and empowered it to confer degrees in statistics, thus giving the Institute the status of a university. From 1 July 1960 the Institute, through its Research and Training School, has been conducting courses leading to the degree of Bachelor of Statistics (B. Stat.), and Master of Statistics (M. Stat.), and a doctorate degree (Ph.D.) is also being awarded, with provision for a higher doctorate (D.Sc.) degree. In 1961, the Institute adopted "Unity in Diversity" as the motto and the banyan tree as a crest, as a result of discussions between the late Sir Ronald A Fisher, Professor P. C. Mahalanobis and Shri C. D. Deshmukh, the President of the Institute from 1945 to 1964, who translated the English words into the Sanskrit version incorporated in the crest.

1.2. *History of Activities:* Since its inception, the Indian Statistical Institute has been carrying out a well-integrated programme of work of theoretical studies with the focus of interest on practical applications of statistics through project work. These projects raised problems whose solution led to original contributions to statistical theory. The Institute's project work involved close collaboration with the Government, and it used to be done on business-like lines for both private enterprises and the Government, with contract grants for specified purposes. The Institute was built up, in fact, on such "business" earnings. Individual training had started in 1932; the lack of trained statisticians and computers led to the establishment of training courses in 1939, and the award of certificates of competence from 1938. The Institute's educational activities expanded with passing time, and included cooperation with international agencies for training programmes in South East Asia.

In the early days, project work was mainly concerned with two problems. The first was the control of floods, particularly in Bengal and Orissa. The results of this work

were partly immediate, in the implementation of proper measures for flood control; and partly long-term, coming to fruition in such schemes as the Damodar Valley Corporation and the Hirakud Dam Project. The second set of problems, which centred round agricultural field trials, led to the establishment of contact with Ronald A. Fisher as early as in 1925 and resulted in the introduction in India of his "design of experiments", before these methods were adopted in any other country outside Britain. Theoretical work on the design of experiments was started in the nineteen thirties and received a great impetus with R. A. Fisher's first visit to the Institute in 1938 which led to the Institute workers making important contributions to this subject field. Earlier work on anthropometry and meteorology provided the basis for contributions to statistical theory, especially multivariate analysis with the formulation of the "generalised distance" in the late nineteen twenties. Work on these problems still continue in the Institute.

In 1936, theoretical and field studies were started, at the desire of the Government of India, to develop sample surveys for the improvement of estimates of production of agricultural crops. These studies led to continuing annual crop surveys in Bengal from 1941, and also to important theoretical developments in the design of sample surveys which secured for the Institute a leading position in the world in this subject.

During the Second World War, the Institute became involved in the study of demographic problems. A detailed tabulation of the 1941 population census had to be abandoned owing to the exigencies of war. The Institute had been able to persuade the Government to retain a small sample of the original census slips. On the basis of this sample, the Institute prepared the detailed tables of demographic statistics for the 1941 census. Since then, research in demography has been an integral part of the Institute's activities.

Research on estimation and distribution theories also started during the war and gradually led to the Institute becoming an internationally-known centre for research in mathematical and theoretical statistics.

During the nineteen fifties, the Institute developed important types of project work. The National Sample Survey, initiated by the Government of India, with the help of the Institute, in 1950, is the most comprehensive and continuing socio-econometric survey in the world today. Statistical Quality Control was started in 1953 and gradually developed into a training and consulting service to industry on an India-wide basis, and is fulfilling a basic need in promoting the industrial progress of the country.

The most important development of the Institute's work during the nineteen fifties was its significant contribution to economic planning. The studies on planning were inaugurated at the Institute in Calcutta in 1954 by the late Prime Minister Jawaharlal Nehru, and the Draft Plan Frame for the Second Five Year Plan was prepared on the basis of these studies. The Institute's Planning Unit has since then worked in close collaboration with the Perspective Planning Division of the Planning Commission, and the National Sample Survey data have been found to be of great help in this work.

Educational Programmes : All over the world, during the last thirty years or so, statistical methods are being increasingly used in new fields of work. This is clearly seen in the number of books which have been published during this period, surveying the applications of statistics in many separate individual fields of natural science, such as geology, which would once have been thought quite remote from the statistical field.

The Institute was given powers to award degrees by an Act of Parliament, sponsored by the late Prime Minister Nehru, and passed in 1959. This, together with the recognition of statistics as a key technology, has resulted in a new approach to the teaching of statistics in the Institute, which is also expressed in its research programme.

In universities, the practice for a long time used to be to provide courses in single subjects like mathematics, physics, biology, economics, etc. During the latter part of the nineteenth century, it became necessary to develop new educational programmes in two important fields, namely, medicine and engineering, because it was essential for the professional students to have some knowledge of and skills in a number of scientific disciplines. A similar development occurred in the field of statistics in the Institute.

Sir Ronald Fisher summed up the position of statistics as "the key technology of the present century" in 1962, pointing out that a technologist must talk the language of both theoreticians and practitioners. The education of a technologist must, therefore, have a broad base. A technologist has to see both sides of the fence, and is the channel through which alone the knowledge and skills of others can be made effective. Fisher said, "It is, I believe, in recognizing statistics as the key technology of our century, that we can appreciate the special features of the Indian Statistical Institute... . What the scientists have to do with statistics lies in the part they must play in the education of any competent statistician."

Statistics, as a new technology, is concerned with the use of the most economic and efficient methods of observation, measurement, survey, and experimentation, and of the processing of data for the drawing of valid inferences. The scope of statistics thus extends over the whole range of both the natural and social sciences.

The courses leading to the B.Stat. or M. Stat. degrees have been formulated to cover a wide range of subjects, somewhat analogous to courses in medicine and engineering. Pure mathematics and the theory of probability are of basic importance. Theoretical and different branches of applied statistics, naturally, form a large part of the teaching programme. Because of the special needs of India, a great deal of attention is given to the economics of planning. In these three groups of subjects, mathematics, statistics, and economics of planning, the course includes a good deal of knowledge of basic results and facts, besides theory and methodology.

In addition, facilities are provided for the students to become familiar with the methods of observation, measurement, survey, and experimentation in a number of scientific subjects. Here the emphasis is not so much on the content of knowledge of facts, or of theories, but on methods; and the stress is, therefore, on practical courses and statistical analysis and the interpretation of data.

The Research Policy : Ronald Fisher had pointed out "that the science with which the student is to become acquainted must be genuine research in its own right, not what is eloquently called a 'mock-up' for the use of students only." It is, therefore, the policy of of the Institute to establish small, high level, research units in both the natural and social sciences, to offer facilities for research and training in the use of statistical methods in practice.

The Government of India approved this policy in a communication from the Cabinet Secretariat dated 15 June 1962 in the following terms :

"Government accept the view that statistics being a new technology, it should be open to the Indian Statistical Institute to establish and maintain research and study units in subjects other than theoretical and applied statistics to offer facilities for research and application of statistical methods and for the provision of training in such methods. The number of such units would depend on the availability of really able research scientists and also on the funds available to the Institute. Similarly, in furtherance of the purposes as set out in Section 5 of the Indian Statistical Institute Act, the Institute may establish and maintain units for the study of different languages (including translation units, library science, documentation, etc.) and for auxiliary studies and teaching in different subjects including humanities."

In this plan, each research unit would be concerned with a particular theme. Where there is more than one professional scientist in the same unit, they may either work jointly on the same topic or on different topics, which would, however, be related to a central problem. Each research paper may be independent, but the results would be capable of being added together to supply a more comprehensive picture of different aspects of the central theme.

This thematic programme of research is particularly useful in underdeveloped countries. In a large department or the faculty of a University, scientists often work on unrelated topics with practically no possibility of communication, or exchange of views and criticisms among them. Scientists in a small research unit working on related groups of subjects can easily communicate with one another; a miniature scientific community can thus be established with the possibility of a free exchange of views and criticisms. Such scientific cells can then gradually build up a scientific community in the country as a whole.

The concept of a thematic programme for each research unit is also useful in preventing the growth of large units with a big staff dealing with a multitude of subjects. The Institute's policy is to have small units of pioneering research arranged in a horizontal or parallel pattern of organization. The Institute's policy is also to encourage joint projects of research and advanced studies by collaboration between two or more research units within the Institute and also with other universities, institutions and organizations.

The Institute's small research units are thus intended to play a quadruple role.

(i) Each will contribute to the teaching of degree courses in statistics, familiarizing students with types of problems, and methods of observations, measurement, and experiment, in its own field of natural science.

(ii) Each unit will actively engage in a programme of pioneering research, which will throw up problems of a statistical nature from time to time, some of which may well stimulate the evolution of new statistical methods.

(iii) It is also hoped that the research units will be able to act as a liaison between workers in similar fields of science in universities and Government organizations, on the one hand, and the research statisticians of the Institute, on the other, to promote the spread of knowledge of statistical methods in scientific research in India.

(iv) Some of these research units have also been functioning in a very encouraging way as the meeting place for active collaboration between the scientists in India and guest scientists from abroad. Such collaboration is an important role of the Institute.

2. General Administration

2.1 *Membership* : The year 1967-68 started with 72 life members (including five honorary life members), six institutional members and 332 ordinary members on the roll. During the year, 29 ordinary members and one institutional member were enrolled and 7 ordinary members became life members. At the end of the year, therefore, the total membership was 440 consisting of 79 life (including five honorary life members), 354 ordinary and 7 institutional members.

Eighty-eight sessional members and 109 student members were enrolled during 1967-68, compared with 73 sessional and 128 student members in the previous year. Sessional and student members are enrolled for one year at a time.

2.2. *Annual General Meeting* : The Annual General Meeting was held on 30 October 1967 to transact the business specified in the Constitution. This included election of the President, Vice-Presidents, Vice-Chairmen and members of the Council, adoption of the Annual Report for 1966-67 submitted by the Council and of the auditors' report with audited statement of accounts and balance-sheet for the year ending 31 March 1967 submitted by Messrs. Price Waterhouse, Peat and Co., appointment of Messrs. Price Waterhouse, Peat & Co., as auditors for the term 1967-68, and consideration of the recommendations of the Review Committee and of the Deshmukh Committee.

As the members did not get sufficient time to peruse all papers relating to the recommendations of the Review Committee and of the Deshmukh Committee and as sufficient copies of the report of the Review Committee could not be made available to the members, another General Meeting of the Institute was held on 24 January 1968 to consider the reports of the Deshmukh Committee and of the Review Committee. There was also a reporting about the informal discussions held between the Government and the Institute representatives on the recommendations of the Review Committee on 6 January 1968.

National Professor S. N. Bose was elected as President of the Institute for the usual term. Four of the Vice-Presidents, Shri Vishnu Sahay, Professor D. R. Gadgil, National Professor S. R. Ranganathan and National Professor D. N. Wadia, were re-elected; Shri Pitamber Pant was elected as a Vice-President.

The election of the office-bearers was not due this year, excepting that Shri S. Dutta, I.C.S. (*Retired*), Vice-Chairman, whose term had expired, was re-elected for one usual term.

The names of the President, Vice-Presidents, Chairman, Vice-Chairmen and other office-bearers and members of the Council as after the election on 30 October 1967 are given in *Annexure I*.

The auditors' report, the audited statement of accounts for the year 1967-68 and the balance-sheet as at 31 March 1968 submitted by Messrs. Price Waterhouse, Peat & Co. are given in *Annexure 7*.

2.3. *Meetings of the Council* : The Council of the Institute met seven times during the year on 3 May, 19 August, 20 August, 27 September, 9 October and 21 October 1967 and 12 February 1968.

2.4. *Meetings of the Governing Body of the Research and Training School* : The Governing Body of the Research and Training School met four times during the year on 19 August, 20 August, 28 October 1967 and 12 February 1968.

Important items of business transacted at the meetings of the Council and the Governing Body of the Research and Training School are briefly mentioned in *Annexure 2*.

2.5. *Meetings of the Finance Committee*: The Finance Committee of the Council and the Finance Committee of the Governing Body of the Research and Training School met on 27 October 1967 to consider (a) auditors' report, balance-sheet, audited statement of accounts for year ending 31 March 1967, (b) revised budget estimates for 1967-68 and tentative budgets proposals for 1968-69.

2.6. *Membership of the Governing Body and Finance Committee*: The names of the members of the Governing Body of the Research and Training School and of the Finance Committee of the Council and the Governing Body are given in *Annexure 1*.

2.7. *Institute Staff*: Professor P. C. Mahalanobis held the office of Honorary Secretary and Honorary Director of the Institute throughout the period. Dr. C. R. Rao continued as the Director of the Research and Traing School.

Shri N. C. Chakravarti, Honorary Joint Secretary, continued as a Special Officer on a part-time basis to look after certain constitutional, secretarial, legal and other matters. Shri S. Basu, Honorary Joint Secretary, also continued as a Special Officer in charge of the administration of the Delhi sub-office, and for liaison with the Central Government and for certain other work.

Shri Pitambar Pant functioned as Honorary Joint Secretary up to October 1967. In the Annual General Meeting held on 30 October 1967, he was elected a Vice-President. Dr. B. S. Minhas was placed in charge of the Planning and Regional Survey Unit at Delhi after Shri Pitambar Pant became a member of the Planning Commission.

Shri P. Ray continued to work as Joint Secretary and Administrative Officer throughout the period. Shri Biswajit Roy, Deputy Librarian, functioned as Assistant Secretary and Administrative Officer up to 17 December 1967, when he was relieved of these special responsibilities to take up his work in the Library on a whole-time basis.

2.8. *New Appointments*: The staff of the Institute was strengthened during the year by the addition of the following persons. The date of joining is shown against each name.

Research and Training School: Dr. C. G. Khatri, M.Sc. (Bombay), Ph.D. (M.S. University, Baroda), 1 July 1967; Shri T. J. Rao, B.A. (Hons.) (Math.), M.Stat., 27 July 1967; Shri J. P. Saksena, M.Sc. (Allahabad), 1 December 1967.

During the academic session, the Institute secured the services of the following two qualified persons from Britain under the Voluntary Service Overseas Organisation (VSO) scheme.

Miss Jennifer Uden who joined in August 1967 is expected to continue till December 1968. She is assisting in an agricultural project in Giridih, which has been taken up by the Institute on the advice of and in collaboration with the British scientist Dr. R. L. M. Synge, Nobel Laureate.

Miss E. M. MacNicol who joined in August 1967 continued till June 1968. She has been teaching English in the courses of the B.Stat. degree and the International Statistical Education Centre.

Planning, Delhi: Dr. Chit Ranjan Kumar Prashar, M.Sc., Ph.D. 16 December 1967.

Sociology : Shri Suhas Kr. Biswas, M.Sc. (Anthropology), 6 September 1967.

2.9. *Resignations and Retirements* : The following members of the staff left the Institute on the dated mentioned : Shri Subhendu Baksi (*Geology*) : 16 December 1967; Shri Suddhendu Biswas (*Demography*) : 29 July 1967; Dr. Indra Mohan Chakravarti (*R.T.S.*) : 1 September 1967; Dr. H. K. Mazumdar (*Planning*) : 1 July 1967; Shri D. K. Roy (*Administration*) : 30 September 1967; Shri Rabi Sen (*Administration*) : 1 July 1967.

The following workers retired on the dates mentioned : Shri Loken Bose : 31 October 1967; Shri A. V. Narsu : 14 June 1967; Shri Brojo Kishore Sinha : 6 January 1968.

2.10. *Obituary* : We are sorry to record that Shri Jitendranath Taluqdar, a senior worker of the Institute, passed away on 13 October 1967. He came to the Institute in July 1935 at the age of 26. Before joining, he had training for two years in rural research at the Visva- Bharati Institute of Rural Reconstruction, Sriniketan, during 1932-34. After eleven years of service in the Institute he joined the Provincial Statistical Bureau, Bengal, in July 1946, where he served for a little over three years. He came back to the Institute in October 1949 and remained here till his death. After rejoining, he was given charge of the Giridih Branch of the Institute in April 1950, where he stayed for 8 years and was posted back in Calcutta in May 1958.

We are sorry to record the sad demise of Shri S. H. Psaha, Technical Officer, (S. Q. C., Bangalore) on 13 September 1967.

Dr. Bimalendu Roychaudhuri, Head, Geological Studies Unit (*RTS*) who was on extended leave from the Institute in the Geophysics Division, Geological Survey of Canada, died on 20 April 1968 at Ottawa, after a short illness.

2.11. *Review Committee* : It was noted in the Annual Report of 1966-67 that the Review Committee, set up by the Government of India, under sub-section (1) of Section 9 of the Indian Statistical Institute Act (No. 57) of 1959, with Professor Humayun Kabir, M.P., as Chairman, had submitted their report to the Government on 22 December 1966; that the Council of the Institute had set up on 14 January 1967, a Committee of 5 members with Dr. C. D. Deshmukh, as Chairman, for advising the Chairman and the Council of the Institute on matters arising out of the report of the Review Committee. It was also mentioned that a copy of the report of the Review Committee had been received from the Government on 24 April 1967 under their D.O.No.16/1/67-Estt. III of 18 April 1967.

Developments which took place subsequently are being briefly indicated below.

The Government letter of 18 April 1967 desired that "action taken on the report may kindly be intimated to the Government within two months." A meeting of the Council was held on 3 May 1967 when the report and the lines of action were broadly examined. The report along with certain notes prepared by the Administration were submitted to the Deshmukh Committee. The Deshmukh Committee (which consisted of Dr. C. D. Deshmukh, Chairman, Professor P. C. Mahalanobis, Shri Pitambar Pant, Dr. C. R. Rao and Professor B. R. Seshachar) met on 18 and 19 May, 13 June and 24 July 1967 and signed its report on 25 July 1967. This report together with notes on the various subjects raised in the Review Committee's report prepared by Administration, in three parts, were circulated to members. As only a limited number of copies of the Review Committee's report had been sent to the Institute, an attempt was made to obtain an adequate number of copies for being sent to

all members of the Institute. When this attempt failed, the report was cyclostyled and sent to all members at a later date.

The Council of the Institute met on the 19 and 20 August 1967, to consider in details the report of the Review Committee and of the Deshmukh Committee together with the explanations etc. which had been submitted by the Administration. Relevant extracts from the proceedings of these meetings along with copies of Deshmukh Committee's report were printed in the booklet "Review and Reappraisal" and were circulated to all members.

The matter was placed before the Annual General Meeting held on 30 October 1967. As, however, many of the members did not have time to peruse all the papers and copies of the Review Committee's report could not be circulated to them earlier, the Annual General Meeting decided to postpone consideration of the matter till a later date. The matter was accordingly considered at a subsequent General Meeting on 24 January 1968.

The results of all the above considerations may be summarised broadly as follows :

(a) It was felt by the Council that a good deal of the views and criticisms expressed by the Review Committee had been based on incomplete or inaccurate information and inadequate appreciation of the real position in respect of the subjects concerned. This resulted particularly from the fact that the Institute representatives did not get any chance of placing correct and full facts etc. in respect of these matters, at the stage of Review Committee's formulating their report.

(b) In respect of a number of matters, the Review Committee did not give importance to certain parts of their terms of reference or was believed to have gone beyond the terms of reference.

(c) In spite of the above, the Council expressed its appreciation of the desire of the Review Committee and its many helpful recommendations to strengthen and develop the future programme of work and organization of the Institute and accepted quite a large number of their suggestions. Such of these suggestions as could be implemented by the Council without additional finance or further reference to other authorities have already been either implemented or were in the process of implementation when the year ended. The details of these were mentioned in the booklet "Review and Reappraisal."

(d) In respect of the recommendations about the National Sample Survey work, the negotiations and discussions were going on between the Government and the Institute when the year ended. A final decision is expected to be reached during 1968-69.

(e) Recommendations of the Review Committee which are acceptable to the Institute with or without minor change, are intended to be implemented as soon as necessary financial and other facilities become available.

(f) In respect of a few other matters, certain discussions were held with the Government representatives on 6 January 1968 in which agreement was reached in many matters. Further action in these respects were being taken when the year ended.

3. Honours and Awards

In recognition of their exceptional and distinguished service to the country in the field of statistics, Professor P. C. Mahalanobis and Dr. C. R. Rao were awarded the Padma Vibhusan and the Padma Bhushan respectively on the Republic Day, 26 January 1968.

Dr. C. R. Rao served as the (i) Chairman, Demographic and Communication Action Research Committee (from 1968); (ii) Chairman, Indian National Committee on Statistics (from 1962); (iii) Chairman, Advisory Committee on Collection of Data for National Accounts (from 1968).

Professor T. A. Davis (*Crop Science*) was given the G. H. Singhania award of Rs. 200 by the Science and Technology Society, Kanpur, on the basis of his paper on the effect of micronutrients on cocoanut palms, which was judged to be one of the two best articles in biological science for 1966.

Shri G. V. S. Desikan (*Statistical Quality Control*) served on the Committee for the Rehabilitation of Sick Cotton Textile Mills.

Dr. S. L. Jain (*Geology*) was elected Foreign Member, Society of Vertebrate Paleontology, USA.

Shri G. Kalyanasundaram (*Computer Science*) served as a non-official member of the team set up by the Government of India during April 1967 to study the demand for computer facilities in Government and public sector organisations and to recommend sites for installing the Honeywell Computers acquired by the Government.

On the basis of research work done in the Institute, Shri Shanti Bhusan Lodh (*Biochemistry*) was awarded the degree of Doctor of Philosophy (Science) by the Calcutta University.

Dr. B. S. Minhas (*Planning*) was elected to the Council, Econometric Society, New Haven, Connecticut, USA.

Professor M. Mukherjee (*Planning*) was elected President of the Indian Association for Research in National Income and Wealth.

Dr. P. R. Pal (*Biochemistry*) was elected an active member of the New York Academy of Sciences by the Executive Committee of the Academy.

Shri Supriyamohan Sengupta (*Geology*) was admitted to the degree of Doctor of Science (Calcutta University) in August 1967.

Shri S. M. Sundara Raju (*Statistical Quality Control*) served as a member of the Expert Committee to award the Annual Quality Control Shield, on the invitation of the All-India Automobile Ancillary Industries.

4. Conferences and Scientific Tours Abroad

Dr. C. R. Rao left Calcutta on 5 April 1967 for London and attended the induction ceremony to the Fellowship of the Royal Society, on 6 April 1967. He attended, on invitation, the Conference on Craniofacial Growth organised by the University of Michigan (1-3 *May* 1967) and the Symposium on Combinatorial Mathematics and its applications organised by the University of North Carolina at Chapel Hill (10-14 *April* 1967). He presented papers at both the conferences. Dr. Rao gave lectures at the Johns Hopkins University, Baltimore; I.B.M. Research Centre, Yorktown Heights; Courant Institute of Mathematical Sciences of New York; the Ohio State University, Columbus; Purdue University, Lafayette; Michigan State University, East Lansing; and University of Illinois, Urbana; during April 1967, before returning to India. He attended the 36th Session

of the International Statistical Institute Conference at Sydney (28 *August* 1967-7 *September* 1967) and presented a paper, "On vector variables with a linear structure and a characterisation of the multivariate normal distribution."

Shri R. L. Brahamachary (*Embryology*) visited the Staziona Zoologica, Naples, for embryological research work and the University of Makarere, Uganda, Africa (*April–July* 1967). At the latter place, he gave a lecture on "Recent advances in molecular embryology."

Dr. B. C. Das (*Biometry*) went to Iran as a biometric consultant to the University of Tehran, for two weeks in August 1967. He presented a paper at the Symposium on Experimental Gerontology sponsored by the European Research Committee on Biology of the International Association of Gerontology, held at Liblice, Czechoslovakia (28 *November–3 December* 1967), and visited scientific laboratories in Prague. He also visited fishery research centres and agricultural research centres in Belgrade, Skoplje and Zemun, Yugoslavia, from 3–16 December 1967.

Dr. Rhea S. Das (*Appraisal*) attended and presented a paper at the Second International Conference on the Cross-Cultural Generality of Affective Meaning Systems, University of Tehran, Iran (13-30 *August* 1967). She presented a paper at the Symposium on Experimental Gerontology held in Liblice, Czechoslovakia (28 *November–3 December* 1967). She visited the University of Belgrade and the Institute for Experimental Phonetics and Speech Pathology, Serbian Academy of Sciences, Belgrade, Yugoslavia, (3-16 *December* 1967) for the purpose of setting up collaborative research projects.

Dr. S. L. Jain (*Geological Studies Unit*) attended the annual meeting of the Society of Vertebrate Paleontology, New Haven, USA, in November 1967 and gave a lecture on "Dinosaur Digging in India." He also gave a lecture at the Carnegie Museum, Pittsburgh, USA on "Recent palaeontological discoveries by the Geological Studies Unit, ISI", in August 1967. At the invitation of the Carnegie Museum, Pittsburgh, USA, Dr. Jain participated in a six-month programme of visiting museum specialists (1 *March–31 August* 1967). He continued research at the American Museum of Natural History, New York (1 *September* 1967–26 *January* 1968) and at the British Council, London (27 *January–10 February* 1968).

Professor M. Mukherjee (*Planning Division*) attended the International Conference on Research Income and Wealth held at Maynooth, Ireland, (20–26 *August* 1967) and presented two papers. He was co-opted a member of the Council of the Association.

Professor A. Neelameghan (*Documentation Research & Training Centre*) presided over the Classification Session of the Thirty-third FID Conference and International Congress on Documentation held in Tokyo (12-22 *September* 1967). He participated in the joint meetings of the FID/OR and FID/RI and spoke on "Research in Classification".

Shri J. Saha, (*Chief Librarian*) went to the United States for four months (*July–October* 1967) at the invitation of the Rutgers—The State University, to study the information transfer problems and the mechanised information handling systems in the U.S.A. He also visited Japan at the invitation of the Institute of Asian Economic Affairs and delivered several lectures on documentation problems with particular reference to social sciences.

Dr. Supriyamohan Sengupta (*Geological Studies Unit*) participated in the 7th International Sedimentological Congress in Great Britain in August 1967 and presented a paper on "Grain size distribution of Gondwana rocks." He did research work at the Geological Institute of the State University of Groniagen, Netherlands, between September 1967 and February 1968. He also visited some sedimentological laboratories in England, Netherlands and West Germany and participated in short field trips in West Germany and Scotland.

5. Study Tours and Assignments Abroad

Shri Suraj Bandyopadhyay (*Sociology*) left for Canada on one year's leave from 1 September 1967 for higher studies in sociology at the McGill University, Montreal, Canada.

Dr. A. K. Chakravarti (*Planning and Regional Survey Unit, Delhi*) rejoined in June 1967 on completion of his OECD assignment as Adviser on Input-output Techniques with the Turkish State Planning Organization.

Dr. M. R. Chakravartti (*Anthropology*) rejoined on 10 November 1967 after working for about a year and a half at the Institute of Anthropology and Human Genetics, University of Heidelberg, West Germany, under a Von Humboldt fellowship.

Dr. S. Das Gupta (*RTS*) left for the USA on 1 September 1967 to accept an associate professorship at the University of Minnesota, U.S.A.

Shri N. C. Dutta (*National Sample Survey*) rejoined on 1 January 1968 on the termination of his UNTAO assignment as Statistician in Household Consumer Expenditure Surveys, Iran.

Shri S. K. Goswami and Shri Ajit Roy (*National Sample Survey*) left India on 29 June 1967 to attend a six-month Seminar on Administrative Data Processing organised by the International Federation for Information Processing at the Institute of Computer Science in London under the Colombo Plan. The seminar continued up to 15 December 1967 and they rejoined towards the end of the year.

Dr. S. L. Jain (*Geology*) rejoined on 19 February 1968 after spending about a year at the Carnegie Museum, Pittsburg, U.S.A. and the American Museum of Natural History, New York.

Dr. C. G. Khatri (*RTS*) left for the USA on 1 February 1968 to accept a visiting professorship at the Purdue University, Lafayette.

Dr. (Mrs) M. Krishnan (*Madras Centre*) rejoined the Institute on 1 July 1967 after spending three years at the University of New York at Buffalo and the Ottawa University.

Dr. T. Krishnan (*RTS*) left for the U.K. on 1 September 1967 to accept a lecturership at the University of Southampton.

Shir Vinod Prakash (*Planning and Regional Survey Unit, Delhi*) has been on study leave since 21 December 1967 for completing his Ph.D. thesis at the Massachusetts Institute of Technology, USA.

Shri R. Anantha Rao (*Statistical Quality Control*) was selected as one of the two delegates from India to attend the special training programme on installing a quality control

system in an industry organised by the Asian Productivity Organisation (APO) in Tokyo, Japan. The five-week programme commenced from 17 January 1968 and trainees from India, Japan, Hongkong, China (Taiwan), Philippines, Korea, Vietnam, Thailand, Pakistan etc. participated. He left India on 18 January 1968 and returned on 21 February 1968.

Shri K. G. Ramamurthy (*Statistical Quality Control*) who left for the United Kingdom on 30 May 1966 on a one-year United Nations fellowship programme rejoined on 29 May 1967, after the completion of an intensive study of the practical applications of operations research techniques. He had assignments with the operations research groups of the British Iron and Steel Research Association and Messrs Urwick, Orr and Partners; he also worked under Professor Cox at the Imperial College, London.

Shri S. Raja Rao (*National Sample Survey*) rejoined on 1 January 1968 on the termination of his ECAFE assignment as Regional Statistical Adviser on Sampling and Training, Bangkok.

Dr. J. Roy (*Computer Science*) rejoined in September 1967 on the expiry of his one-year assignment in the Pennsylvania State University, and took over charge as the Head, Computer Science Unit, from Dr. B. P. Adhikari. During his stay abroad, he gave invited lectures at the University of North Carolina, the Arizona State University and the Ohio State University. He also visited the IBM Research Centre at White Plains, New York.

Dr. K. R. Saha (*ETS*) rejoined on 6 November 1967 after spending about three years at the University of Michigan.

Shri K. Sankaranarayan (*National Sample Survey*) went to Canada in January 1968 for training in survey methods (including the analysis of non-sampling errors in censuses and surveys) under the Colombo Plan.

Shri B. K. Sarkar (*Statistical Quality Control*) proceeded to the USA on a one-year United Nations fellowship programme for both specialised course work and practical observations in the field of industrial engineering. He left India on 3 December 1966 and returned on 26 November 1967. He attended selected courses at the Georgia Institute of Technology and participated in a programme of work in some important industrial plants.

Shri S. Sen Gupta and Shri N. Das (*National Sample Survey*) left for France on 29 June 1967 for technical training in the Theories of Population Dynamics at the Institut National d'Etudes Demographiques, Paris, under the Indo-French Technical Cooperation Scheme. After the successful completion of the training, they rejoined on 1 April 1968.

Shri N. S. Sreenivasan (*Statistical Quality Control*) left for the United Kingdom on 17 January 1968 on a nine-month fellowship under the Colombo Plan Programme, for undergoing intensive studies in operations research. He has been working with the operations research department of the United Steel Companies, Sheffield, U.K.

Dr. T. N. Srinivasan (*Planning and Regional Survey Unit, Delhi*) was a visiting professor at the Stanford University, USA, throughout the year.

6. Research and Training School

The Research and Training School carried out its activities under the guidance of the Director, C. R. Rao. The Units for applied research and science laboratories attached to the Research and Training School, together with the names of the heads of units, are as follows :

Biswanath Prosad Adhikari (*Anthropology*), Prabhat Ranjan Pal (*Biochemistry*), Bhupendra Chandra Das (*Biometry*), Subodh Kumar Roy (*Botany*), Jogabrata Roy (*Computer Science*), Trupapur Antony Davis (*Crop Science*), Shyamal Kumar Gupta (*Chemistry*), Manapadom Venkateswarier Raman (*Demography*), Ratan Lal Brahamachary (*Embryology*), Ajit Kumar Sinha (*Flood Research*), Sohan Lal Jain (*Geology*), Sibabrata Chatterjee (*Psychometric Research and Service*) and Ramkrishna Mukherjee (*Sociology*).

Subodh Kumar Roy was the Dean of Studies. Asoke Maitra was in charge of the training at the International Statistical Education Centre, Sujit Mitra was in charge of the Summer School and B. Ramachandran, in charge of the Evening Courses.

Dr. (Mrs.) Rhea S. Das, Professor Samarendra Kumar Mitra and Professor Monimohon Mukherjee were respectively in charge of the Appraisal Division, Electronics Division and Planning Division at Calcutta. Dr. B. S. Minhas was the head of the Planning and Regional Survey Unit in Delhi.

The Appraisal Division, Electronics Division, Planning Division at Calcutta and the Planning Unit at Delhi were placed administratively in the Research and Training School with effect from December 1967.

During the year under review, a new diploma course offering specialisation in Quantitative Genetics was introduced. The research and training courses conducted by the Research and Training School in 1967-68 were as follows :

1. *Research Courses*
   - 1.1 Research and advanced studies, general.
   - 1.2 Research leading to the Ph.D. degree.
2. *Degree Courses*
   - 2.1 Four-year course leading to the B.Stat. degree.
   - 2.2 Two-year course leading to the M.Stat. degree.
3. *Specialised Courses in Applied Statistics leading to diplomas.*
   - 3.1. Econometrics and Planning.
   - 3.2 Demography
   - 3.3 Large Scale Sample Surveys.
   - 3.4 Statistical Quality Control.
   - 3.5 Quantitative Genetics.
4. *Summer Course in Statistics*
5. *Training Courses in Statistics*
   - 5.1 Statistical Officer's Training Course (jointly with the Central Statistical Organisation, 6/9 months).
   - 5.2 Special Short-duration individual training for officers on deputation.
6. *Evening Courses*
   - 6.1 Statistical Methods and Applications, at Delhi (in collaboration with the CSO).
   - 6.2 Statistical Methods and Applications, at Hyderabad (in collaboration with the Indian Institute of Economics).

6.3 Statistical Methods and Applications, at Trivandrum (in collaboration with the University of Kerala).

6.4 Statistical Methods and Applications, at Bombay and Madras (by the branch offices) and Calcutta.

6.5 Elementary Techniques of Computation, Calcutta.

7. *Electronic Computer Courses*

7.1 One-year Automatic Data Processing Systems.

7.2 Three-month Intensive Course on Programming and Applications.

7.3 One-year Diploma Course in Computer Science.

8. *Courses at the International Statistical Education Centre, Calcutta* (in collaboration with the International Statistical Institute under a Board of Directors with the representatives of the International Statistical Institute, Indian Statistical Institute and the Government of India).

9. *One-year Training Course in Documentation at Bangalore.*

10. *One-year Diploma Course in Statistical Quality Control*

11. *Diploma and Certificate Examinations* (all-India examinations, open to external candidates).

11.1 Statistical Field Survey, Junior Certificate

11.2 Statistical Field Survey, Senior Certificate

11.3 Statistical Field Survey Diploma

11.4 Computer's Certificate

11.5 Statistician's Diploma

12. *Awards for Higher Professional Attainments*

12.1 Associateship of the Indian Statistical Institute (AISI) on the basis of report submitted, of professional work.

12.2 Associate Fellowship of the Indian Statistical Institute (AFISI) on the basis of report/thesis submitted of professional work.

13. *Awards for Outstanding Contributions*

13.1 D.Sc. degree of the Institute in recognition of outstanding published work in the field of statistics.

13.2 Fellowship of the Indian Statistical Institute for fundamental contributions in the field of statistics.

6.1. Admissions to Degree and Training Courses

The selection tests for admissions to the B.Stat., M.Stat. degrees and post—M.A./M.Sc. research courses leading to registration for the Ph.D. degree, as well as other diploma and certificate courses of the Institute were held in July 1967 at eight centres: Bombay, Calcutta, Delhi, Hyderabad, Madras, Trivandrum, Varanasi and Waltair. The selections of candidates to the courses were made by committees consisting of the representatives of the Indian Statistical Institute, the Institute of Agricultural Research Statistics and the Central Statistical Organisation.

A table showing the number of students admitted to the various courses is given in *Annexure* 3.

6.2. Summer School

The Advanced Summer School for Statisticians (started seven years ago for the benefit of University teachers and research workers desiring to utilise their summer holidays for advanced studies and research) was conducted during May/June 1967 in Bangalore at the premises of the Mysore Veterinary College. The course was inaugurated by Dr. G. Rangaswami, Dean, University of Agricultural Sciences, and lasted for six weeks beginning 15 May 1967. The course was attended by 14 participants from universities and research institutions.

Besides the staff members of the Research and Training School, Dr. K. R. Nair, Director, Central Statistical Organisation, New Delhi, Professor K. Nagabhusana, Andhra University, Waltair, and Dr. R. P. Pakshirajan, University of Mysore, gave courses of lectures.

Two foreign visiting scientists, Dr. D. M. Chibisov and Dr. V. V. Sazanov, Steklov Mathematical Institute, USSR Academy of Sciences, gave a series of special lectures to the participants.

6.3. International Statistical Education Centre (ISEC), Calcutta

The ISEC 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 Twentyfirst Term functioned under a Board of Directions with Professor P. C. Mahalanobis as Chairman.

Thirtyone trainees from twelve different countries in the Middle-East, South-and South-East Asia, the Far East and also from the Commonwealth countries of Africa attended the regular course during the Twentyfirst Term of the International Statistical Education Centre, Calcutta.

The Government of India awarded a total of 27 fellowships for the foreign trainees in the Twentyfirst Term, under the Technical Co-operation Scheme of the Colombo Plan (25), and Special Commonwealth African Assistance Plan (2). In addition, there was a trainee on UNTAO fellowship for a special course on Small Scale Industries Statistics.

The Twentyfirst Term opened on 1 July 1967. The training imparted included lectures, laboratory work, project training, assisted reading and field work. The first three months at Calcutta were devoted to general Statistical Methods including Auxiliary Mathematics, Computational Techniques, Probability Theory, Numerical Mathematics, Sampling Techniques, Economics, Economic Statistics, and Statistical Organization and Procedures. As in the previous terms, a six-week training in governmental statistics was given at the Central Statistical Organization, New Delhi, during the period October–November 1967. From February 1968 up to the end of April 1968, specialization courses on an individual basis were given in the following fields : Large Scale Sample Surveys, Economic Planning, Data Processing, Vital Statistics and Demography. During the second semester of the general course lasting approximately three months, general lectures were also given on Probability Theory, Vital Statistics and Demography, Sampling Theory, Statistical Distributions, Large Scale Sample Surveys with special reference to the National Sample Survey, Advanced Statistical Methods, Analysis of Variance, Elements of the Theory of Design of Experiments, Economic Statistics and Economic Planning. A series of lectures was also arranged for the trainees of this Centre on Electronic Data Processing Systems.

Professor T. Onoyama, Visiting Professor to the ISEC, also delivered a series of lectures to the trainees on Markov Chains.

In the final examinations, 28 trainees of the Regular Course came out successful and were recommended Certificates of Merit, while two were recommended Certificates of Attendance. One trainee had to be repartriated home due to illness.

6.4. Sixth Convocation

The Institute held its Sixth Convocation for awarding the B.Stat., M.Stat. and Ph.D. degrees on 12 February 1968. Certificates were also distributed at this function to the trainees of the International Statistical Education Centre and diplomas to the successful candidates in the Statistician's Diploma and Diploma in Statistical Quality Control, Demography, Planning and Econometrics and Computer Science. National Professor S. N. Bose, F.R.S., the President of the Institute, presided. Shri Subimal Dutt, Vice-Chairman of the Institute, welcomed the guests. Sir Harry Campion, Kt., C.B., C.B.E., the immediate past President of the International Statistical Institute and the former Director, Central Statistical Office, London, delivered the Convocation Address, "Patterns of Development of Economic and Social Statistics." Professor P. C. Mahalanobis spoke on the theme : Unity in Diversity. Dr. C. R. Rao presented the Annual Review of training and research. Professor S. K. Roy, the Dean of Studies, proposed the vote of thanks.

Four candidates were awarded the Ph.D. degree, thirtyfive the M.Stat. degree by examination, four the M.Stat. degree by thesis and twentyone the B.Stat. degree. Three candiates were awarded the Diploma in Computer Science, four in Demography, two in Econometrics and Planning and seventeen in Statistical Quality Control. Besides these, eight candidates were awarded Associateship in Documentation Research and Training. The Statistician's Diploma and Diploma in Punched Card Data Processing were awarded to three candidates and one candidate respectively.

Certificates were awarded to thirty students of the International Statistical Education Centre.

The complete proceedings of the Sixth Annual Convocation held on 12 February 1968 with texts of speeches are given in *Annexure* 4.

A list of papers published and papers sent for publication is given in *Annexure* 5.

7. Visiting Scientists

A number of distinguished foreign scientists participated in the research, training and other scientific activities of the Institute during the year. Some of them came to the Institute on invitation, some came under the different cultural exchange programmes and spent fairly long periods at the Institute to assist in the regular work, while others came for short periods and gave lectures and seminars. Most of them were available for consultations by research workers and teachers of the Institute.

I. The following scientists visited the Institute on invitation and worked for fairly long periods during the year.

1. Professor George Akerlof, University of California, Berkeley, USA (Arrived 17 *August* 1967) came to the Institute partly on a Fulbright Fellowship and partly on a Ford

Foundation grant. He is doing research in the Planning Unit, Delhi, on "Macro-economics" and "Project evaluation." He is also participating in the teaching programme of the Institute in Delhi.

2-4. The following delegation of three Soviet scientists from the USSR Academy of Sciences came to the Institute : (i) DR. L. B. ALAYEV, Senior Research Worker, Institute of Peoples of Asia, (*Arrived* 18 *January* 1968); (ii) DR. N. E. BRUSILOVSKY, Vice Director, "NAUKA" Publishing House, (13 *February*-6 *March* 1968); and (iii) DR. OLEG K. DREYER, Director, Oriental Literature Publishing House, (13 *February*-6 *March* 1968). They had important negotiations relating to a joint project in collaboration with the Soviet Academy, for which they visited the Institute centres in Bombay, Bangalore, Delhi, Madras, and Trivandrum.

5. SIR HARRY CAMPION, Kt., C.B., C.B.E., immediate past President, International Statistical Institute and former Director, Central Statistical Organisation, London (7-21 *February* 1968). He addressed the Sixth Annual Convocation of the Institute on "Patterns of Development of Economic and Social Statistics."

6. DR. VIOLET CANE, University of Cambridge, U.K. (3-17 *May* 1967). A course of three lectures : (i) The use of "Jack-Knife" in the removal af bias (ii) Approximate solutions of the epidemic model, and (iii) Leucocyte kineties as a clue to leukemia.

7. DR. L. L. CAVALLI-SFORZA, Institute of Genetics, University of Pavia, Italy (1-7 *August* 1967). *Lectures* : Statistical problem in the reconstruction of evolutionary processes.

8. PROFESSOR J. L. DOOB, Department of Mathematics, University of Illinois, USA, and Member, United States National Academy of Sciences, was accompanied by his wife Dr. (Mrs.) Elsie Field. (17 *July*-23 *August* 1967). During his six-week stay in India, Professor Doob gave an advanced course of 25 lectures on "Probability and potential theory." Dr. Field, an expert in the field of family planning, participated in the symposium on family planning conducted by the Regional Family Planning Training Centre, Government of West Bengal.

9. Dr. D. J. FINNEY, F.R.S., Department of Statistics, University of Edinburgh, U.K. (27 *December* 1967-14 *January* 1968). During his stay in Calcutta, he had discussions with the heads of science units and members of the teaching staff. In Delhi, he met the Prime Minister and the Cabinet Secretary. He prepared a detailed report on the teaching, research and other activities of the Institute. *Lecture* : Problems of Selection.

10. DR. R. L. KIRK, John Curtin School of Medical Research, Australian National University (2-15 *December* 1967). He prepared a report on some new lines of research in Human Genetics which could be undertaken at the Institute. *Lecture* : Problems of Human Genetics.

11. PROFESSOR STEPHEN A. MARGLIN, Harvard University, Cambridge, U.S.A., (*Arrived* 12 *September* 1967) is on a visit to the Institute on a Ford Foundation grant and is doing research on the "optical use of irrigation water." He is also participating in the teaching activities of the Institute in Delhi.

12. DR. (MRS.) P. NAIDENOVA, Scientific Collaborator, Institute of Economics, Bulgarian Academy of Sciences, had come to the Institute in December 1966, to study the

techniques of large-scale sample surveys developed at the Institute and other centres in India. She continued her stay up to 7 June 1967. During the current year, she gave lectures on (i) Input-output analysis, and (i) Economic development of Bulgaria in recent times.

13. DR. T. ONOYAMA, Tsuda College, Tokyo (16 *January*–2 May 1968) came as a Visiting Professor at the ISEC. He gave a series of seminars on "Time changes in flows."

14. DR. P. L. ROBINSON, University College, London (20 *July*–18 *August* 1967) visited the Institute for the first time in 1957. Since then, she has been coming periodically to advise the workers of Geological Studies Unit. During the current year, she paid a short visit to help in arranging the field programme for the current year and in planning future research work.

15. DR. H. L. SHAPIRO, Chairman, Department of Anthropology, American Museum of Natural History; Member, National Academy of Sciences, USA (12–25 *August* 1967). He assessed the progresses of the project initiated by him during one of his earlier visits to study the effect of urbanisation on human physiology, as an indication for increased levels of tension in the human system. He has suggested further investigations which are being undertaken by the Anthrolopogical Research Unit of the Institute.

16. ACADEMICIAN IVAN STEFANOV, Institute of Economics, Bulgarian Academy of Sciences (14 *September*–29 *November* 1967). During his two and a half month's stay in India, he visited the Institute centres in Calcutta, Bangalore, Bombay, Delhi, Madras and Trivandrum and held discussions with the staff members on problems relating to economic growth, demography, indices of agricultural productivity, etc. Academician Stefanov also delivered lectures on statistical, demographic and economic topics at the various places he visited. He conducted lectures and seminars on (i) Sampling practices in Bulgaria, (ii) Main flows of internal migration in Bulgaria, (iii) General characteristics of the Bulgarian economy before the Second World War, (iv) Structural changes in the Bulgarian economy after the Second World War, (v) Methodological problems of statistics of internal migration (vi) Economic growth and structural changes in developing countries, (vii) Problems of internal migration.

17. PROFESSOR R. L. M. SYNGE, Nobel Laureate, F.R.S., Rowett Research Institute U.K. (29 *June*–7 *July* 1967). This was Dr. Synge's third visit to the Institute. He helped the Institute to develop research work on plants and soils for increasing food production.

18. MRS. ALICE THORNER, Ecole Pratique des Hautes Etudes, France, (27 *December* 1967–22 *January* 1968). She conducted seminars on "Problems relating to labour force, census and allied subjects."

19. DR. D. THORNER, Director of Studies, Ecole Pratique des Hautes Etudes, France, (30 *July*–24 *September* 1967). He discussed problems of agriculture with the staff members of the Planning Unit. *Lecture*: (i) Advanced sector in Indian agriculture, (ii) Capitalist agriculture in India: prospects and obstacles.

20. DR. THOMAS E. WEISSKOPF, Harvard University, Cambridge, USA, who worked during the year in the Planning Unit (Delhi), had arrived in India on 24 September 1966. He has been teaching economics to trainees and also doing research on planning models and input-output analysis. During the current year, he gave a seminar on "Domestic savings and foreign exchange constraints on Indian economic development."

II. The following is a list of scientists and scholars who visited the Institute under different cultural exchange programmes. A brief description of their activities is given against each name.

21. Dr. V. A. Avrejanov, Chief Engineer, Ministry of Precision Instruments, Bylorussian Soviet Socialist Republic; United Nations expert on magnetic core memory devices (31 *January*–1 *August* 1967). He advised on the techniques of testing of magnetic cores and fabrication of core memory planes. An automatic core sorting machine was designed under his guidance.

22. Dr. A. L. Batalov, Institute of Peoples of Asia, USSR Academy of Sciences (*Arrived* 18 *January* 1968). He is an expert in Indian industrial development, and visited many important places in India to study industrial location in India (Indo-Soviet Cultural Exchange Programme). *Lecture*: Industrial development of India and Russia.

23. Dr. Elena A. Braguina, Senior Scientific Assistant, Institute of World Economics and International Relations, USSR Academy of Sciences (5 *December* 1967–3 *January* 1968), (Indo-Soviet Cultural Exchange Programme).

24. Dr. D. M. Chibisov, Steklov Mathematical Institute, USSR Academy of Sciences (16 *May*–26 *October* 1967). He did scientific work on Non-Parametric Statistics and gave lectures at the Seventh Summer Course in Statistics, Bangalore (Indo-Soviet Cultural Exchange Programme). *Seminar*: Limits of empirical distribution functions.

25. Dr. S. A. Kuemin, Economic-mathematical Institute, USSR Academy of Sciences (25 *April*–28 *June* 1967). He had discussions with the staff members on economic and mathematical problems (Indo-Soviet Cultural Exchange Programme).

26. Dr. T. S. Pokatayva, Institute of World Economics and International Relations, USSR Academy of Sciences (21 *November* 1967–22 *May* 1968). She studied the socio-economic changes associated with urbanization. For this purpose, she visited Poona, Hyderabad and Madras (Indo-Soviet Cultural Exchange Programme). *Lecture*: Education in the USSR.

27. Dr. V. V. Sazanov, Steklov Mathematical Institute, USSR Academy of Sciences (16 *May*–26 *October* 1967). (Indo-Soviet Cultural Exchange Programme). *Lectures*: (i) Multidimensional-central limit theorem (ii) A course of four lectures on probability measures on topological groups. He also lectured in the Seventh Summer Course in Statistics, Bangalore, and at the S.Q.C. Unit, Madras.

28–30. Three Soviet scientific workers of the Peoples' Friendship University, Moscow, namely (i) Dr. Galenko Zhanna Georgievna (Biological science), (ii) Mr. Kuchkerenko Nikolai Egorovich (Agricultural science), and (iii) Mr. Fudin Arkadi Fedotovich (Economical science) arrived in Delhi on 23 January 1968 and in Calcutta on 24 January for three-months' training in their respective subjects at the Institute. They left Delhi for Moscow on 24 April 1968. (Indo-Soviet Cultural Exchange Programme).

III. The following scientists paid short visits and gave lectures and/or seminars:

31. Dr. Krishna B. Athreya, Stanford University, USA (21 *June* 1967) *Lecture*: Limit theorems for Markov branching processes and some classical Urn schemes.

32. Dr. A. P. Basu, University of Wisconsin, USA (21 *August* 1967): *Lecture*: Some rank tests based on censored data.

33. Dr. R. Bhattacharya, University of California, Berkeley, (26 *July* 1967) *Lecture*: Berry-Esseen bounds for the multidimensional central limit theorem.

34. Dr. (Miss) Estelle Brodman, Librarian and Professor of Medical History, Washington University, School of Medicine, St. Louis, U.S.A.; United Nations expert on documentation at the Central Family Planning Institute, Delhi (5 *January* 1968). *Lecture* (at the DRTC, Bangalore): Trends in documentation in the United States.

35. Professor W. Brus, Faculty of Economics, Warsaw University (26 *March*-6 *April* 1967) *Lecture*: Some recent trends in Polish economic thought.

36. Dr. I. M. Chakraborty, University of North Carolina, USA (4 *September* 1967) *Lecture*: On some combinatorial composition and extension methods.

37. Dr. S. D. Chatterjee, Department of Mathematics, Kent State University Ohio, USA. (7-8 *September* 1967): *Lecture*: Smoothness of Bernoulli convolutions.

38. Mr. Vikas Chitre, University of Toronto, Canada (21 *September* 1967) *Lecture*: A dynamic programming approach to the demand for money.

39. Dr. J. Douglas Carroll, Bell Telephone Laboratories, New Jersey, U.S.A. (31 *March*-2 *April* 1968); accompanied by Mrs. Carroll. *Lecture*: Multi-dimensional scaling.

40. Dr. G. A. Evans, Director of Libraries, British Council, India (5 *January* 1968). *Lecture* (at the DRTC., Bangalore): Contact Libraries.

41. Dr. Donald Ferguson, School of Library Science, University of California, U.S.A. (13 *January* 1968). *Lecture*: Document retrieval by machine.

42. Professor Max Hamilton, Nuffield Professor of Psychiatry, University of Leeds, U.K.; accompanied by Mrs. Hamilton (9 -14 *August* 1967). *Lecture:* Applying statistical methods to psychiatry: some problems.

43. Dr. K. Ishikawa, Faculty of Engineering, University of Tokyo, Japan (6-14 *December* 1967), international expert on quality control, participated in the All-India Conference on Quality Control, Madras, organised by the Indian Statistical Institute. He presented papers of basic importance with valuable suggestions for the growth of SQC in India at top-management group discussions organised in Bangalore and Calcutta. He also had discussions with the technical staff of the SQC Division.

44. Dr. N. Kaldor, King's College, Cambridge, U.K. (6-12 *July* 1967) He held useful discussions on issues relating to planning of economic development. *Seminars*: (i) Some issues of public finance relating to economic development, and (ii) Growth and distribution.

45. Dr. P. Kirkegaard, Royal School of Librarianship, Copenhagen, Denmark (24 *December* 1967). Lecture (at the DRTC., Bangalore); Library education in Denmark.

46. Professor Edwin Kuh, Massachusetts Institute of Technology (13 *July* 1967). *Lectures:* Planning models and fiscal policy moels.

47. Dr. Herman Liebaers, Chief Librarian, Royal Library, Belgium (23 *December* 1967). *Lecture* (at the DRTC., Bangalore): Library system.

48. Dr. L. I. Lukin, Institute of Peoples of Asia, USSR Academy of Sciences (9 *March* 1968). In a seminar organised by the Planning Division, he discussed the co-ordination of Plans of socialist countries.

49. Professor Alan S. Manne, Stanford University, USA (15 *April* 1967). *Lecture:* A model of aid requirements and self reliance for the Indian economy.

50. Mr. Frank Nixon, Chief, Quality and Reliability Engineering, Rolls Royce, Derby, U.K. (1–14 *December* 1967), international expert on quality control, took part in the All-India Conference on Quality Control, Madras, organised by the Indian Statistical Institute. Papers of basic importance with valuable suggestions for the growth of SQC in India were presented by him at top-management group discussions organised in Bangalore and Calcutta. He also had discussions with the technical staff of the SQC Division.

51. Professor Satoki Ninomiya, Aoyamagakuin University, Tokyo. (4 *August* 1967) *Seminar*: The structure of ALGOL and natural language.

52. Academician V. Obolkin, USSR Academy of Sciences. (26 *October* 1967) *Lecture*: Economic development of the USSR during the last 50 years.

53. Professor M. L. Puri, Courant Institute, New York, USA (8 *September* 1967). *Lecture*: Non-parametric procedures in multivariate analysis.

54. Professor D. K. Roychoudhuri, Ohio University, USA (2–5 *August* 1968). *Lecture*: Characterisation of line graph II.

55. Professor M. A. Stephens, McGill University, Montreal Canada (27–30 *September* 1967). *Lecture*: Distributions on the circle and the sphere.

56. Dr. S. R. S. Varadhan, Courant Institute, New York (31 July 1967). *Lecture*: Diffusion processes.

57. Dr. E. Weber, Faculty of Agriculture, University of Kiel, West Germany (22–27 *September* 1967). *Lectures*: (i) Transformation of frequency distributions with the acid of the third moment and its application in path analysis, (ii) Interpretation of the results of MANOVA by computer plotting programmes, (iii) Selection of regressors in multiple regression analysis with the aid of the least standard deviation of residuals.

58. Dr. Niklaus Wirth, Assistant Professor, Computer Science Department, Stanford University (20-22 July 1967). *Lectures*: (i) Syntactic grammar for algorithm languages for computers, (ii) Compiler construction and precedence grammars.

IV. The following visitors from abroad came to the Institute during the year. The date of visit is mentioned within brackets against each name :

59. Mr Irwin Grossaug, Programme Economist, US Agency for International Development, New Delhi (28 *March* 1968).

60. Mr. Alexander Kessler, Chief, Human Reproduction Unit. World Health Organisation, Geneva (13 *September* 1967).

61. Mr. E. Lunenberg, International Statistical Institute, The Hague (16–18 *August* 1967).

62. Professor Rainer Mackensen, Department of Sociology, University of Münster, Federal Republic of Germany (13–15 *August* 1967).

63. Mr. William H. May, Research Assistant Professor, University of Illinois, U.S.A. (11–12 *September* 1967).

64. Mr. T. B. Morgan, Nutrition Division, Food and Agricultural Organisation (24 *January* 1968).

65. Dr. E. C. K. Peach, Department of Geography, University of Oxford, U.K. (2 *August* 1967).

66. Dr. Yukie Shibuya, Professor of Econometrics, Waseda University, Japan, (5–6 *January* 1968).

67. Dr. Francois Van Honk, Head of Training Division, Organisation for Economic Co-operation and Development (O.E.C.D.) Centre, Paris (16 *January* 1968).

68. Dr. M. J. Weber, Department of Geography, Australian National University (22–29 *January* 1968); accompanied by Mrs. Weber. *Seminar :* Locations Theory.

8. Professional Examinations

Holding of Professional Examinations : The following examinations were held during the year : all the three professional diploma examinations —Statistician's Diploma (SD), Statistical Field Survey Diploma (SFSD), and Punched Card Data Processing Diploma (PCDPD) examinations and all the three certificate examinations—Computer's Certificate (CC), Statistical Field Survey Certificate, Senior (SFS–Sr.) and the Punched Card Machine Operator's Certificate (PCMOC). The field examinations were held exclusively during the November session. No candidates were available for the Junior Certificate examination.

The examinations were held in the following centres : Bangalore, Bombay, Calcutta, Delhi, Giridih, Lucknow and Madras. No examinations were, however, held in Bangalore during the November session, for lack of sufficient response.

The May 1967 session examinations were held during 17 May to 29 May and the 1 November 1967 session examinations were held from 6 November to 18 November. The November examinations were brought forward by about two weeks, primarily to meet the needs of the Indian Statistical Service examinees.

Statistician's Diploma Examination : During 1967, 183 candidates registered (99 in May; 84 in November), compared with 209 (92 in May; 117 in November) in 1966. Twenty-five candidates were absent through in 1967 (14 in May; 11 in November), compared with 30 in 1966 (7 in May; 23 in November). Of those who finally appeared, 70 candidates (40 in May; 30 in November) passed in one or more papers in 1967, compared with 107 candiates (50 in May; 57 in November) who passed in one or more papers in 1966.

Statistical Field Survey Diploma Examination : The two candidates who registered also appeared and both passed in one or more papers in November 1967. One candidate was, however, allowed to submit a dissertation in lieu of the written paper SFSD (IV). He was not declared successful.

Punched Card Data Processing Diploma Examination : Only one candidate who registered and also appeared in May, qualified for both the papers in which he was examined. In November 1967, two candidates registered and appeared for this examination, and both passed in the papers for which they had registered.

Computer's Certificate Examination : During 1967, 17 candidates registered (11 in May; 6 in November), compared with 28 (14 in May; 14 in November) in 1966. One candidate failed to appear in any of the papers in 1967 (1 in May; nil in November). Of the candidates who finally appeared, 11 passed in one or more papers in 1967 (6 in May; 5 in November), compared with 11 who passed in one or more papers in 1966 (5 in May; 6 in November).

Statistical Field Survey Certificates—Senior only : There was only one candidate for the Senior Certificate Examination, while no candidate registered for the Junior Certificate Examination. This candidate qualified in both the papers for which he had registered.

Punched Card Machine Operator's Certificate Examination : The examination was not held in May as no candidate had registered. One candidate registered, appeared and passed in three papers of this examination during November 1967.

Candidates qualifying for Diplomas and Certificates : The total number of candidates who qualified for the award of diplomas and certificates during 1967, having completed the entire examination during the year, were 10 (3 in May; 7 in November) for the Statistician's Diploma, 1 for the Statistical Field Survey Diploma in November, and 3 (1 in May; 2 in November) for the Punched Card Data Processing Diploma Examination.

The following number of candidates qualified on the same basis for the Computer's Certificate Examination (2 in May; nil in November); Statistical Field Survey Senior Certificate examination (1 in November). No candidates could appear at Punched Card Machine Operators' Certificate examination and complete all the papers during May and November 1967.

Award of Diplomas : Fourteen diplomas for the professional statistical examinations (10 Statistician's Diploma, 1 Statistical Field Survey Diploma and 3 Punched Card Data Processing Diploma) were awarded at the Sixth Convocation of the Indian Statistical Institute held on 12 February 1968.

The list of successful candidates under different categories during May and November 1967 examinations are given in *Annexure* 4.

9. Planning Division

The Planning Division in Calcutta and the Planning Unit in Delhi were placed administratively in the Research and Training School (RTS) with effect from 18 December 1967.

9.1. *Planning Division, Calcutta :* The work in the Planning Division, Calcutta, during the year included research, teaching, seminars, discussions and some other activities. Research was mainly confined to national income and allied topics, econometric studies, applied economics and other studies. A brief research summary is given separately.

Eighteen seminars and lectures on scientific topics were organised in the Planning Division during the year. Among the foreign experts who took part, particular mention may be made of: 1. Professor W. Brus, Faculty of Economics, Warsaw University, 2. Dr. S. A. Kuzmin, Economic-Mathematical Institute, USSR Academy of Sciences, 3. Academician V. Oboltion, USSR Academy of Sciences, 4. Academician Ivan Stefanov, Institute of Economics, Bulgarian Academy of Sciences and 5. Dr. Daniel Thorner, Ecole Pratique des Hautes

Etudes, Paris. Courses of lectures on econometrics and other selected topics were given by the members of the staff.

As in previous years, the Planning Division, Calcutta, shouldered the bulk of the responsibility of teaching economics and econometrics in the Research and Training School, and the International Statistical Education Centre. The courses include the B. Stat. and M. Stat. degree courses, Statistical Officers' Training Course, the Statistical Courses of the ISEC and the One-Year Evening Course for Statisticians. The Division shared with the Delhi Planning Unit the responsibility of the specialization course in planning and econometrics for the second-year M.Stat. students and also of the new diploma course in planning and econometrics. Apart from organising lectures and practical lessons for the above courses, arrangements were made for intensive specialization for the ISEC students and for project work leading to dissertations for students of the M.Stat second year and the Diploma Course. Research supervision also continued to be an activity of the Division. Besides papers published and sent for publication (*Annexure* 5), twentytwo working papers and technical notes were also prepared.

A new series, *Students Quantitative Economics*, was started recently for publication in a mimeographed form selected working papers prepared in the Division, with the object of having a wider circulation among research workers and institutions.

Seven workers participated in conferences and seminars held during the year. The Division helped in organising the Seventh Econometric Conference held at the Gokhale Institute of Politics and Economics, Poona, in November 1967.

A small Field Unit maintained mainly for methodological enquiries carried out, some time back, a survey on employment and attitude to registration in Calcutta.

9.2. *Planning and Regional Survey Unit (PRSU), New Delhi :* The fields of research covered in Delhi were related to the structure of the Indian economy, planning models and investment, agriculture, studies on regional development, consumption, etc. A number of foreign experts who were associated with the research work also took part in teaching and gave special lectures and seminars. Particular mention may be made of the following :

1. Professor George Akerlof, University of California, U.S.A.; 2. Dr. N. Kaldor, King's College, Cambridge; 3. Professor Stephen A. Marglin, Harvard University, U.S.A.; 4. Dr. M. J. Weber, Department of Geography, Australian National University; and 5. Dr. Thomas E. Weisskopf, Harvard University, U.S.A.

Several articles dealing with the planning experience of other countries and development techniques were translated into English from Russian and French. Ten M.Stat. and Diploma (in Econometrics and Planning) students were under training for a eight-month course and most of the senior workers and visiting professors participated in the teaching. The teaching programme of the One-year Evening Course in Statistics was conducted by the PRSU and 35 students were on training in the current session.

Structure of the Indian Economy, Planning Models and Investment : The studies relating to inter-industries were continued. "A Dynamic Multisectoral Programming Model for India" was formulated and applied to a 37-sector input-output description of the Indian economy. This work represents a further development of the earlier study, "A Programming Model for Input Substitution in India" published in the *Sankhyā* (Series B, December 1967).

Experiments with dynamic multisectoral planning models were conducted in order to investigate alternative growth patterns available to the economy. A capital structure matrix for India with 150 sectors and 50 capital components from India and U.S. data has been under preparation.

A project on the estimation of gestation lags of investments in Indian industries was undertaken. Time series data on capital formation and gross outputs in a large number of Indian industries are being tapped to investigate the lags between different types of investments and the creation of capacity (ASI, SSMI, CMI data are analysed for this purpose).

Agriculture : A comparative study of the crop-output growth in India and Pakistan during the period 1951-52 to 1964-65 was carried out and a paper on this subject is under preparation. The growth experience of the Package Programme districts is being analysed and the results will be available shortly.

The work on the response of crops to different plant nutrients has been progressing satisfactorily. Experiments were made with different ways of estimating these response functions and the data from farmers' fields as well as experimental farms have been utilised for this purpose. Economics of fertiliser use has been under study and a paper on "Risk and Returns in Fertiliser Use" is under preparation.

A new line of work in the area of economic efficiency of irrigation water was undertaken during the year. A preliminary survey of technique for estimating the water requirements of crops and available data was prepared and is available in the Discussion Paper "Water Requirements of Crops and Efficiency of Irrigation Water in India."

Since September 1967, a team of research workers of the Planning Unit have been investigating the problem of scheduling the operation of the Bhakra system. A detailed description of this project is available in our working paper No. 28, entitled "Scheduling the Operations of the Bhakra System : A Research Prospectus."

Studies on Regional Development : A report on "Cement Industry—A case study in National and Regional Perspectives, 1967" was published in the *Bombay Geographical Magazine*, November 1967. Studies on regional patterns and variations in resource structure are in progress. A number of maps relating to important industries and inter-regional flow of goods were prepared during the course of these studies.

As a part of the study on the evaluation of agricultural land-use potential by regions, a study was made of regional variations in natural environment. Distinct regional physical complexes were identified in terms of groups of districts. A preliminary report on this study was prepared and circulated.

A study on regional characteristics and variations in cropping pattern is in progress with a view to elucidate the concept of core and peripheral areas of major crop-associations on the evaluation of crop production potential and the break-up of national targets of production on a regional basis. A working paper was prepared to high-light the approach.

Regional demand projections for various commodities for 1970-71 and 1975-76 under various alternatives were made and published in the *Indian Economic Journal*, 1967.

Economics of Social Services and Employment: The investigations aimed at forecasting the demand for manpower and educational requirements in the economy continued. The survey of the fertilizer industry in the country undertaken in this connection was completed. All the major nitrogenous fertiliser plants have been covered. The work was carried out in collation with the Perspective Planning Division and the London School of Economics. The data obtained from the survey, being tabulated at London, are expected to be received shortly. A final report would be written as soon as the tabulated data are received.

Consumption: A good deal of progress was made to obtain projection of consumption on per head basis, in constant rupees of 1960-61 relating to the year 1970-71 and 1975-76, Rural/Urban India. Some results of this research were presented to the Seventh Econometrics Conference, Poona: November 10-12, 1967.

10. National Sample Survey

National Sample Survey Project: This Division of the Indian Statistical Institute functions as the technical wing of the Government of India's National Sample Survey Organisation.

The twenty-second round of the regular Socio-economic Survey and the Annual Survey of Industries for the years 1965 to 1967 were in operation during the period under review. About eleven different country-wide enquiries were conducted in the socio-economic surveys. The special integrated schedule covering all economic aspects of a household was again included in the current year's programme. A new survey on farming practices was started this year. A special schedule was prepared by copying down selected items from various schedules for a quick tabulation.

The activities of the Division covered the following types of work during the year:

(a) the statistical planning of the surveys including sample designs, concepts and definitions, methods of collecting primary information, selection of sample villages and urban blocks, preparation of schedules of the different enquiries, training of field workers and technical work relating to field enquiries;

(b) programme of statistical processing and the laying down of detailed specifications;

(c) conducting the field work in the State of West Bengal and the city of Bombay, together with experimental researches for the improvement of sample designs and techniques; and

(d) the processing of the NSS data and the preparation of the statistical reports.

The processing and tabulation work covered data collected in the seventeenth to twenty-second rounds of Socio-economic Surveys, the Annual Survey of Industries, 1962 to 1965, and the PCS (Livestock).

The tabulation and processing work was carried out in Calcutta (Baranagar), Delhi and Giridih. The number of schedules scrutinised was a little more than five lakhs, the number of cards punched was about 48.6 lakhs and there were about three-crore card passages.

The equipment consisted of seventeen tabulator units with necessary auxiliary machines, of which eight units were at Calcutta, five at Delhi and four at Giridih.

The field survey of the twentyfirst round (NSS) in West Bengal was completed in June 1967 and that for the twenty-second round which commenced in July 1967 is still in progress. The survey for Farm Practices were taken up in October 1967 and the requisite data have been collected from 2/3 of the villages selected for crop-cutting experiments.

Out of 34 of the commitments of the NSS Programme of Work Committee to the Government of India in respect of end -results, 28 were duly completed within the period under review and the remaining six are nearing completion.

The work on planning, sample designing and sample selection for the twenty-third round (NSS) has already been taken up. The discussions and studies were conducted in this round, specially with a view to undertake a large-scale sample survey on small-scale manufacturing enterprises. The time standards obtained on the basis of the twenty-first round time-record analysis were used in programming for the twenty-third round. The sample selection for the Annual Survey of Industris (ASI), 1966, was completed and the processing of the investigator's time-records for the ASI is in progress.

A joint study by the Indian Statistical Institute and the Registrar General's Office was undertaken in 92 villages of West Bengal to study the response error in birth and death reporting.

Seminars : Eight well-attended seminars of general interest were undertaken by the NSS staff members. Two foreign visitors Academician I. Stefanov and Dr. (Mrs.) P. Naidenova of Bulgaria delivered lectures on sampling practices followed in their country. Some specialised seminars on selection and estimation problems in sample surveys were held with Shri T. J. Rao and Shri M. P. Singh as the main speakers.

Training : The one-year course in sampling theory and sample survey methods undertaken last year for three United Nations trainees (two from Burma and one from Ethiopia) was completed druig this period. The training programme in survey techniques was arranged for research apprentices of the RTS, statistical officers from Government departments and the trainees of the International Statistical Education Centre (ISEC). A specialisation course in lare-scale surveys were conducted for the ISEC trainees. Regular classes on sampling theory were taken for the B.Stat. course of the RTS.

Some of the senior staff attended meetings of the advisory committees related to NSS work and programme, participated in regional training conferences and also took part in all-India econometric and agricultural conferences, where they read papers.

The technical staff prepared fourteen technical papers, five technical notes and five working papers.

Three reports were printed and twenty draft reports were submitted to the Government of India (*Annexure* 6).

A list of papers published and those sent for publication by staff members is given in *Annexure* 5.

11. Appraisal Division

During the period under review, the psycho-linguistic research project was extended to include psycho-phonetics, in particular, accoustic phonetics and phonologic structure of language. In addition to providing new areas for the application of statistical methods,

acoustic phonetics and phonologic are important for investigating the psychology of language, and for scientific speech rehabilitation of deaf and hard-of-hearing individuals. To date, the following work has been completed :

(i) The analysis of vowel interrelationships in Serbo-Croation language, (ii) A phonetic characterisation of the Bengali language; (iii) Recording of infant birth cries as the first step in tracing the development of the acoustic phonetics of the Bengali language, and (iv) Determination of the structure of effective meaning in the Bengali language.

Work is underway on statistical models of the phonologic structure of language; and on the accoustic phonetics of Bengali as spoken by adults. To further this research programme, preliminary arrangements have been made for the exchange of research professors between the Indian Statistical Institute and appropriate institutions in Yugoslavia. Research has also continued on the following topics requiring an integration of statistical and psychological methods : (i) Theoretical and practical problems in the application of sampling theory to the construction of psychological tests and educational examinations; (ii) Changes in psychological attributes as a function of age.

12. Electronics Division

The Institute has been a pioneer in the field of electronic computers. The Electronics Division of the Institute had designed and constructed the first electronic computer in India in 1953, an account of which was published in the *American Review of Scientific Instruments* in 1955. The Institute also installed the first electronic computer in India (British HEC 2M) in 1956 and the second computer in India, the Soviet URAL, received as a gift from the USSR through the United Nations in 1959.

In 1961, a scheme was drawn up in collaboration with the Jadavpur University for computer development. The ISI-JU Joint Computer Project was for building two computers, the first in the Jadavpur University and the second in the Indian Statistical Institute. As a result of this collaboration, a modern solid state computer was designed and built in the Jadavpur University by the joint efforts of the workers of the Institute and the University. This was commissioned by the Minister of Education on 2 April 1966.

The ISIJU-1 computer has been working satisfactorily. An important problem for the planning of electricity distribution in a power grid sent by the State Electricity Board was solved satisfactorily. A number of smaller research problems received from scientific institutions were also solved. The remaining work for the project is being completed according to schedule. Two twenty-feet masts and the VHF antenna for the radio data-link between the Jadavpur University and the Institute have been designed and constructed in the ISI machine shop.

Mr. V. A. Averjanov, Chief Engineer, Ministry of Precision Instruments, Bylorussian Soviet Socialist Republic and United Nations expert on magnetic core memory devices, worked in the Electronics Division for six months, in an advisory capacity.

Research : Both theoretical and experimental research was conducted and among the different types of research carried out in the Division may be mentioned the following :

A. *Theoretical Research :* 1. Linear Electrical Network Theory; 2. Numerical Analysis; 3. Particle Physics.

B. *Experimental Research :* 1. Pattern and spoken word detection and recognition; 2. Development of hardware for computers.

A list of papers published and sent for publication is given in *Annexure* 5.

13. Documentation Research and Training Centre (DRTC), Bangalore

The important features of work done in the Documentation Research and Training Centre (DRTC) during the year included the following :

i) *Teaching Technique in Documentation :* The training of persons in advanced methods of documentation was continued. The use of a modified Case Study Method for teaching Reference Service and a useful method for assessing the grasp of the principles and techniques of cataloguing by the students, were successfully experimented.

ii) *Promotion of Research in Library Science :* The need for, the different kinds of, the helpful methods adaptable to, and the preparation necessary for, research in library science were elaborated. The research done and a list of problems for research on the Structure and Development of the Universe of Subjects and in Classification were outlined.

Research : The broad lines of research were as follows :

(i) *Universe of Subjects : Its Structure and Development :* (a) Laws of Library Science as Basis, (b) Density of Seminal Contributions, (c) Incidence of Facets, (d) Kinds of Bonds between two main subjects (ii) *Classification :* (a) Design and Development of Schedules, (b) Common Property Isolates, (c) Principles of Facet Sequence, (d) Tool Phase, (iii) *Cataloguing :* (a) Revision of Rules, (b) Class Index Entry.

During the period, the staff contributed 125 articles to the periodicals in Library Science. A list of articles published and sent for publication is given in *Annexure* 5.

Publications : The revision of the book, *Cataloguing : Fundamentals and Procedure*, by S. R. Ranganathan, assisted by G. Bhattacharyya, was completed. The revision of the book, *Physical Bibliography*, by S. R. Ranganathan, assisted by A. Neelameghan, was completed.

A book entitled, *Free Book Service for All : An International Survey*, sponsored by the Mysore Library Association, was edited by S. R. Ranganathan, A. Neelameghan, and A. K. Gupta.

The papers and the proceedings of the DRTC Seminar (5) (1967) were brought out in a mimeographed volume.

The DRTC continued to collaborate with the Sarada Ranganathan Endowment for Library Science in the editing and publication of the periodical, *Library Science with a slant to Documentation*.

Seminars and Lectures : The Fifth All-India DRTC Seminar on Documentation, held from 15 to 19 December 1967, was inaugurated by Shri G. S. Pathak, Governor of Mysore. The subjects discussed were, Classification, Subject Heading, and Management of Reprography Service. Twenty-one papers were contributed to the seminar by 25 authors. About a hundred librarians and documentalists participated.

Nine visiting professors from India and abroad delivered lectures on library science at the DRTC, during the year.

Ten papers were presented by the DRTC staff at conferences in India and abroad.

Consultations : The staff of the DRTC actively collaborated with the Indian Standards Institution in the formulation of Standards in the field of documentation. The alumni of the DRTC consulted the Centre in the planning and organisation of the documentation services in their institutions. Other institutions also sought similar guidance from the DRTC.

Twenty-three propositions were discussed at the meetings of the Library Research Circle held in the DRTC. Twenty weekly colloquia by visiting professors were also organised.

Library : During the year, the library received 134 books, 144 reports/reprints, and 34 periodicals.

14. Library

The library together with its branches at Giridih, Delhi, Bombay, Madras and Bangalore had a collection of 1,18,243 books and bound journals, 29,110 reprints, monographs, specialised technical reports, and also a large collection of microfilms and photoprints. During the year, the library added 4,023 volumes and 50 new periodicals, of which 31 periodicals were on subscription, 12 on exchange and 7 as gift. The total number of periodicals received by the library was 2,376. Scientific and technical publications in different languages, particularly Russian and Japanese, were also received from various agencies on an exchange basis. The library also subscribed to 29 newspapers for the news-clipping service. The Workers' Circulating Library had a collection of 22,580 volumes, with the addition of 647 during the year.

The personal library, comprising about 4,000 books and research documents, of the late Professor W. A. Shewhart, U.S.A. generally known as the "Father of Statistical Quality Control", was donated by Mrs. Shewhart, to the Indian Statistical Institute.

During the year, 1,482 documents were classified and 3,206 documents catalogued. While the number of cards filed in the catalogue was 7,397 and that of self-list cards filed, 2,192, the cards prepared and consolidated numbered 11,283 and 1,328 respectively.

The total membership of the library was 1,929 at the end of the year under review. During the period, the library issued out 947 special documents, 34,261 books, 11,089 periodicals and 96 monographs and other reading materials. In inter-library loan transactions made with 37 local and out-station libraries, the library borrowed, during the period, 76 books while it lent out 130 books.

The library continued to issue documentation lists and compiled subject bibliographies and reading lists on different subjects. *The Index to Statistical Literature* and the *Monthly Bulletin* issued by the Library during the period included 2,194 citations and 2,568 entries (books and official reports taken together) respectively.

During the year, the Photography Unit provided 698 photographs required by the scientific departments of the Institute and prepared 105 slides for lectures. The Reprography Unit and the Photography Unit together microfilmed 9,136 pages and made 9,519 pages of photoprints.

The Translation Unit attached to the Library provided the research workers of the Institute with translations from foreign languages. During the period, 18 documents were

translated, of which six were from French (320 pages), three from German (30 pages), four from Japanese (92 pages), five from Russian (58 pages) and the subjects covered included biology, mathematics, palaeontology, probability theory, sciences of man and statistical quality control.

Shri J. Saha, Chief Librarian, presented a paper on "Social Science Research Centres in India" at the International Conference on Comparative Research on Social Change and Regional Disparity within and between Nations, with special reference to Southern Asia, held in Delhi.

15. Statistical Quality Control (SQC)

The SQC Division of the Institute was established with the principal object of fostering the growth and development of the use of SQC and allied technique in industrial and other establishments in the country and to assist them in organising systematic quality control to secure quality assurance and quality improvement in their output of goods and services as well as an increase in production and reduction in costs. The activities of the Division were carried out through its nine operating units located in important industrial centres of the country, viz., Bangalore, Baroda, Bombay, Calcutta, Coimbatore, Delhi, Ernakulam with sub-units in Trivandrum and Madras. A special Training and Promotional Unit is located in Calcutta. The work of the SQC units can broadly be classified as follows : (i) promotion, (ii) training, and (iii) plant service.

Promotional Activities : The technical officers of the Division gave 51 lectures and talks to industrial and management personnel, members of professional bodies and institutions. Besides organising 7 seminars and symposia, they also sponsored and attended 47 seminars and conferences, jointly with other industrial and professional bodies like the National Productivity Council, Institution of Engineers, Local Productivity Council and the Textile Association of India. Two special seminars on an industrywise basis were organised on Quality Control in Foundry and in Textiles and a third on the use of Statistical Techniques in Production Planning. The technical officers paid 93 promotional visits to plants, carried out 10 pilot surveys and issued 13 promotional reports. The units also published four technical papers and prepared hand-outs and special training manuals pertaining to industries like jute, cotton textiles etc. Thirty technical papers were published and also prepared for conferences by the staff members.

Training : The training of personnel at different levels is the sheet anchor of the development of SQC in the country and the Indian Statistical Institute has been continuously engaged in this vital task of training and education. During the period, the units conducted six basic courses and five special courses which were attended by 215 persons. The in-plant training courses which have proved their efficiency in stimulating the interest of plant personnel in the adoption of SQC and which lay the foundation for successful organisation of systematic quality control in plants were conducted in several plants on a priority basis. Twenty-five such courses of different levels were attended by 536 persons.

In the SQC post-graduate diploma course, specially devised to train engineers, technologists, scientists and statisticians, to a level of professional competency in SQC and conducted by the Training and Promotional Unit in Calcutta, 34 students were undergoing training in the current batch, of whom 12 were deputed by the defence organisations and three by the

public sector. The candidates from the earlier courses have now been employed by the industries as well as the SQC Units.

At the request of the Ministry of Defence, a special 10-week course on SQC, organised for the senior staff of the ordnance factories, was attended by 23 officers deputed by the factories. Special courses were also conducted in three ordnance factories.

To meet the persistent demand for larger admissions to the SQC diploma course, similar diploma courses are being planned in other centres, as also recommended by the Review Committee. As a preliminary, a specially devised one-year post-graduate Evening Course in SQC/OR was started in Madras from 25 March 1968. Thirty candidates, mostly working engineers and technologists were admitted, out of 230 applications received. The course was specially devised as a part-time evening course to encourage employed executives to undertake training. It is planned to develop this course into a full-fledged post-graduate diploma course. The preliminary work to start a similar part-time evening course in Bombay was also undertaken.

The units also imparted on-the-job training to the junior staff and apprentices. Ten apprentices of the last year's batch completed their training and 14 new apprentices commenced training during the period. The field training for 66 students of the SQC diploma course was also organised and supervised by the SQC Units.

The staff participated in training programmes relating to SQC-OR etc. of sister organisations like the Productivity Councils, Institutes of Management, Institutes of Engineers, Administrative Staff College, Hyderabad and the Small Industries Service Institute etc.

The details of the training courses are given in *Annexure* 3. The total number of trainees covered by all these courses is 751.

Plant Service: During the year, service on a regular membership basis was rendered to 75 plants. While 20 new plants were taken up for SQC services, the SQC units withdrew from 16 plants, after assisting them to organise their own SQC cells. The plants serviced included a variety of industries like textile—cotton and jute, light and heavy engineering, chemicals and pharmaceuticals, electricals and electronics, automobiles, foundry, iron and steel, mining and other miscellaneous industries both in the private and public sectors.

Over 450 technical reports were submitted to the plants on the projects taken up in member organisations.

All-India Conference on Quality Control at Madras: The SQC Division organised the Fourth All-India Conference on Quality Control at Madras on 7, 8 and 9 December 1967. Over 500 delegates consisting of managers, technical executives, Government representatives and SQC practitioners from the industries participated. Over 120 technical papers including 14 from the SQC units dealing with different aspects of quality control e.g. Operational Concepts, Training and Development, Organisation and Management for Quality Control etc. were presented and discussed in the conference. Special sessions were arranged for small-scale plants and for quality control in civil construction. A strong recommendation was made by the conference for the organisation by the Institute of training courses both at the basic level and the advanced level in SQC on a country-wide basis. Valuable suggestions were also made for organising for quality in-plants.

An exhibition was organised during the conference to illustrate the use of SQC techniques for the economic control of quality. A souvenir was published on the occasion by the Institute and special supplements were issued by leading newspapers.

The ESQC journal (Rotterdam) reported that the conference was organised efficiently and added that "the Indian SQC units are rendering a valuable service to industry by helping firms of all sizes and in all industries to establish themselves upon sound lines."

The conference urged that it should be held on an annual basis in different parts of the country, as it served a very useful purpose in promoting quality consciousness and quality manufacture through modern scientific methods.

Foreign Experts : Dr. K. Ishikawa, Faculty of Engineering, University of Tokyo, Japan, and Mr. Frank Nixon, Chief Quality and Reliability Engineering, Rolls Royce, U.K. international experts on quality control, presented papers and participated in the Fourth All-India Conference on Quality Control. After the Conference, the SQC Division organised two special top-management group discussions in Bangalore on 11 December 1967 and in Calcutta on 13 December 1967 in collaboration with the Calcutta Productivity Council. The experts presented papers of basic importance with valuable suggestions for the growth of SQC in India, and participated actively in all these programmes. They also held detailed discussions with the technical staff in Bangalore and Calcutta.

Liaison with other organisations : As in previous years, the SQC Units worked in close cooperation with organisations like the Indian Standards Institution, National and Local Productivity Councils, Institutes of Management, Indian Society for Quality Control, Institute of Production Engineers, Small Industries Services Institute, Management Associations, Operations Research Societies, National Institute for Training in Industrial Engineering, Universities and other Governmental and scientific agencies. The programme of collaboration included participation in seminars, conferences, training programmes, contribution of papers, and the organisation of special courses.

Publications : QC News : In order to spread the message of quality control and to bring to the notice of the industrial and other personnel the quality control activities in the country and abroad and to arouse their interest in the field, the Training and Promotional Unit inaugurated the scheme of issuing a monthly news-letter, *QC News*, from May 1967. The news-letter has been well received and earned the appreciation of industrial and technical personnel all over the country. An encouraging result has been that references and enquiries are being received from management executives, technologists, technical journals, etc., pertaining to the reports in the news-letter. Enquiries have been received from the European Organisation for Quality Control and the United States Organisation for Quality Control for publishing extracts from the *QC News*.

Research : The problem of evolving new approaches, modifying old methods or devising new formulae etc. to meet the challenge of varied types of problems face the staff in their plant work. They are thus engaged in applied research extending the frontier of knowledge in the subject. The papers published by the staff as a result of this work during the year is given in *Annexure 5*.

Advanced Training for Staff : Four members of the staff went abroad for advanced training on United Nations and Colombo Plan fellowships.

16. Family Planning Research Unit

The programme of work undertaken by the Family Planning Research Unit during the year included survey, action programme development, and special research studies.

Survey: The following programme was undertaken: (i) completion of the third annual resurvey to measure the changes in fertility behaviour of the Calcutta City Project Population, (ii) completion of the household listing work of the sample villages and urban blocks in Hooghly District, West Bengal, and (iii) completion of the Second Hooghly Fertility Survey.

Action Programme Development: (i) An exhibition was held for motivating target couples in Calcutta City Project towards the acceptance of oral contraceptives, (ii) A clinic-based programme on oral contraceptives was started in the Calcutta City Project.

One paper was published and another sent for publication (*Annexure* 5). Four papers on family planning were mimeographed.

17. Publications

The following were published during the year:

Sankhyā: The Indian Journal of Statistics: Series A, Volume 29, Parts 2, 3, 4; Volume 30, Part 1. Series B, Volume 29, Parts 1 to 4.

Indian Statistical Series: Twenty-two books were published in the Series up to the end of March 1965. The book *Surveys and Plans for Rural Industries* by Nihar Chandra Chakravarti was published during the year. The printing of another book, *Studies on Consumer Behaviour: Vol. II* by P. C. Mahalanobis, M. Mukherjee, N. S. Iyengar, A. K. Biswas, D. K. Bose, H. P. Biswas, R. K. Som, S. N. Mitra, J. Roy, S. K. Dhar and N. Bhattacharyya was completed during the year.

The Research and Training School issued 51 technical reports in Mathematics and Statistics, 5 in Physics and 6 in Natural Sciences during the year.

The RTS also issued the following mimeographed publications during the year:

SM-67-1	Dynamic Programming in Markov-Chains	...A. Maitra
SM-67-2	Invariance in Testing and Estimation	...J. K. Ghosh
SM-67-3	Elements of Queues and Inventories	...J. Sethuraman
SM-67-5	Limit Theorems for Empirical Distribution Functions	...D. M. Chibisov

Dr. M. N. Murthy's book, *Sampling Theory and Methods*, was published by the Statistical Publishing Society, Calcutta.

18. Visitors

Over 300 visitors from India and abroad (from 18 foreign countries and international organizations) came to the Institute during the year.

19. Construction and Maintenance of Buildings

The general civil engineering original and maintenance works, (except carpentry and smithy works) were entrusted to the Institute Engineer since November 1967. The

additions and alteration works were in progress on the ground floor of the main building at 203 Barrackpore Trunk Road in connection with the installation of the Honywell Computer, by inviting sealed tenders from reputable contractors.

20. Branches

20.1. *Mysore State Branch :* There were 46 members of different categories at the end of the year. The office-bearers and members of the Executive Committee of the Branch for 1967-68 were elected at the fourteenth annual general body meeting held on 23 June 1967.

Admission Tests and Examinations : The selection tests for admission to the M.Stat. and B.Stat. degree courses and the SQC Diploma Course, etc., were held in Bangalore on 25 June 1967. The professional examinations in statistics (Statistician's Diploma and Computer's Certificate etc.) were held in Bangalore during 17-24 May 1967.

The admission test for the Indian Institute of Management, Calcutta, designed by the Psychometric Unit (RTS) of the Indian Statistical Institute, was held in Bangalore on 11 11 February 1968.

Training Course : On the recommendation of the Branch, the One-year Evening Course in Statistics was inaugurated in Bangalore on 19 September 1967 by Shri S. Nijalingappa, Chief Minister of Mysore. Some members of the Branch had been assisting in the teaching of the Course and other programmes. In connexion with the training course on statistics applied to industry, conducted jointly with the Mysore State Productivity Council, certificates of attendance were distributed to the candidates on 17 February, 1968 by Shri C. S. Seshadri, I.A.S., Director of Statistics, Government of Mysore, who also addressed them.

Seminars : The following three seminars could be organized successfully, with financial assistance from the head office, to promote quality control techniques in industries :

(i) Over 80 delegates from various industrial, commercial and research organizations in Bangalore participated in a Seminar on Quality Control in Production Planning.

(ii) The Seminar on Quality Control in Foundry jointly organized with the Indian Society for Quality Control, Bangalore Branch, and the Institute of Indian Foundrymen, Bangalore Chapter, attracted as many as 100 delegates from Bangalore, Baroda, Bhadravati, Ernakulam, Hydrabad, Madras, Madurai and Poona. The seminar was inaugurated by Shri M. D. Shivananjappa, I.A.S., Chairman, Mysore Iron and Steel Ltd. Eleven working papers were discussed in the four technical sessions.

(iii) Over 100 delegates from 35 mills and organizations in Andhra Pradesh, Kerala, Madras, Mysore and Maharashtra participated in the Seminar on Quality Control in Textiles organized jointly with the Textile Association, Mysore Branch. The seminar was inaugurated by Shri Y. N. Gangadhara Setty, President, Mysore Chamber of Commerce. Twelve papers were presented and discussed in the four technical sessions.

Shri K. G. Katwey, President of the Branch, was deputed to attend the Fourth All-India Conference on Quality Control organized by the Indian Statistical Institute in Madras in December 1967.

Visiting Scientists : Along the foreign visiting scientists who came to the Mysore State Branch and gave lectures, may be mentioned : 1. Dr. P. Naidenova, Scientific

Collaborator, and Academician Ivan Stefanov, economist and statistician, both from the Institute of Economics, Bulgarian Academy of Sciences; and Dr. O. K. Dreyer, Director, Oriental Literature Publishing House, USSR Academy of Sciences.

20.2. *Bombay Branch :* A Council meeting was held on 22 May 1967. The Council accepted the resignation of Shri K. A. Antony, Honorary Secretary, who accepted an United Nations assignment in Zambia, and placed on record its appreciation of his valuable services. Shri P. K. Bhaumik Joint Secretary, was requested to look after the functions of the Honorary Secretary. The Annual Council Meeting and the General Body meeting were held on 22 and 24 February 1968 respectively. The office-bearers for 1967-68 were elected.

National Sample Survey : The field work for the twenty-first round was completed and the twenty-second round started during the period. Thirteen investigators worked on the survey.

Statistician's Diploma (S.D.) Examination : The S.D. Examinations of the Indian Statistical Institute were held as usual in May and November 1967. Eleven candidates appeared in May out of 13 registered, and the seven who registered appeared in November.

Evening Course : The Evening Course on Statistical Method and Applications (1966-67) ended in August 1967. Six trainees appeared for the examinations, but none passed. In the current batch, started in September 1967, 37 candidates applied and 35 were called for interview. The selection committee recommended 25 candidates, but only 20 joined the course.

Admission Test : An admission test for the Indian Institute of Management was held on 11 February 1968 at Bombay.

Visiting Scientists : Among the foreign scientists who visited the Bombay Branch may be mentioned the following from the USSR Academy of Sciences : Dr. L. B. Alayev and Dr. A. L. Batalov, Institute of Peoples of Asia; Dr. N. E. Brusilovsky, Vice Director "Nauka" Publishing House; Dr. O.K. Dreyer, Director, Oriental Literature Publishing House; and Dr. (Mrs.) T. S. Pokataeva, Institute of World Economics and International Relations.

Library : The Branch Library collected 58 volumes and 86 periodicals during the year. The total collection of volumes came to 1,048 and 599 periodicals. Eighty members were taking advantage of the Library facilities. The Library continued the inter-library loans.

20.3. *Kerala Branch* : The number of members on the rolls rose to 22 from 16 during the year. The Management Committee had five members.

Evening Course : The main activity of the Branch continued to be the conducting of the One-year Evening Course in Statistics. Of the seven candidates for the final (Part II) examination of the Course, six passed (three with distinction) and the remaining candidate passed in two papers.

Thirteen candidates out of 20 applicants were selected for admission to the One-year Evening Course in Statistics (1967-68), but only 12 joined. Three students dropped out from the Part II Course and only 9 continued. Five part-time teachers conducted the training.

Visiting Scientists : Academician Ivan Stefanov, Institute of Economics, Bulgarian Academy of Sciences, gave two lectures. Among other foreign scientists who visited the Branch may be mentioned Dr. Z. G. Galenko and Dr. N. E. Kucherenko, both from the People's Friendship University, Moscow; and Dr. T. S. Pokataeva, Institute of World Economics and International Relations, USSR Academy of Sciences.

RESEARCH SUMMARY

A brief account is given in this section of the progress of research in the different divisions and sections of the Institute. The lists of scientific and technical papers published and submitted for publication are given in *Annexure 5*. References are also given in this section to relevant papers in *Annexure 5*.

I. Statistics

1. *A note on linear programming :*

A method for solving the linear programming problem is described. The method is essentially the same as the dual-simplex technique proposed by C. E. Lemke, except that if possible, it replaces two basic variables by two non-basic variables at each iteration. The method will lead to the optimal solution faster than dual-simplex technique itself. (*S1*) 39/67.

2. *Distribution of most significant digits in certain functions, whose arguments are random variables :*

It is empirically well established that in large collections of numbers the proportions of entries with the most significant digit A is $\log_{10}\frac{A+1}{A}$. The property of the most significant digit has been studied in the present paper. It has been proved that when random numbers or their reciprocals are raised to higher and higher powers, they have log distribution of most significant digit in the limit. The property is also demonstrated in the limit by the products of random numbers as the number of terms in the product becomes higher and higher. The property is not, however, demonstrated by higher roots of the random numbers or their reciprocals in the limit. Actually there is a concentration at some particular digit. It has been shown that if X has log distribution of the most significant digit, then so does $\frac{1}{X}$ and CX, C being may constant under stronger conditions.. (*S2*) 12/67.

3. *Optimal spatial allocation of advertising expenditure over M-campaigns :*

The problem of allocating a given amount of money for advertising in different cities during different campaigns is taken and a method to solve the problem using Dynamic Programming is given. Two different models are formulated and the problem is solved in each case using functional equation technique. In the first model, we have N cities, and we want to do M campaigns on the whole. We are also given how much to spend K-th campaign, $1 \leqslant K \leqslant M$. Our problem is to find, 'where to do the K-th campaign, $1 \leqslant K \leqslant M$, such that the total number of customers of our Brand in all the cities at the end of M campaigns will be maximized ?' Each time a campaign is undertaken in only one of the cities. In the second model, we have N cities, and we want to do M campaigns on the whole. We are only given the total amount of money to be spent in all these M campaigns. Each time a campaign is undertaken in only one of the cities. Now our problem is to find : 'where to do the K-th campaign and how much to spend during that campaign, $1 \leqslant K \leqslant M - >$the total number of customers of our Brand in all the cities at the end of M campaigns will be maximised ?. (*S3*) 38/67.

4. *Invariant sets for translation-parameter families of measures :*

Let (X, a) be the real line with its Borel sets and μ a probability measure on (X, a). Let $\underset{\theta}{\mu}(A) = \mu(A+0)$, $[\mu] = \underset{\theta}{\mu}; -\infty < \theta < \infty$. A set A is $[\mu]$-invariant if $\underset{\theta}{\mu}(A) = c$ for all θ. $[\mu]$ is weakly incomplete if there exists a $[\mu]$-invariant set A with $0 < c < 1$. Properties of dominated weakly incomplete families $[\mu]$ and their invariant sets are studied in this paper. It is proved that if $[\mu]$ is weakly incomplete, then the Fourier transform $\hat{\mu}$ of μ vanishes at an infinite number of points. It then follows that weak completeness $[\mu]$ does not imply its bounded completeness. A sufficient condition for $[\mu]$-invariant sets to form (up to null sets) a translation invariant countably generated sub- σ-field is given. A necessary and sufficient condition is given for $[\mu]$-invariant sets to contain a translation invariant countably generated sub- σ-field.

Similar problems are considered when X is a locally compact, second countable, commutative group.

An application of weak completeness is made to answer a question raised by Basu [6]. (S4) 34/67.

5. *On some characterizations of statistics :*

A statistics T is a mapping of a measurable space (X, A) into another measurable space (Y, B). Corresponding to each family p of probability measures on (X, A) the statistic T defines a family 2 of probability measures on (Y, B). The classical problem of distribution theory is to find 2 for a given p and T. In this paper, the authors consider the reverse problem and try to characterize T given p and 2. The general problem is unfortunately too complicated and the authors had to restrict themselves to the family of normal measures. For instance, if p be a sufficiently large class of normal measures on the p-dimensional Euclidean space R^p and 2 be the class of normal measure on R^1 then T is necessarily linear. A few similar problems are also considered. (S5) 28/67.

6. *Some statistical models of individual performance on semantic differential measures of affective meaning :*

A semantic differential is defined as a sample of k adjectival scales drawn from a population of K adjectival scales. If a sample of m concepts is drawn from the population of M concepts, then each concept ($j = 1, 2, \ldots, m$) can be rated on each of the k scales ($i = 1, 2, \ldots, k$). An individual's response on the i-th scale to the j-th concept is denoted by X_{ij} and the $k \times m$ matrix of X_{ij}'s gives that individual's performance on the semantic differential measures of affective meaning. Three statistical models are proposed for the analysis and interpretation of the $k \times m$ matrix of X_{ij}'s. In the first, the individual's response set is evaluated by using the sampling variance of the sample mean as the measure of intra-individual variability. In the second, the variance-components model of the analysis of variance is used to estimate variance-components due to adjectives (adjectival scales), due to concepts, and due to residual or error. In the third, individual expression of the affective meaning dimensions is measured by obtaining the means and variances of the factor score estimates, using previously established empirical equations. The models are interpreted in terms of psychological theory and illustrative data are provided. (S6).

7. *An approximation to the distribution of a sample correlation coefficient when population is not normal :*

In this paper an approximation to the distribution function of $X = \frac{1+r}{2}$, where r is the sample correlation coefficient computed from a sample of size n drawn at random from a bivariate population, not necessarily normal, has been obtained. This has been done by expanding the density function of X in terms of a beta density function and Jacobi polynomials. The first four terms of the series have been worked out in terms of population cumulents.

Accuracy of this approximation has been studied numerically. (87).

8. *Two approximtaions for the distribution of double non-central beta :*

Two approximations based on Laguerre series expansion and Jacobi series expansion have been obtained for the distribution function of the random variable $Y = \chi_1^2/(\chi_1^2+\chi_2^2)$ where χ_1^2 and χ_2^2 are independent noncentral χ^2 variables with parameters $2\chi_1$ and $2\chi_2$, and degrees of freedom n_1 and n_2 respectively. Efficiency of these approximations have been studied numerically. (88).

9. *Some aspects of discrimination function coefficients :*

The means and the covariance matrix of the coefficients in the sample linear discrimination function are computed under the normality assumption. The asymptotic distribution of these coefficients is evaluated. A class of hypotheses on the discriminant function coefficients is posed and the optimality of some of the standard tests is pointed out. The power functions of some tests are studied from the standpoint of monotonicity property. In particular, it is shown that the power function of the 'step-down test' does not have the usual monotonicity property but it has this property in a 'weak' sense. (89).

10. *Problems of estimation for truncated strata :*

If a stratum is truncated after the sampling units are selected, the problem is one of obtaining a valid estimate for the truncated strata. Some five estimators for the truncated stratum are suggested in this paper, of which one is unbiased and the remaining four are biased. Expressions for the estimates of sample variance of two of the five estimators are given and of these one is unbiased and the other is conditionally unbiased. To study the suitability of different estimators, an empirical study has been undertaken with data from an actual sample survey where estimates for aggregates, ratios and sample variance of aggregates estimates for expenditure on items like cereals, milk and products, total food, total non-food, total consumer expenditure and population were considered. The relative difference of each biased estimate from the unbiased one in respect of aggregate and ratio of estimate are obtained. The estimates of mean square error for the biased estimators are also given. (810).

11. *Identities involving generalised Fibonacci numbers :*

Following the definition of Generalised Fibonacci Number H_n given by A. F. Horadam viz. $H_1 = p$, $H_2 \equiv p+q$, $H_n = H_{n-1}+H_{n-2}$ $n \geqslant 3$, the author has derived a number of

identities involving H_n's. All the relations are given as sums up to n terms of which some of them are listed below :

Terms like $\sum_{r=1}^{n} H_{3r-1}$, $\sum_{r=1}^{n} H_{3r-2}$, $\sum_{r=1}^{n} H_{3r-1}$, $\sum_{r=1}^{n} H_{3r-2}$ etc.

Terms of the form $\sum_{r=1}^{n} H_{3r}^2$, $\sum_{r=1}^{n} H_{3r-1}^2$, $\sum_{r=1}^{n} H_{3r-2}\ H_{3r-1}$ etc.

Cubic terms like $\sum_{r=1}^{n} H_r^3$, $\sum_{r=1}^{n} H_{2r}^3$, $\sum_{r=1}^{n} H_{3r}^2 H_{3r-1}$ etc.

And lastly sums of the form

$$\sum_{r=0}^{n} rH_r,\quad \sum_{r=0}^{n} (-1)^r\ rH_r,\quad \sum_{r=0}^{n} (-1)^r\ H_{3r} \text{ etc.} \qquad (S11).$$

12. *Some results on Fibonacci quaternions* :

The n-th Fibonacci Quaternion Q_n is defined by the relation $Q_n = F_n + iF_{n+1} + jF_{n+2} + kF_{n+3}$ where F_n stands for the n-th Fibonacci number of the sequence 1, 1, 2, 3, 5,.... It is given by the formula $F_n = \dfrac{a^n - b^n}{a-b}$ where a and b are the roots of the equation $x^2 - x - 1 = 0$.

Defining analogously the n-th Lucas Quaternion $T_n = L_n + iL_{n+1} + jL_{n+2} + kL_{n+3}$ where L_n is the n-th Lucas number in the sequence 2, 1, 3, 4, 7, ..., we see that $L_n = a^n + b^n$ whereas above a, b are roots of the same quadratic equation.

In this paper some of the relations connecting F_n and L_n are presented. Then relations connecting Q_n's to F_n and L_n are derived, as also those connecting T_n's to F_n and L_n. Lastly some relations existing between the Q_n and T_n are obtained. (*S*12).

13. *More identities involving Fibonacci numbers* :

From the definitions of n-th Fibonacci Number F_n and the n-th Lucas Number L_n the author has obtained identities connecting these numbers. Some of them are given below as a sample.

$$\sum_{r=1}^{n} \frac{F_{3r}}{F_r} = L_{n+2} - L_2\ ;\quad \sum_{r=1}^{n} \frac{F_{4r}}{F_{2r}} = L_{2n+1} - L_1$$

$$\sum_{r=1}^{n} \frac{F_{3r+2}}{F_{3r+1}} - \frac{F_{3r}}{F_{3r-1}} = \frac{F_{2n}}{F_{2n+1}}\ ;\quad \sum_{r=2}^{n} \frac{F_{3r+2}}{F_3} - \frac{F_{3r}}{F_{3r-3}} = \frac{F_{2n-3}}{F_{2n}} \text{ etc.}$$

Then relations of the type

$F_{2n}^2 - 5F_{2n}^2 = 4F_{2n}^2$; $F_{3kn} + F_{2n}^3 = 2F_{kn}F_{kn+1}$ $F_{2kn}^2 - F_{2n}^2 L_{2kn} = 2(-1)^{kn} F_{2n}^2$
for any positive integer k. (*S*13).

14. *A note on an inequality for normal distribution :*

Let $x = (x_1, x_2, ..., x_p)$ be distributed as multivariate normal with zero means and covariance matrix $V(x)$. Such a law of distribution will be denoted by $x \sim N(0, V(X)$. Dunn's conjecture namely

$$(1) \qquad P[|x_i| \leqslant c_i, i = 1, 2, ..., p] \geqslant \prod_{i=1}^{p} P[|x| \leqslant c_i],$$

was established recently by Khatri, Sidak and Scott by using different methods. The purpose of this note is to generalise this result in the case of convex and symmetric region in x about the origin, $i = 1, 2$. Then, generalisation of (1) can be given by

$$(2) \qquad P[D_1(x) \bigcap D_2(x)] \leqslant P[D_1(x)]P(D_2(x).$$

Some applications of (2) are given with a view to illustrate the use of (2) in simultaneous confidence bounds. (*S*14).

15. *Some identities and approximations concerning positive and negative multinomial distributions :*

This paper generalises some results which are well-known for positive and negative binomial distributions. Thus, identities are obtained connecting incomplete sums of multinomial probabilities with incomplete probability integrals of Dirichlet distributions of first and second kind. For approximations to the multinomial distribution by normal distribution and product of normal and Poisson distributions, correction terms are obtained up to order $0(\frac{1}{n})$, while correction terms for the Poisson approximation are given up to order $0(n^1)$. The final section deals with approximations to the c.d.f. of compound multinomial distributions. (*S*15).

16. *Some characterisations of the gamma distribution :*

Let $X_1, X_2, ..., X_n$ be independent and positive random variates, $Y_i = \sum_{j=1}^{n} b_{ij}X_j$, $i = 1, 2, ..., p$ and $Y_t = \prod_{j=1}^{n} X_j^{b_{tj}}$, $t = p+1, ..., n$. In this paper, the conditions under which the equations $E(Y_i | Y_{p+1}, ..., Y_n) =$ constant, $i = 1, 2, ..., p$, imply gamma variates for $X_1, X_2, ..., X_n$ are examined. For $X_1, ..., X_n$ independent variates having $E(X_j^{-1}) \neq 0$, $j = 1, 2, ..., n$, $Y_i = \sum_{j=1}^{n} b_{ij}X_j^{-1}$, $i = 1, 2, ..., p$ and $Y_t = \sum_{j=1}^{n} b_{tj}X_j$, $t = p+1, ..., n$, the equations $E(Y_i | Y_{p+1}, ..., Y_n) =$ constant, $i = 1, 2, ..., p$, imply gamma or conjugate gamma variates for $X_1, ..., X_n$ under the same conditions on the coefficients b_{ij}'s as before. The proofs require the solution of two types of new functional equations. We have also investigated the form of the distribution functions for the random variates $X_1, X_2, ..., X_n$ under the conditions $E(Y_i | Y_{p+1}, ..., Y_n) =$ constant, $i = 1, 2, ..., p$ where $Y_i = \sum_{j=1}^{n} b_{ij}g(X_i)$, $i = 1, 2, ..., p$, $Y_t = \sum_{j=1}^{n} b_{tj}X_j$, $t = p+1, ..., n$, $g(x)$ being a continuous function of x. The general form of the density function under some conditions is shown to be

$$f(x) = \exp\left[-\alpha \int_{a}^{\infty} (q)y) - \beta)dy \right],$$

where α and β are the parameters and a is a constant of integration. (*S*16).

17. *Solutions to some functional equations and their applications to characterisation of probability distributions :*

Three sets of results are contained in this paper.

The first is on a new matrix product. If A and B are two matrices of orders $p \times r$ and $q \times r$ respectively, and if $\alpha_1, \ldots, \alpha_r$ are column vectors of A and $\beta_1, \ldots, \beta_r$ are those of B then the new product $A(\underline{\cdot})B$ is the partitioned matrix

$$(\alpha_1(\underline{\times})\beta_1 \vdots\ \alpha_2(\underline{\times})\beta_2 \vdots \ldots \vdots\ \alpha_r(\underline{\times})\beta_r)$$

where $(\underline{\times})$ denotes the Kronecker product. Propositions involving the new product of matrices are stated.

The second is on the solution of functional equations of two types. One is of the form

$$\sum_{u=1}^{p} c_{ju}\psi_u(\underline{e}_u'\underline{t}) + \sum_{i=1}^{r} b_{ji}\phi_i(\underline{\alpha}_i'\underline{t}) = g_j \text{ (constant)}\ j = 1, \ldots, q$$

involving a vector variable t where e_u are unit vectors of an identity matrix of order p, α_i are given column vectors and ψ_u; ϕ_i are unknown continuous functions. Another is of the form

$$\sum_{j=1}^{n} d_{ij}\phi_j(b_j t) = g_i,\ i = 1, \ldots, q$$

involving an unknown function ϕ of a single variable t. Conditions under which the unknown functions in these two types of equations are polynomials of an assigned degree are given.

The third, on the characterisation of normal and gamma distributions, extends the earlier work of the authors (Rao, 1967 and Khatri and Rao, 1967). We consider two sets of functions $L_1, \ldots, L_q$ and $M_1, \ldots, M_p$ of independent random variables $X_1, \ldots, X_n$ with the condition $E(L_i \mid M_1, \ldots, M_p) = g_i$ (constant) for $i = 1, \ldots, q$. When L_i and M_j are linear, the X_i have normal distributions. When L_i are linear in the reciprocals of the variables and M_j are linear in the variables, the X_i have gamma or conjugate gamma distributions. When the X_i variables are non-negative, L_i are linear in the variables and M_j are linear in the logarithms of the variables, the X_i have gamma distributions. These results are proved under some condition on the compounding coefficients for $p > 1$ and in the case of $p = 1$ with the further condition that the X_i are identically distributed. (*S*17).

18. *Algorithm for multiple-precision range transformations :*

This paper describes an algorithm for general range transformation of multiple-precision (floating point) numbers in a general radix (base). The rules of the algorithm are derived using error analysis.

Of particular interest in numerical analysis (particularly in function evaluation) is the transformation of a number such that its leading or most significant digit is a unity with its next digit zero. For such a transformation it is shown that a more economical algorithm can be devised. This algorithm is justified by using diopantine analysis. (*S*18).

19. *Variable precision division in signed-digit number systems* :

Described in this paper is a divide —and—correct method for variable precision division in signed digit number systems. The least precision requirement for the segmented division which will yield a trial quotient estimate within ± 1 of the true value, is shown to be a function of the radix and the choice of maximum allowed digitmagnitudes in the operands and the quotient. In general, however, for any radix and allowed digit magnitudes, a segmented division consisting of the five leading characters of the current partial remainder by the four leading characters of the standardised divisor is shown to be sufficient to obtain the quotient estimate within ± 1 of the true value. The correction required for obtaining the true quotient is decided as zero or plus one (or minus one) according as the magnitude of the corresponding remainder in the segmented division process is a minimum or not respectively, (*S*19).

20. *Topologies with restriction on the class of all continuous functions* :

It is shown that topologies such that for any two continuous mappings into itself with ranges non-disjoint there exists a point where they take the same value. In particular, every continuous functions is having a fixed point. Finally, attempt has been made to compare maximal elements of the partially ordered space of such topologies. (*S*20).

21. *Absolute square graphs and line graphs* :

Consider undirected graphs without multiple edges and loops. A product of two graphs is defined. It is proved that under certain assumptions the product of two graphs can have at most two connected components and then a necessary and sufficient condition is obtained for this product to be connected.

Relations between the absolute square graph and line graph are studied. Minimal structures whose absolute squares are complete graphs are characterised. (*S*21).

22. *On higher powers of a graph* :

If G and H are finite undirected graphs without multiple edges and loops having the same vertices (at least three) and satisfy the equation $G \times (G \times H) = H$, then under the assumption that G is connected, unless H is null or complete, G is non-bipartite and H is a power of G. (*S*22).

23. *On the unique sample, the surveyed one* :

In this paper, the author presents some of his thoughts on the foundations of sampling theory as one who has been intimately associated with application of sampling techniques in large scale surveys for the last two decades and who has been facing difficulties of conveying convincingly the real import of the sample survey estimates to intelligent but lay users of statistical data. The author points out the fallacy in implicitly using the (sampling) standard error as a measure of precision of the *observed* (sample estimate, illustrating this point with a number of examples drawn from the current theory. To get over the specific difficulty of the assessment of the precision of the observed estimate, the author suggests for this purpose the possibility of the use of the standard deviation of the entire set of estimates obtainable from all samples which are of almost the same 'dependability,' as the observed one. All these estimates are given equal weight irrespective of the fact whether some of these estimates are realizable or not, and when realizable whether the corresponding samples are selected

with equal or unequal probability. The author concludes the paper by stating that the difficulties pointed out in this paper are real and that the solutions offered are given in a heuristic spirit. (*S23*).

24. *The Indian National Survey : The strategy for analytical studies—design aspects :*

The Indian National Sample Survey (NSS) was started in 1950 as a nation-wide data collection organisation. A multi-agency survey organisation with the central government, the state governments and other organisations participating in its work, the NSS conducts multi-purpose and multi-subject surveys on a continuing basis. Provision of mere inventory type data is not adequate for analytical studies of socio-economic variables: an investigation of the cause and effect relationships existing among various factors is primarily needed for that purpose. But in the absence of an appropriate theoretical frame work, only studies of covariation between suitably chosen variables can be done. Such studies may lead to a more or less agreed cause-effect theory. This study of covariational relationships has been facilitated through the adoption of a multi-subject integrated survey scheme with the household as the ultimate sampling or entry unit for most of the characteristics even when these relate directly to other types of units like buildings or business establishments. A multiplicity of covariational studies are made possible by the provision of links between different types of units: persons, households, localities and so on. Links are established over time as well. For the past few years, an integrated household schedule is being canvassed in the NSS. This schedule while presenting a comprehensive and over-all picture of the socio-economic activities of a household has widened the scope of covariational studies.

The NSS sample consisting of households (about 3 million for some simple items) selected from some 25,000 widely scattered localities is large, both in absolute magnitude and in relation to cost, mainly because of its multi-subject nature. Multi-variable stratification with suitable allocations of this large sample and systematic selection after proper arrangement of units have aided to make the sample sufficiently representative of different socio-cultural and economic milieu and flexible enough for multi-purpose analysis. (*S24*).

25. *Some congruences for the elementary divisor functions :*

It is proved that

$$\sigma_{q+\alpha}(n) \equiv \left(\frac{n}{p}\right) n^{\alpha}\sigma^{\alpha}_{q-\alpha}(n) \pmod{p^{\lambda}} \tag{1}$$

where p is any odd prime, $p \nmid X$, $q = \frac{1}{2}(p-1)p^{\lambda-1}$, $\lambda \geqslant 1$, α is any non-negative integer, n/p is Legendre symbol and $\sigma_k(n)$ is the sum of the k-th powers of the divisors of n.

$$\sigma_{q+\alpha}(n) \equiv n^{\alpha}\sigma_{q-\alpha}(n) \pmod{2^{\lambda}} \tag{2}$$

where $q = 2^{\lambda-2}$, $\lambda > 1$, n is odd and α is any non-negative integer.

$$\sigma_q(n) \equiv 0 \pmod{p^{\lambda}}, \quad \text{where} \quad q = \tfrac{1}{2}(p-1)p^{\lambda-1}, \tag{3}$$

p is any odd prime, $\lambda \geqslant 1$ and n is a quadratic non-residue of p. (*S25*).

26. *Some restricted partition functions : Congruence modulo 5 :*

The value of the restricted partition function $75rp(n)$ is obtained by counting all the unrestricted partitions of n excepting those which contain as a part any number of the forms $75n$ or $75 \pm r$

Results of the following types are proved

(1) For "almost all" values of n

$$\underset{20}{75}\, p(n) \equiv \underset{5}{75}\, p(n-5) \pmod 5$$

(2) For all value of

$$\underset{30}{75}\, p(n) \equiv 0 \pmod 5$$

(3) For all values of n

$$\underset{35}{75}\, p(25n) - \underset{35}{75}\, p(5n) \equiv - \underset{10}{75}\, p(25n-5) + \underset{10}{75}\, p(5n-5) \pmod 5. \quad (S26).$$

27. *Identities connecting the Partition, Divisor and Ramanujan's functions :*

The following identities for Ramanujan's function $T(n)$ are proved.

$$(1) \qquad 2^{11}.3^6 \,.\, 11T(n) = \sum_{i=1}^{5} 5_i(n)\sigma_{11-4i}(n) + 2^{14} \,.\, 3^4 \,.\, 5 \,.\, 691 \sum_{v} \pm v^4 p(n-v)$$

where $\sigma_k(n)$ is the sum of the k-th powers of the divisors of n, v stands for the pentagonal numbers, $p(n)$ is the number of unrestricted partitions of n and $\sigma_i(n)$ is a specified i-th degree polynomial (sign to be attached to $\pm\sigma p(n-0)$ depends upon the character of v)

$$(2) \qquad 2^{11}3^6 \,.\, 11T(n) = 5^3 \,.\, 7 \,.\, 13 \,.\, \sigma_{11}(n) - 691 \sum_{v} \pm P(v, n) vp(n-v)$$

where $P(v, n)$ is a polynomial in v and n Identities for $\sigma_k(n)$, $k = 1, 3, 5, 7$ and 9 of the following type are obtained.

$$7\sigma_5(n) \equiv \Sigma \pm [180n^3 - 30d_1(v) \,.\, n + d_2(v)] \,.\, vp(n-v),$$

where $d_i(v)$ is a i-th degree polynomial in v. (S27).

28. *Dynamic programming approach to stochastic games with countable state space :*

In this paper it is proved that the stochastic game has a value using the results on dynamic programming due to Blackwell (Discounted dynamic programming —*Ann. Math. Stat.*, 1965). Essentially, it has been shown that the stochastic game has a value if and only if certain dummy games have value when the state space is countable. Measurability difficulties arise in the uncountable state space case. (S28).

29. *A note on positive dynamic programming :*

We consider in this article the positive dynamic programming problem with finite optimal return, state space S. Borel, action space A compact metric, immediate return r bounded, non-negative, upper semi-continuous function on $S \times A$ and with the law of motion q satisfying the condition : $(s_n, a_n) \to (s_0, a_0)$ implies $q(. \mid s_n, a_n)$ coverages weakly to $q(. \mid s_0, a_0)$. It is proved that, for any $\varepsilon > 0$, there exists an ε-optimal semi-Markov plane and that the optimal return is a Baire function of the second class. (*S29*).

30. *Discounted dynamic programming on compact metric spaces :*

In the discounted dynamic programming problem, let the state space S be a Borel subset of a Polish space, let the action space A be compact metric; the immediate return r is a bounded, upper semi-continuous functions on $S \times A$, and the law of motion q is continuous, that is, $(s_n, a_n) \to (s, a)$ implies $q(. \mid s_n, a_n)$ converges weakly to $q(. \mid s, a)$. Under these conditons, it is proved that there exists an optimal stationary plan, and, moreover, that the optimal return is upper semi-continuous. (*S30*).

31. *A robust property of the OC of binomial and Poisson sampling inspection plans :*

The paper assumes a prior distribution for quality of lots submitted for acceptance inspection. For any acceptance plan and a given prior distribution calculate the average probability of acceptance of a lot. The definition of equitable quality level (EQL) as given in this paper ensures that the proportion of lots of quality better than the EQL (as obtained under the assumed prior distribution) shall be equal to the average probaility of acceptance. This paper shows that under fairly general conditions on the prior distribution, for binomial or Poisson plans involving a large sample size n the EQL is approximate given by $(c+1)/(n+1)$ and $(c+1)/1$ respectively, when c is the acceptance number. (*S31*).

32. *A new class of g-inverse of square matrices :*

Necessary and sufficient conditions are obtained for a matrix A to have a g-inverse with rows and columns belonging to specified linear manifolds. For a square matrix A, a g-inverse, with columns belonging to the linear manifold generated by the columns of A, is denoted by $A_{\widetilde{R}}^{-}$. Such a g-inverse exists if and only if $R(A) = R(A^2)$. The following properties of $A_{\widetilde{R}}^{-}$ are established; (a) $A_{\widetilde{R}}^{-} = A(A^2)^{-}$, (b) For any positive integer m, $(A_{\widetilde{R}}^{-})^m$ provides a reflexive inverse of A^m, (c) If x be an eigen vector corresponding to a non-null eigen value λ of A, x is also an eigen vector $A_{\widetilde{R}}^{-}$ corresponding to its eigen value $1/\lambda$. The converse of this result is also true, (d) A special choice of $(A^2)^{-} = (A^2)^{-} A$ leads to $A_{\widetilde{R}}^{-} = A(A^2)^{-} A$ which is unique irrespective of the choice of $(A^2)^{-}$ and is in fact same as the Soroggs-Odell pseudo-inverse (J. SIAM 1966) of A. When $R(A) = R(A^2)$ this indeed is a much simpler way of calculating the Scroggs-Odell pseudo-inverse compared to the method indicated by its authors. (*S32*).

33. *Simultaneous reduction of a pair of quadratic forms :*

Given two quadratic forms $Q \equiv x' Ax$ and $Q \equiv x'Bx$ one of which (say Q_2) is p.d., it is well known that both are simultaneously reducible to forms containing square terms only by a real non-singular transformation and also by contragredient transformations. In this paper, necessary and sufficient conditions are obtained for other cases as shown below.

Q_1	Q_2	n.s. condition for reducibility	
		single transformation	contragredient transformations
arbitrary	n.n.d.	$R(AB\|) \vee R(B\|)'AB\|)$	$R(AB) \vee R(BAB)$
n.n.d.	n.n.d.	always possible	always possible
arbitrary	non-singular	AB^{-1} is semi-simple	AB is semi-simple
arbitrary	arbitrary	$R(AB\|) \vee R(B\|)'AB\|)$	$R(AB) \vee R(BAB)$
		$(A-AB\|(B\|)'AB\|)-$ $-(B\|)'A)B\}$ —is semi-simple	AB is semi-simple

For a pair of symmetric matrices A and B of the same order and B n.n.d., the paper introduces the concept of a proper eigen value and a proper eigen vector of $'A$ with respect to B'. Such eigen vectors are shown to determine the required transformation for the simultaneous reduction of associated quadratic forms. (*S*33).

34. *A labelling-type algorithm for the travelling salesman problem :*

A labelling-type algorithm is presented for solving the travelling-salesman problems. The algorithm is similar to the labelling (primaldual) algorithm for the transportation problems of Ford and Fulkerson in that as soon as a feasible solution is obtained for the primal, it is also optimal. The method starts with the formation of a number of 'blocks' each of which is a cyclic or reversible sequence of a subset of integers from (1, 2, ..., n). These 'blocks' are combined by releasing additional cells, until a single sequence is obtained that statisfies all the requirements for it being a feasible solution. The method presented in this paper has the following properties. (a) It guarantees optimal results. (b) It is applicable to both symmetric and asymmetric problems with random elements. (c) It does not use subjective decisions so that it can be completely mechanised. (d) It is general, i.e., not ad hoc to the specific numerical problem. (e) It is appreciably faster than any other method proposed. (*S*34).

35. *Optimal sequencing of multi-stage flow-shop operations :*

In this paper a method of obtaining optimal sequencing of a number of items, which have to be processed through a number of machines, is presented. It is assumed that the manufacturing time of an item on a machine is specified (i.e. non-stochastic) and the order of processing is identical for all items. The optimality criterion is the total elapsed time. The method consists in finding a lower bound on the length of all sequences in which the position of certain items is specified, proceeding with the one having the least lower bound until one sequence is obtained in which all the items are assigned a position and whose length is less than or equal to the lower bound on the length of all other sequences.

The Branch and Bound method considers lower bounds on the length of all sequences the first r positions of which are specified. In this paper we consider bounds on sequences whose first r_1 and/or last r_2 positions are specified. This considerably reduces and the searching of the tree and thus reaches the optimum much faster than the 'Branch and Bound' algorithm. (*S*35).

36. *Weakly stable families of transformations*:

The notions of weak stability and weak mixing for an arbitrary semigroup V of contractions on the L_2-space $L_2(\Omega)$ of a probability space (Ω, B, m) are introduced and studied in this paper. The Cartesian square semigroup $\tilde{V}$ of V is defined on $L_2(\tilde{\Omega})$ where $\tilde{\Omega}$ is the Cartesian square of Ω. It is proved that V is weakly stable if and only if $\tilde{V}$ is so and also if and only if $\tilde{P} = P \times P$ where $P(P)$ is the subspace of $V_-(\tilde{V})$ invariant functions in $L_2(\Omega)$ $(L_2(\tilde{\Omega})$. The case when V is the semigroup generated by the family of isometries which is induced by a family Y of measure-preserving transformations on Ω is of particular interest. In this case, the above results appear as generalizations of the 'mixing theorem' of ergodic theory. Further, if the family Y itself is a probability space, it induces a Markov transition function as well as a certain 'skew' transformation. The weak stability of the latter two are shown to be equivalent and equivalent to the property that the family Y has the number 1 as its only eigen value. This property of Y is shown to be weaker than the weak stability of the generated semigroup mentioned above. (*S*36).

37. *Invariant measures for families of transformations*:

The existence of an invariant probability measure for a family of transformations or transition functions on a compact Hausdorff space as well as the existence of a finite invariant equivalent measure for a family of transformations or transition functions on a measure space are considered in this paper. The main tools used are fixed point theorems and invariant means for amenable semi-groups. The existence of a strictly positive invariant function for a semi-group of positive contractions on L^1-space is also considered. The results obtained generalize most of the known results for families of transformations. (*S*37).

38. *Some results on characteristic functions and characterisations of the normal and Generalized Stable Laws*:

A variety of results are presented in this paper. Some results are established concerning how the behaviour of a characteristic function (c.f.) in the neighbourhood of the origin affects the existence of moments of the corresponding distribution function (d.f.); it is shown, *inter alia*, that if two c.f.'s coincide at a sequence of points tending to the origin and one of them corresponds to a d.f. having moments of all orders and uniquely determined by its moments, then the two c.f.s coincide.

A new class distribution called 'generalized stable laws' has been introduced and studied. Theorems are proved on the possible distributions followed by a random variable X, under the condition that the regression of one linear statistic $a_1 X_1 + \ldots + a_n X_n$ on another $b_1 X_1 + \ldots + b_n X_n$ is constant, where $X_1, \ldots, X_n$ are n independent observations on X. The results generalize all the previous results and open up a wide variety of problems, some of which are solved in the present paper. (*S*38).

39. *On linear independence in finite projective geometry*:

Let $PG(n, s)$ denote a finite projective geometry of n dimensions based on a Galois Field $G.F.(s)$ or order s. Let $G.F.(s) = G_1$ be a subfield in $G.F.(s_1)$. Every geometric point has $s-1$ analytic representations. A set P_r of $r+1$ geometric points is said to be Restricted Linear Analytic (RLA) independent with respect to (S_r, G_1) where S_r is a set of fixed analytic points one corresponding to each geometric point of P_r, if no linear combination of the analytic points of S_r with coefficients chosen from the sub-field G_1 vanishes unless all the coefficients

are zero. Taking a set P_r which is RLA independent with respect to (S_r, G_1) consider all linear combinations of analytic points S_r with coefficients restricted to the sub-field. A geometric point, for which one of its associated analytic points lies in this set of Restricted linear combinations will have (s_1-1) analytic representations in this set. An RLA independent set P_r is said to be Generating if a geometric point has either zero or (s_1-1) analytic points in the set of all Restricted Linear (RL) combinations of points of S_r.

It is proved that the space Δ_r of geometric points associated with the analytic points of the set of RL combinations of points of S_r is isomorphic to a $PG(r, s_1)$ if P_r is a Generating RLA independent set with respect to (S_r, G_1). Δ_0 are points, Δ_1 are called Line segments. These are also defined to be non-singular imbedded geometries of dimensions 0 and 1 respectively. The imbedded geometry Δ_r obtained by the generating set P_r of RLA independent set (S_r, G_1) said to be non-singular if Δ_{r-1} obtained by the generating set P_{r-1} of RLA independent set (S_{r-1}, G_1) is non-singular and the geometric point of P_r which is not in P_{r-1} is not incident to any line generated by points of Δ_{r-1}. Necessary conditions for the existence of non-sigular geometry Δ_r are obtained.

A number of combinatorial properties of Line segments are obtained in detail.

Let Δ_r be a non-singular imbedded finite projective plane of order s_1 (which could be generated as indicated above) in a $PG(2, s)$. A line of $PG(2, s)$ is classified as an outside line (it does not have any points in common with the imbedded plane) or a tangent (it has exactly one point in common with the imbedded plane) or a secant (it has a line segment of the imbedded plane in it). If $s = s_1^2$ every line is shown to be either a tangent or a secant. (*S39*).

40. *Role of the theory of graphs in operations research :*

The article gives an introduction to the theory of graphs mainly stressing its applications to problems of operations research, Market research and linear programming. After introduction in Section 1 where the generalities on graphs are dealt with, Section 2 contains a brief historical sketch leading up to modern trends and Section 3 while introducing basic definitions also throws light on the role of graph theory in several operations research problems and related topics. New problems like constructing graph on n vertices with m edges such that no more than r edges cross at a non-vertex point and no more than such points appear on an edge are presented in course of discussions on applications. (*S40*).

41. *Some theorems of perfect graphs :*

Consider a graph G on vertices representing code letters and two vertices being joined if the corresponding letters may be confused at the receiving end. A maximum set of letters, no two of which can be confused corresponds to a maximum set of independent points called a stable set S. ($|S| = \alpha(G)$) of G. A clique is a set of vertices which are mutually joined by edges in G. The minimum number $\theta(G)$ of cliques that partition the vertices of G is called the partition number α of G. If $\alpha(A) = \theta(A)$ for every sub-graph A of G then G is said to be α-perfect, otherwise α-imperfect. Imperfect graphs are useful in obtaining richer codes for n-letter words.

It is proved that a graph with $\alpha(G) = 2$ is α-imperfect if and only if it has complement of an odd cycle as a sub-graph.

A critical α-imperfect graph is defined as an α-imperfect graph such that deletion of any vertex leaves on α-perfect graph. An α-imperfect graph always contains a critical α-imperfect graph. Further a critical α-imperfect graph with $\alpha > 2$ and without triangles is shown to be an odd cycle of length $2\alpha+1$. The minimum degree for complementary graph is determined.

A graph which can be imbedded in a triangulated planar graph is proved to be without 'double wheels' or their homeomorphs. (*S*41).

42. *An external problem in graph theory:*

We consider the problem of determining the class of all connected graphs, called extremal graphs, on n vertices with m edges and having a maximum number of articulation vertices. In Theorem 5.5, we show that any extremal graph with n vertices and $m(\geq n)$ edges consists of a subgraph of one of the following types with a (possibly empty) elementry chain attached at each of its non-articulation vertices.

(1) An elementary chain (which may be a single vertex) separating a complete graph at one end and a triangle at the other end.

(2) A complete graph with another vertex joined to it by $l(\geq 2)$ edges.

(3) A graph of type (2) in which any k edges of the complete subgraph are absent, $k < l-1$.

In a graph of the first type, the sum of the length of all free chains and the chains separating the complete graph and the triangle is $r-1$ where

$$r = \max \left\{ q : m \leqslant \binom{n-q}{2} + q \right\}$$

In a graph of the other two types, the sum of the lengths of all free chains is r.

The only extremal graph when $m = n-1$ is the elementary chain with n vertices.

The analogous problem of maximization of articulation edges is also solved. (*S*42).

43. *On the power sequence of a graph:*

In a connected graph G, the power of a vertex x is the number of connected components resulting when x is removed. The power of a graph is the maximum power of a vertex of the graph.

A necessary and sufficient condition for $p_1, p_2, \ldots, p_n$ to be the power sequence of a connected graph on n vertices with m edges is found.

The graphs which attain the maximum power among all connected graphs on n vertices with m edges are determined. (*S*43).

44. *A theorem on Hasse diagrams:*

Let $\mathcal{F}$ be a family of non-empty subsets of a finite set Y. The Hasse Diagrams of $\mathcal{F}$ is the graph whose vertices are the different elements of $\mathcal{F}$, an arc going from $F \epsilon \mathcal{F}$ to $F' \epsilon \mathcal{F}$ if and only if (1) $F \subset F'$ and (2) no $F'' \epsilon \mathcal{F}$ exists such that $F \subset F'' \subset F'$.

In this paper, it is proved that a necessary and sufficient condition for a finite graph to be a Hasse Diagram is that it has no circuits and is anti-transitive. (*S*44).

45. *On vector variables with a linear structure and a characterization of the multivariate normal distribution :*

A vector random variable X is said to have a linear structure if it can be expressed as $X = \mu + AY$ where μ is a constant vector, A is a matrix and Y is a vector of independent non-degenerate random variables (called structural variables). Two structures $\mu_1 + A_1 Y$ and $\mu_2 + A_2 Z$ are said to be equivalent if one can be reduced to the other by suitable scaling and choice of location of the structural variables.

It is well known that if X is a multivariate normal variable then the structural representation is not unique both with respect to the number of structural variables and their coefficients. The converse of this proposition is proved to characterize a multivariate normal distribution. It is shown that if there exist two structural representations $\mu_1 + A_1 Y$ and $\mu_2 + A_2 Z$ of X such that no column of A_1 is a multiple of any column of A_2, then X must have a multivariate normal distribution.

Conditions under which a structural representation is unique with respect to the structural coefficients and the number of variables are investigated.

It is shown that non-uniqueness arises due to some of the structural variables having a normal distribution or having a normal component individually or in linear combinations.

Finally, a theorem is proved regarding the vector random variable as the sum of two independent variables X_1 and X_2 where X_1 has a unique structure and X_2 is multivariate normal. (*S45*).

46. *A decomposition theorem for vector variables with a linear structure :*

A vector variable X is said to have linear structure if it can be written as $X = AY$ where A is a matrix and Y is a vector of independent random variables called structural variables. In earlier papers the conditions under which a vector random variable admits different structural representations have been studied. It is known, among other results, that complete non-uniqueness, in some sense, of the linear structure characterizes a multivariate normal variable. In the present paper, we prove a general decomposition theorem which states that any variable X with a linear structure can be expressed as the sum $(X_1 + X_2)$ of two independent variables X_1, X_2 of which X_1 is non-normal and has a unique linear structure, and X_2 is a multivariate normal variable with a non-unique structure. (*S46*).

47. *A note on a previous lemma in theory of least squres and some further results :*

Let Y be a vector of random variables such that $E(Y) = X\beta$ where β is a vector of unknown parameters and Σ be the covariance matrix of Y. A linear function $L'Y$ is said to be best linear unbiased estimator (BLUE) of a parametric function $p'\beta$ with respect to $\tilde{\Sigma}$ if $L'\tilde{\Sigma}L$ is a minimum subject to $p' = L'X$. The paper deals with necessary and sufficient conditions that, for every estimable parametric function or for a given subset, the BLUE with respect to Σ is the same as the BLUE with respect to $\Sigma = I$ (identity matrix) or same as the BLUE with respect to $\Sigma = \Sigma_0$ (a given matrix).

Let Z be a matrix of maximum rank such that $X'Z = 0$. It is shown that when Σ_0 is non-singular or rank $(X \vdots Z) =$ rank $(X \vdots \Sigma_0 Z)$, then a NAS condition for the equality of BLUE's of all estimable functions for Σ and $\tilde{\Sigma}$ is that Σ_0 is of the form

$$\Sigma = X(\underline{B})X' + \Sigma_0 Z \Gamma Z' \Sigma_0 + \Sigma_0$$

where $(\underline{H})$, are arbitrary. The representations of Σ in other situations where Σ_0 is singular have also been obtained. (*S47*).

48. *A note on Generalized Wallman Compactifications*:

A characterization of the Generalized Wallman Compactifications (G.W.C.) is given, which, though seems to be difficult to handle, yields some interesting results. Pertinent definitions are given. The theorem A compactification $\boldsymbol{X}$ is a G.W.C. of X if and only if $\boldsymbol{X}$ has a disjunct ring normal base associated to $\boldsymbol{X}$ is proved. Certain compactifications are shown to be of this type. It is proved that the closed unit sphere in n-dimensional Euclidean space is a G.W.C. of the open unit sphere. This disproves a conjecture of Njastad. However, the question as to whether every compactification is of this type remains unsettled. (*S48*).

49. *On the minimal thick sets of a measure space*:

Let (X, S, μ) be a measure space. A set $\subset X$ is called a thick set of (X, S, μ) if the μ. inner measure of its complement is zero. A thick set A is called a minimal thick set if no proper subset of A is a thick set. The following results are obtained.

If (X, S, μ) admits a minimal thick set A, then A is countable and μ is atomic, a finite product of minimal thick sets is a minimal thick set. Some topological lemmas are proved. If X is a complete, separable metric space without isolated points, S, the σ field generated by open subsets of X, the following conditions are equivalent.

(1) (X, S, μ) is non-atomic.

(2) (X, S, μ) admits a thick set whose complement is also a thick set.

(3) (X, S, μ) admits a decreasing sequence of thick sets tending to the empty set. Some examples are given. (*S49*).

50. *The fourth power of a tree*:

In this paper, we obtain a necessary and sufficient condition for a graph to be the fourth power of a tree by providing an algorithm for determining a tree that is the fourth root of any graph known to be the fourth power of some tree. The method utilizes a result of F. Harary and I. C. Ross for determining all the cliques in a given graph, where a clique is a maximal complete subgraph with at least five vertices. In general, the tree fourth root of a graph is not unique. All graphs which have exactly one tree fourth root are characterized. Some results in the general case are also obtained. Finally, the algorithm is illustrated by an example. (*S50*).

51. *A note on πPS sampling strategies*:

The problem of minimisation of the expected variance of the Horvitz-Thompson [*Jour. Amer. Stat. Assn.*, 47 (1952) 663-685] estimator under a general super-population model leads to the question of choice between various πPS strategies and a comparison between these strategies is made in this paper. (*S51*).

52. *On a variance of the ratio estimator*:

In an earlier paper [Rao, T. J. (*Metrika*, 10(1966) 89-91)], an exact expression for the variance of the ratio estimator under the Midzuno-Sen sampling scheme was obtained and here we study some of the interesting properties of the coefficients involved in this expression which depend on the auxiliary information. Use of these coefficients is made of in

finding out an exact expression for the Mean Square Error and the Bias of a general ratio estimator. (*S52*).

53. *On optimal routing problems-directed networks* :

A number of problems involving the shortest path through a net-work, both in deterministic and stochastic cases have been solved. Some problems of finding the shortest path under various constraints have also been discussed and solved. In the present note, we intend to discuss the following problem :

"Suppose that the route from i to j is unidirectional i.e. a movement from i to j is possible but not from j to i. What will be the effect of such a restriction on the total distance to be traversed from a given origin to a known destination ?" This is equivalent to studying processes involving irreversible operations. (*S53*).

54. *A comparison of Bellman's and Howard's techniques in solving shortest route problems* :

A number of methods exist for solving optimal routing problems. The functional equation technique has been used by Bellman, Freimer. Howard's method is based on the analysis of finite Markov chains. In this note, a comparative study of the two methods is made. The same problem (in the deterministic case) has been solved by both methods. From this, we can compare the two methods for their relative merits and demerits. A work on similar lines can be done for the stochastic case. (*S54*).

55. *A dynamic programming treatment of job assignment problems* :

Some solutions have appeared for the job assignment problem by linear programming and flows network techniques. The aim of the present paper is to solve the problem by the functional equation technique of dynamic programming. The problem in general, is : 'How to assign the given men to given jobs so as to obtain the maximum profit ? We also consider the case when men (m) are less than the jobs (n) and the ratio n/m is an integer. Further, it is assumed that one man can do some jobs better than the other, so it will be profitable to absorb him in a set of jobs he likes. (*S55*).

56. *Economical pseudo-division processes for obtaining square root, logarithm and arctan* :

Modifications of certain digit by digit methods, earlier suggested by Meggitt, for evaluation of elementary functions like square root, log and certain are described. These methods resemble repeated subtraction division (and hence may be called pseudo-qumber of significant digits obtained from the most significant end of the pseudo-quotient.

In the methods described here we have introduced certain restrictions on the pseudo-partial remainders thereby restricting the pseudo-quotient to assume a form close to the minimal representation in the given radix of choice.

These methods will be of interest for both signed-digit and conventional variable word length computers for software and hardware implementations. (*S56*).

57. *Stopping time of a rank-order sequential probability ratio test based on Lehmann alternatives—II* :

It is proved that the rank-order sequential probability ratio test based on Lehmann alternatives terminates with probability one under any continuous parent distribution. Furthermore, the moment generating function of the sample size required exists. This closes the gap encountered in the previous work with the above title by I. R. Savage and the author.

The present proof uses the standard ideas on the subject due to Wald. It is noteworthy that this is the second non-trivial sequential test whose termination behaviour is known under all parent distributions. (*S57*).

58. *On a class of extremal graphs :*

Let $G(n, k)$ be the class of undirected graphs without multiple edges and loops such such that the coefficient of external stability is greater than or equal to $k(\geq 1)$. The problem is to determine the maximum number of edges $m_0(n, k)$, a graph in $G(n, k)$ can have. When $k > 1$, it is shown that $m_0(n, k) = (n-k)(n-k+2)/2$ when $n-k$ is even and $= (n-k)(n-k+2)-1/2$ when $n-k$ is odd.

An attempt is made to characterize the graphs with maximum number of edges (called extremal graphs). It is shown that the extremal graphs contain $k-2$ isolated vertices and a subgraph C on $n-k+2$ vertices where (1)[1] every vertex of C has degree $n-k$ when $n-k$ is even and (2) every vertex of C has degree $n-k$ except one vertex which has degree $n-k-1$ when $n-k$ is odd. (*S58*).

59. *Normal operators on quaternionic Hilbert spaces :*

A neat and powerful technique of handling normal operators on quaternionic Hilbert space is developed and exploited to yield not only the complete structure theory of the individual normal operator but also an understanding of the structure of one-parameter unitary groups and weakly closed abelian self-adjoint algebras of operators.

It is shown that every normal operator A on a quaternionic Hilbert space can be completely described in terms of a 'spectral system' canonically associated to A to A and that a complete set of unitary invariants for normal operators is given by a multiplicity function based on finite non-negative measures with compact support contained in the upper-half of the complex plane. Two interesting theorems are deduced : (i) Every normal operator on a quaternionic Hilbert space is unitarily equivalent to its adjoint. (ii) If A is hermitian and B commutes with every operator commuting with A then B is hermitian. The notion of a function of a normal operator is introduced and analogues of well-known theorems in the complex case obtained. On a separable quaternionic Hilbert space if A is normal then B is a function of A if and only if B commutes with every operator commuting with A; the set of all functions of A coincides with the smallest W^*-algebras containing A.

An analogue of Stone's theorem on weakly continuous one-parameter unitary groups on quaternionic Hilbert spaces is proved; every one such can be expressed as an integral of 'simple' such groups.

Finally, commutative W*-algebras are considered and a complete set of unitary invariants obtained for them. It is deduced that on a separable quanternionic Hilbert space any commuting family of normal operators can be expressed as functions of a single norml operator and that the Double Commutant Theorem is valid for commutative W^*-algebra on quaternionic Hilbert spaces. (*S59*).

II. Anthropometry

60. *Association between Diabetes and Dermatoglyphics :*

The exact nature of relationship between Diabetes Mellitus and Dermatoglyphics has been discussed. The patients are compared against the healthy siblings from the same families, who are not affected with Diabetes. An increase of Radial loop is noticed in the

IV and V digits of both hands of the patients, while in the controls these are lacking. ($\chi^2_4 = 6.75$; $P = 0.05$). High pregnancy of distal axial triradii (t'') and patterns (loops) in II and III inter-digital areas in palms of the diabetic patients is noticed ($\chi^2_4 = 20.61$; $P = 0.01$). Patterns on the hypothener and thenar areas per person show significant differences ($\chi^2_4 = 26.85$; $P = 0.001$). No conclusion could be offered as to the factors which might influence pattern formation in Diabetic patients. This could only take place before the formation of dermatoglyphics was accomplished in the early months of foetal life. (*S*60).

61. *Hairy Pinnae in Indian Populations :*

The incicence of hairy pinnae and the probable age of onset were studied from the two upper caste groups of West Bengal. Frequencies increase siguificantly with age. The over-all mean of hairy pinnae in the Indian population has been calculated as 16.8%. The all-Brahmnis and all-Kayasthas do not differ significantly. Zonal rearrangements show significant differences between the zones. The inter-relationships among hairy pinnae, age, hairy tragus, chest hair and head hair are also discussed. Out of ten comparisons, three turned out to be highly significant and four were significant. In addition to the population study, an attempt has also been made to estimate the affected and expected, if *y*-linked of the relatives of propositi by age. The data completely agree with the theory of *y*-linkage. (*S* 61).

62. *Consanguinity in India :*

The various endogamous groups of India are no doubt isolates, but most of them are made up of several thousands of people. In most of the endogamous groups, the cause for the very high rate of inbreeding is not the lack of choice of partners as in the Jewish community. In India, endogamy is to be clearly distinguished from inbreeding. The coefficient of inbreeding for autosomal genes (F) in the north varies from .001-.010, while in the rural areas of the south the range of variation is between .005-.032. The excess value for the sex-linked genes being contributed entirely by the matrilateral type. There exists a positive correlation between consanguinity, literacy and the rural background. Effect of inbreeding on morbidity and mortality show that these are increased in the offsprings of consanguineous marriages as compared to those of unrelated parents. (*S* 62).

63. *On some social-historical factors affecting somatic affinities of Bengal Brahmins :*

Of many outstanding features of the caste system in India, mode of marriage within it is a crucial issue in determining a complex pattern of mating as to marrying in the same caste and not marrying certain kin or other though of the same caste. Endogamy has historically been developed as a regulating device to safeguard biological (physical) and social distinctions of the social groups constituting Hindu society. Within the Brahmanic system of Hindu society, matrimonial alliances cannot act efficiently if 'social area of choice of patterns in marriage' remains undefined. As such, inter-caste as well as intra-caste relationships have a significant role to play in demarcating such 'social area'. In a study (1960) on race elements in united Bengal, different *social groups* residing in specific geographical habitat had been stressed and 'regional differences within a social group, that is, between individuals adopting the same caste tribal or religious name (label) but living in different areas' have been pointed out. Specifically, this has been stated 'a term like Brahmins of Bengal' has to be used with some caution; and when an investigator measures a sample of Brahmins, it is necessary to specify the localities to which the individuals belong (Mahalanobis : 1958). In

this paper, to understand *social genesis* of a very important endogamous group of India, namely, *the Brahmins* attempt has been made to outline the historical evolution of the said group and simultaneously, significance of such evolution and subsequent dispersions of the constituent members of the said group within India has been discussed from sociological and anthropometrical standpoint. Anthropometrically, it has been established that 'the Bengal Brahmins resemble the other castes far more clearly than they (the Brahmins) resemble castes from outside Bengal' and again, 'the Bengal Brahmins stand out prominently as the only caste in Bengal which show definite evidence of resemblance with 'upper castes' outside Bengal'. Several historical-social facts have been discussed in the paper to show how and in what context the Bengal Brahmins acquired such resembling physical affinity with other social groups living within and without Bengal. Anthropometric data so far available on the Bengal Brahmins have been supplemented in the paper for ready reference. (*S* 63).

64. *Family organisation in rural Bengal* (1946-47):

The pattern of distribution of family structures has been studied on the basis of family data collected from several villages of *undivided* Bengal 1946-47). Proportional occurrences of different types of households and family organizations in peasant society of West and East Bengal have been especially analysed for a comparative study. (1) Single members of either sex living without any other kins occurred distinctly more in the villages of West Bengal, (2) Simple families without any complex constituents were organized significantly in lesser strength in rural West Bengal, but simple families (with complex-constituents were found comparatively more in West Bengal villages, (3) Joint families without complex-constituents were formed significantly more in villages of East Bengal, but joint families with complex-constituents occurred comparatively more in West Bengal villages. The salient features of family organizations in West and East Bengal prior to partition are thus exposed to highlight the forms of family organizations in undivided Bengal. (*S* 64).

III. Biometry

65. *Age-related trends of the amylase, glycoprotein, lipoprotein and serum protein in human blood:*

An enzyme, amylase; a carbohydrate-containing protein, glycoprotein; and the primary lipid-carrying protein, lipoprotein, present in human blood have been investigated, simultaneously with the serum proteins, which provide the reference scale for electrophoretic mobility. All four proteins have been evaluated for 317 adult males and 97 females by agar electrophoresis. The protein components identified electrophoretically are: amylase, alpha, beta-1, beta-2, and gamma; glycoprotein, alpha, beta, and gamma; lipoprotein, alpha and beta; and serum proteins, albumin and alpha-1, alpha-2, beta-1, beta-2 and gamma globulin. Significant age-related trends were observed for: alpha-1 and gamma serum globulin, beta lipoprotein, and gamma amylase. In addition to providing normative data for medical diagnosis in India, the following results are new: absence of significant effects due to age on gamma amylase, and due to weight on alpha and gamma amylase; and identification of four electrophoretic components in human serum amylase. Stratified random sampling was employed to select the samples of subjects, and effects of age, height and weight were examined by multiple regression analysis. (*S* 65).

IV. Crop Science

66. *Statistical analysis of bilateral symmetry in plant organs :*

An attempt is made to understand the laws operating on the bilateral symmetry expressed by certain organs of several plant species and the relationship between the substructures.

Data on the floral asymmetry in several species of the families Malvaceae and Bombacaceae, screwing stems of *Euphorbia antiquorum* and *E. nerrifolia*, foliar spiral of *Linum usitatissimum*, the ways of rolling up of the leaf laminae in *Cordyline rubra* and *Pothos scandens*, and the arrangement of the perianth segments of plam fruits are presented. Using the theory of graphs, all possible structures in those plant organs and their statistical distributions under the null hypothesis are obtained, on the basis of which statistical tests are performed.

The possible structures of *Euphorbia nerifolia* with 5 buds per node correspond to restricted random graphs on 5 vertices. The values on the null hypothesis for the two kinds of off-shoots per node is 72.63 which is significant. Therefore, not all structures are equally likely for this species. The possible arrangements of the six perianth segments of a palm fruit give rise to the restricted random graphs on six vertices. The χ_3 value computed (summed over all patterns) is 510.39 which is quite significant statistically. Hence it is obvious that in the course of evolution of the arrangement of the perianths of palm fruits, certain structures are preferred by Nature over the others. (*S.* 66).

67. *Two cases of ulbil-bearing Borassus flabellifer Linn.* :

Of the two bulbil-baaring *Borassus flabellifer* palms reported here,the one from West Bengal has five simple bulbil-shoots instead of the usual spadices. Only five of the flower-bunches produced during the first year of flowering in 1966 revised into bulbils while the rest emerged the same year and those of the two succeeding seasons developed into only fruit-bunches. The bulbils of this palm are lean and lanky, and the many spathes that make a bulbil show a gradual transformation into palmate leaves. A further peculiarity noticed here was that one of the bulbils bore a terminal spadix with four spikes, each bearing a few young female flowers.

The second palm growing in the Andhra Pradesh develops numerous stout and compact bulbil-shoots at its leaf axils. Many of these shoots produce secondary and tertiary branches beset with palmate leaves. Thus, the intermediary stages of the transformation of a spathe into a pinnate leaf are wanting in this case. While the three bulbils of the former palm continue to grow in its crown during the past three years, those of the latter wither away when their subtending leaves dry and drop off. However, these bulbils remain attached to the crown for much longer periods than if they had developed into flower bunches. These two rare palms seem ideal for effecting clonal propagation even though none of the bulbils produce aerial roots. (*S* 67).

68. *Variation in the Spike-number of star grass (Dactyloctenium aegypticum Linn. Beauv) :*

The inflorescence of the star grass (*Dactyloctenium aegypticum*), a fodder grass, flowering from August to December in Calcutta is composed of short unbranched spikes ranging from two to ten, all of which starting almost from the terminal node of the peduncle. The number of spikes per inflorescence varies significantly between shoots, and with time. Four spikes

per inflorescence is the most frequent occurrence. The percentage of inflorescence bearing four spikes maintains itself more or less uniformly throughout, while that of inflorescence having five spikes drops with time after an initial rise in September. The mean length of spikes per inflorescence is the maximum for the five-spiked inflorescence followed by that of the six-spiked ones. When the mean lengths of spikes (per inflorescence) were compared for November and December, it was observed that the spikes got shorter in December. (*S* 68).

V. Demography

69. *A broad view of the social class mortality pattern in Calcutta City*

Various mortality indices for the different social classes in the city have been worked out to assess the mortality differential in them. The factors responsible for such differentials have been examined. The death rate in the lower social class was found to be about two and a half times higher than that in the higher class. (*S* 69).

70. *A sixteen-year trend of the regional mortality in India*, 1947-63, *Bombay City.*

The study is based on mortality data obtained from the municipal corporation of Bombay City. Trends in general, age specific and infant mortality, have been examined. (*S* 70).

71. *Demographic data—an imperative need for the welfare of the tribal population in India :*

The paper deals with tribal demography in West Bengal. An investigation was carried out among the Totos of Jalpaiguri district in West Bengal to examine, among other things, the general view held by a section of the social scientists that some of the tribal populations are declining. The study revealed that though the rate of growth of the Totos had declined in the past, it had shown a sharp rise since 1951. A further rise in the growth rate is, however, expected with the fall in mortality. Also it was seen that the Totos have high fertility (*S* 71).

72. *A sixteen-year trend of the regional mortality in India*, 1947-63 : *Madras City :*

The study is based on mortality data obtained from the municipal corporation of Madras City. Trends in general, age specific and infant mortality, have been examined. (*S* 72).

73. *Trend in urbanisation in India and projection for the future :*

The rapid growth of population is largely from a rural influx, affected by such factors as economic opportunity, income differential, changes in social organisation, agricultural pressure on land etc. The urban population increase has greatly outstripped the general populations increase.

The tables presented show that since 1921 urbanisation has steadily increased in 1951 but in the last decade there was a lull.

The tables show that a notable feature of urbanisation has been the increase in city populations. The number of small towns has actually decreased, and more cities have arisen. If we call a town with a population of one lakh or more as a city, it can be seen that the city population in 1961 formed 44.4 % of the urban population in India and about 8 p.c. of the total population. During 1951-61, 75 % of the total increase in the urban population occurred in the cities.

If one assumes that the urban population will continue to increase as it has in the last four decades and that the lull during 1951-61 was temporary, it can be calculated that in 1986 the urban population will be about 32 % of the total population of India. This figure becomes 19.27 % if one assumes that the forces that produced the 1951-61 lull will continue to operate. Assumptions based on a growth but intermediate between the two extremes above give us a projected urban population that will form 24 % of the total population of the country. (*S* 73).

74. *Estimation of net inflation in West Bengal Census* 1941 *by sex and age groups :*

The West Bengal Census figures for 1941 being distorted by over-statement of their numbers by major communities of the State, the true age distribution has been estimated, and by comparison with the distorted age distribution, the net inflations by sex and age groups have been calculated and applied to obtain the correct population figures in 1941. (*S* 74).

75. *Some features of the growth, distribution and pressure of population in West Bengal :*

There has been considerable inter-district variation in the rate of growth of population due to differentials in the rates of natural increase and migration. General drop in mortality and influx of population account for the unprecedented rise in the population during 1951-60. The growth of population in the districts classified on a functional basis has been examined (*S* 75).

76. *Some aspects of post-census and post-survey checks :*

Some techniques used for assessing the errors in census and sample survey data through check-surveys are briefly discussed. A description of 'coverage' and 'content' errors is given and the techniques of assessing non-sampling errors covered in this note are the following : sample check, unitary check, aggregate check, external record check, and the use of statistical quality control techniques. The questions of quality of check survey and the sample size required are also considered in this paper. (*S* 76).

77. *Some aspects of use of sampling methods in demographic censuses and survey :*

In this paper, the scope and applications of sampling methods in demographic censuses and surveys have been discussed. After giving an account of the types of demographic data requirements, the uses of sampling in population censuses, vital statistics registration and demographic surveys have been described. This has been followed by a detailed discussion on planning of demographic surveys with emphasis on choice of sampling design, processing of data and control of non-sampling errors. (*S* 77).

78. *Estimating the parametric function of a finite population :*

In this paper a unified approach has been made to the problem of estimating a general parametric function (gpf). This gpf includes all parameters expressible as sums of single-valued set-functions defined over a class of sets of units belonging to the finite population. At first, the non-existence of a uniformly minimum variance estimator of the gpf is established in the class of linear unbiased estimators, and then this result is extended to the entire class of unbiased estimators by providing a general admissible estimator for this class. Some well-known estimators of the population total and the variance of the Horvitz-Thompson estimator have been shown to be special cases of the general estimator. Admissibility of this general estimator is also established in the class of linear estimators, relaxing the unbiasedness condition. (*S* 78).

79. *Comparison of some ratio cum product estimators :*

In this paper two estimators which utilise information on two supplementary variables y_2 and y_3 are suggested for estimating the ratio $R(=\bar{Y}_0/\bar{Y}_1)$ of the population means of the variavles y_0 and y_1. These estimators are given by

$$R_s = r\left(\frac{\bar{y}_2}{\bar{Y}_2}\right)^{\alpha_2}\left(\frac{\bar{y}_3}{\bar{Y}_3}\right)^{\alpha_3} \text{ and } R_s' = w_1 r\left(\frac{\bar{y}_2}{\bar{Y}_2}\right)^{\alpha_2} + w_2 r\left(\frac{\bar{y}_3}{\bar{Y}_3}\right)^{\alpha_3}$$

where $r = \bar{y}_0/\bar{y}_1$ is the usual ratio estimator of R, $\bar{y}_j$ is the usual unbiased estimator of $\bar{Y}_j$ $(j = 0, 1, 2, 3)$, α_2 and α_3 are some constants to be suitably chosen and w_1 and w_2 are weights such that $w_1 + w_2 = 1$. The exact optimum values of α_2 and α_3 being quite complicated, their approximate values have been suggested for use in practice. These estimators are compared with the usual ratio estimator r and another estimator suggested earlier by the author (*Sankhyā*, 1965, 27, 321-28). An empirical study is also included for illustration. It is pointed out that similar estimators can be obtained for estimating the product $P = \bar{Y}_0\bar{Y}_1$ and also for estimating the population mean $\bar{Y}_0$ itself if $\bar{Y}_1$ is known. (*S* 79).

VI. Documentation and Library Science

80. *Principle of unity of idea in a catalogue code :*

The helpfulness of distinguishing between work in the idea plane and in the verbal plane is stated. After listing the structural elements in a catalogue code, the rule-level, the chapter-level, and the part-level of the Principle of Unity, the rule-level, the chapter-level, and the part-level of the Principle of Unity of Idea are examined and the qualities necessary in the idea plane and in the verbal plane are listed. In the light of these principles, a comparative study of Rule 58 of ALA 1908 and the corresponding rules of the other codes is made, indicating the impact, if any, received by any code from earlier codes. (*S* 80).

82. *Chain procedure and micro subjects*

Mentions the need for providing facility of browsing among the Main Entries for micro documents. Demonstrates the unhelpfulness of the Class Index Entry (CIE) with Multiple Headings derived by applying the Chain Procedure to the full class number of a micro subject. Suggests (1) deeming a micro subject as a multi-focal one; (2) its division into convenient smaller compound subjects going with one and the same Basic Subject; (3) preparing a Main Entry for each of these compound subjects; and (4) deriving (CIE) from each Class Number by applying the Chain Procedure. Also demonstrates a method of rendering the (CIE) by cyclic permutation of the terms in the Heading and reading it keeping the syntax of its language intact. (*S* 82).

83. *Basic subjects and their kinds :*

Begins with the definitions of the necessary technical terms, the schedule for main subjects, other basic subjects, partial comprehensions, subject-bundles, and a schedule of environment for use in the formation of Specials. Explains the formation of Main Basic Subject and Canonical Basic Subject, System Basic Subject, or Special Basic Subject by Fission and of Superimposed Basic Subject. Describes also the formation of new main subjects by Distillation and Fusion respectively. Shows the removal of the inhibition due to notational plane by increasing its capacity successively by the Sector Device, Interpolation Device by Emptying Digits and Empty and Emptying Digits. (*S* 83).

VII. Educational Psychology

86. *Utilization of aptitude test scores in combination with school examination marks for improving the allocation process at the end of Class VIII—a validity study :*

In earlier studies by the authors aptitude test scores were found to be of diagonstic value in determining the most suitable stream of study after class VIII. Whether examination marks could be used with profit along with the aptitude test scores for the same purpose, was investigated in this study. It was observed that the use of school examination marks along with the aptitude test scores significantly increased the validity coefficient. (*S* 86).

87. *A note on the confidence interval of the true score* :

It discusses the use of confidence interval of the true score of a test when the observed score is available and suggests it s use instead of the commonly used confidence band, (*S* 87),

88. *Construction and development of a non-language test of verbal intelligence* :

It deals with the study done with respect to the development and standardisation of the Non-Language Test of Verbal Intelligence. Validity study on the basis of the data obtained on the experimental form of the test has also been presented here. It briefly discusses the development of the test from the pilot study to the final revised form. (*S* 88).

89. *Hospital utilization as a function of age, sex and diagnosis* :

The diseases and causes of disability which affect the individual human being vary qualitatively and quantitatively according to the individual's age. They differ qualitatively in symptoms produced, organ systems affected, and case of restoring health. Quantitatively, they differ in extent or prevalence in the population, and in intensity or degree of debility imposed upon the individual. The influence of age on susceptibility to disease and disability may be shown if cases are classified by diagnosis, separately for each sex, and then are distributed according to age. In the present report, hospital admission rate, prevalence, mean hospital bed days, and mean duration of spell have been examined in terms of age, sex, and diagnosis for data from Czechoslovakia, Great Britain (England and Wales), and Switzerland (Zurich). Throughout the discussion, uniformities rather than differences, and trends rather than absolute values, have been emphasized so as to reveal the underlying role of age. (*S* 89).

90. *Selected papers in behavioural sciences in personnel management* :

Methodological analysis of interview data for personnel selection, alternative methods of assessment of personnel selection using behavioural indices, and a quantitative rating method for screening letters of application for jobs in industry are described. (*S* 90).

91. *Some observations on educational evaluation by sampling universes of questions :*

The sampling of universes of questions is proposed as a statistical method for setting examinations according to specifications of difficulty level and subject matter coverage. Psychometric properties of samples of questions are investigated. Formulae are given, along with illustrative results, for estimation of required sample size, second, or third. The problem of comparability of samples from different universes of questions is discussed. (*S* 91).

VIII. Embryology

93. *Transcription in Limnaea embryos :*

The report describes the pattern of P^{32} incorporation and the effects of Actinomycin and Chromomycin in course of development of *Limnaea*. The incorporation starts in the uncleaved eggs of *Limnaea*. It rises smoothly and reaches the peak at the late Trochophore stage. The peak declines throughout the Veliger stage. NaOH digestion shows that the major part of the incorporation is due to RNA synthesis. Partial suppression can be obtained with the help of Actinomycin and Chromomycin. Sucrose Density Gradient proves that the Actinomycin-insensitive RNA of the Veliger Stage is largely of the *t*-RNA and *r*-RNA type. On the other hand, a major portion of the Trochopore RNA seems to be of the *m*-RNA type. (*S* 93).

IX. Geology

95. *An inexpensive technique for sketching biological and palaeontological specimens quickly :*

The technique employs a simple projector, "Magnajector", with certain modifications and improvisations for drawing to scale scientific objects accurately. This technique has been used for several varied materials to test its feasibility in reductions and enlargements while sketching. It has none of the disadvantages of conventional camera lucida which, quite often, gives distortion during sketching of three dimensional objects. (*S* 95).

97. *On sieving and settling techniques for sand analysis :*

Advantages and disadvantages of mechanical analysis of sand by Ro-Tap sieving and by settling in sedimentation balance are discussed. Basic differences between these techniques are pointed out. Construction and working principle of a sedimentation balance designed at the Groningen Institute are described. It is concluded that neither sieving nor settling technique can produce an authentic measure of grain size distribution in a natural sand sample. Sedimentologists are urged to use the settling velocity rather than size as a guide to aqueous transport of sand grains in nature. (*S* 97).

X. Network Theory

98. *Consequences of generalised Kirchhoff's Laws and proof of Thevenin and Norton theorems :*

Some properties of the conductivity matrix of the generalised Kirchhoff's Laws for continuous media have been deduced. The diagonal elements of this matrix are shown to be all positive and non-diagonal elements all negative. For the usual network of resistors, the non-diagonal elements are identified with the branch conductances with negative sign. The two distinct approaches for studying the application of vacuum tubes are reconciled. The two well-known theorems in network theory are deduced from the generalised Kirchhoff's Laws. (*S* 98).

XI Numerical Mathematics

99. *A statistical method for detecting the presence of truncation error of algorithms for numerical solution of differential equations :*

On the assumption that the rounding-off errors present in the tabulated values of an analytic function are distributed independently under a Normal Distribution, the errors propagated in the differences are proved to be distributed normally. This property has been

used to devise a test for the detection of the presence of any systematic error due to truncation propagated in the solution of differential equations by step by step integration, particularly, the fourth order Runge-Kutta algorithm. The test has been applied to tables of some well-known functions (five in total) and the agreement with the theoretical values has been found to be very close. The same test has been applied to tables of exponential-function computed by solving the differential equation, strictly following the Runge-Kutta algorithm by keeping the fifth differences within the Comrie limit 12. The computed results failed to satisfy the test, and comparison with the values of the exponential function given in standard tables revealed that these computed values became systematically lower than the actual values as the computation proceeded, that is to say, the test detected the presence of a systematic truncation error (discretisation error) of the algorithm, which could not be detected during the initial stages of computation. (*S* 99).

XII. Planning, Economic Statistics and Econometrics

100. *Socio-economic trends in India*, 1871-1961 :

The work on long-term trends of the economy during the period 1871-1961 was continued with special reference to population, output and national income. An annotated bibliography of published books on socio-economic trends in India during the above period was also prepared in collaboration with others. (*S* 100).

101. *Concentration of economic power in manufacturing sector :*

The purpose of the paper is to make a survey of the results of some of the works on the subject relating to India. The paper contains a historical resume of concentration from the first decade of this century. Works of Shri Asoka Mehta shows the managerial integration increased between 1911 to 1931. The vice of multiple directorship as a means of control by a small group was prevalent widely. Amalgamation as a process of concentration also played an important role. The process of concentration sharpened after 1939. Nigam and Chaudhuri's works throw a flood of light with regard to the position of the corporate sector after 1950. Legislative attempts to curb the power and influence of the Managing Agents were circumvented in various ways. Professor R. K. Hazari's study "conclusively establishes that there was an increase in the concentration of economic power between 1951 and 1958". Dr. Mahnot's study established that "there has been an advance, however modest, in the concentration of employment control between 1929 and 1949. The concentration was generally growing between 1929 and 1959." Dr. M. M. Mehta mentions concentration of ownership and control in fewer hands as a most striking feature of India's industrial development. Banking Sector, as revealed by the Reserve Bank of India, also falls in the line. Two big banks in 1959, excluding the State Bank of India, forming half per cent of the 'Universe' control 212 per cent of the aggregate deposits, and on another extreme, 269 non-scheduled banks forming 75 per cent of 362 banks in India had only 3.7 per cent of total deposits. It was pointed out in the paper that investment in the private sector during the plan period mostly represented funds from sources other than those who control the sector. The managing agents who made economic history in the nineteenth century consolidated further after the independence. (*S* 101).

102. *An introduction to a select bibliography on socio-economic conditions of India*, 1871-1961 :

This paper being an introduction to a Select Bibliography on Socio-Economic Conditions of India, 1871-1961, was presented at a Seminar on Trends of Socio-Economic Changes

in India along with the manuscript of the bibliography containing a catalogue of 3,000 books duly annotated and classified. The paper contains an indication of printed books available during the period on the subject. The paper gives a history of the gazetteers of India together with a survey of their contents, a history of the statistical survey and statistical movement of India together with the type of materials available, a list of census publications, a brief survey of important Parliamentary Papers. The paper deals with the writings of nationalist and other schools. The available source materials are divided into several groups and each group is discussed briefly. The pamphleteers occupy a position of pride in the annals of writings. The paper deals with the gap in information and gives an indication of future work. (*S* 102).

103. *Characteristics of Foreign Trade of Turkey and prospects of Indo-Turkish Trade :*

This paper aims to highlight the pattern of foreign trade of Turkey and to point out areas where possibilities of promotion of trade between India and Turkey exist. Though Turkey is a country which is in its initial stage of development, the economy reveals certain characteristics of foreign trade which dimensionally assume proportions that are different from those of other developing economies. The years 1961 through 1965 have been covered in this paper to reveal the recent movements in the Turkish foreign trade. The most recent trends in Indo-Turkish trade have been examined, and possibilities of promotion of trade between India and Turkey have been suggested, (*S* 103).

104. *Deflation of private consumption expenditure :*

The paper deals with the problem of deflation of private consumption expenditure. Two series of aggregate private consumption expenditure for the period 1953-54 to 1963-64 have been built up on the basis of NSS data as well as on the basis of official national income statistics. The problem of deflation of the two series is then investigated in detail. Since it is easier to obtain commodity breakdowns of the series based on the sample survey data, an attempt is made to find out how best one could deflate the survey series and its commodity components. (*S* 104).

105. *Post-independence growth of the Indian economy in the light of national income statistics :*

The paper attempts an appraisal of the progress of the Indian economy during the post-independence period mainly on the basis of national income statistics. It has been observed that the economy witnessed a high rate of growth of real income and per capita real income during the period associated with a very high rate of the growth of population. The rate of growth of real income was low for agriculture and allied activities, moderate for mining and manufacturing, and trade and transport, and high for various service activities. The relative share of wages in national income increased for non-agricultural activities but did not change materially in agricultural activities. The average earnings in agriculture became a smaller fraction of the average earnings in other activities when reckoned in real terms and the real size distribution of income probably became more unequal. The pattern of consumption, surprisingly, varied relatively less in India. (*S* 105).

106. *Some estimates of adult equivalent scales for cereals consumption in rural India :*

In this note, an attempt has been made to construct scales of equivalence of household members of different age-sex groups with respect to household quantitative consumption of cereals. Based on NSS 4th round (April 1952 to September 1952), the quantitative monthly

consumption of cereals of a household has been expressed as a linear function of the individual members of six age-sex groups. The regression coefficients are then estimated from appropriate normal equations by the method of least squares. Proportion of these estimates with regard to that obtained for a male adult gives the scales of equivalence. The results have been obtained for six population zones and rural India. Standard errors for the regression coefficients as also for the scales of equivalence have been calculated. (*S* 106).

107. *Economics of coal mining industry in India :*

The objective of the paper is mainly to examine the various combinations of different factors responsible for production of coal and to correlate different scales of operation with efficiency in operation. Larger collieries are more capital intensive. Although their labour productivity is higher in comparison with small collieries and they make economy in the wage bill, the high rates cost of repair and maintenance of fixed assets and of consumption of inputs eat up all the advantages. Again, the small collieries are to pay more to labour and productivity of labour is also lower. The benefits in the shape of lower rates of cost of repair and maintenance and of consumption of input are compensated by the former. (*S* 107)

108. *Choice of regressor in Engel curve analysis :*

In this paper, we examine the Engel elasticities estimates from three combinations : (i)regressing specific expenditure per capita on per capita total expenditure, households being classified by per capita total expenditure, (ii) regressing per household expenditure on specific commodity on per household total expenditure, households being grouped by household total expenditure and (iii) regressing per capita expenditure on specific commodity on per capita total expenditure, households boing classified by household total expenditure. The Engel elasticities from these three combinations are estimated and examined for fourteen commodity groups based on Indian National Sample Survey data separately for rural and urban India. Some theoretical examinations of the relation between elasticities obtained from the different models are done and it is found that empirical results are consistent with the mathematical analysis. We observe that total expenditure elasticity approximates to unity in all the three models and this indicates that bias, if any, is not systematically in the same direction and the ordering of the commodities by the values of elasticities is not very different between the different models. (*S* 108).

109. *Productivity of labour and capital in Indian manufacturing industries during* 1951 *to* 1961 :

In this paper, the aggregate industrial production, labour supply and capital stock of Indian manufacturing industries for the period 1951 to 1961 are analysed by fitting Cobb-Douglas production function after empirical verification of its suitability, and the marginal productivities of labour and capital are shown. Some theoretical properties of Cobb-Douglas model are also discussed since this model has the merit that it takes specific cognizance of changes in the productivity of labour and provides a frame for considering the laws of factor returns.

In calling attention to the marginal efficiency of labour it is shown that there is a broad agreement between marginal net productivity of labour and average wage rate and this is keeping with the marginal productivity theory of wages. In the course of the investigation, we find that wages per unit of labour is determined by the net productivity per unit

of labour and total wage bill is more or less a fixed share of total gross or net products and productivity per labour is determined by capital invested per labour and the rate of growth of wages and output have practically remained the same and thus the share of net output going to labour has remained the same and also the ratio of labour force to total population has remained fixed after the first, two five year plans. (*S* 109).

110. *Projected demand of cereals in India during the fourth and fifth five year plans :*

The paper projects the demand of cereals in India for the years 1966-67 to 1975-76. The parameters involved and estimated for the projection are (i) the elasticity from Engel Curve, (ii) the postulated increase in per capita total consumption expenditure, and (iii) the expected rate of increase in population.

The formulae derived for the projection are (i) $[I_t = 100(1+\beta.\mu)^t - 1]$ and (ii) $D_t = D_0(1+r)^t(1+\mu.\beta)^t$ where I_t and D_t stand respectively for percentage increase in per capita demand and aggregate demand at t year; and μ the elasticity, β the annual increase in per capita total consumption, r the annual rate of increase of population and D_0 the aggregate demand in base year.

While estimating elasticity, incidentally it is shown that if value and quantity elasticity follow constant elasticity form, then the quality elasticity also follows constant elasticity form for

$$\gamma/\gamma' = \alpha/\alpha' \times \mu_v - \mu_q$$

where μ_v and μ_q are respectively value and quantity elasticity so that the difference $\mu_v - \mu_q$ gives the quality elasticity. (*S* 110).

111. *Growth of Indian industries during first two plan periods :*

In this paper, the marginal efficiencies of labour and capital of the industrial sector of Indian economy are discussed by analysing the aggregate industrial production, labour supply, and capital stock of Indian manufacturing industries for the period 1951 to 1961. The exponents of capital (G) = 0.54 is interpreted as an index of the state of industrialisation of Indian economy. (*S* 111).

112. *Relative merits of estimating Engel Elasticity from specific concentration curves and regression methods :*

Since standard weighted least squares methods of estimating Engel elasticity from grouped family budget data is not suitable because it uses logarithmic of group means and not the group means of logarithmic, two alternative models of estimating Engel elasticity from specific concentration curves are discussed where model 1 is based on the assumptions (i) income (or total expenditure) distribution is lognormal (ii) Engel curve is of constant elasticity form and model 2 is based on the assumptions (i) income distribution is log-logistic and Engel curve is of constant elasticity form and the assumptions are seen to be reasonable on empirical investigations. (*S* 112).

113. *Compensation for loss of real income graded rates based on income elasticity :*

As a measure of relief from price increases, dearness allowance has to be granted more liberally to lower grade workers compared to upper grade ones because articles of essential consumption form a substantial part of the poorer families' budgets. At present the cost of living indices are used to determine the scale of dearness allowance, the rates of

compensation being fixed more or less arbitrarily. Despite their many recognised weaknesses, these indices remain the only tool for measuring the loss of real income. The present paper suggests a method by which variable and constant elasticities are used, for classifying items into essential and non-essential categories, and thus provides for a better and more acceptable basis for calculating the full compensation for additional expenditure on essential goods. The data, used as illustration, is derived from the Middle Class Family Living Survey for Calcutta and Delhi. (*S* 113).

114. *Some aspects of the growth of Indian economy during first three plans* :

Measurement of economic growth is possible only when requisite data of real change over time in the concerned sectors of the economy are available. The total picture for any sector for a given period of time is obtainable from aggregates. Aggregation is possible when the components are expressed in monetary terms. It is well known that there is as yet no satisfactory means of making monetary aggregates comparable over time and space. In view of this difficulty it is necessary to choose such components of the sector under consideration as are amenable to measurement in terms of physical quantities. An attempt has, therefore, been made in this paper to select a few items relating to the sectors of agriculture and manufacturing industries to observe the physical changes over time and to study the rates of growth. The study extends over the first, second and third plans. (*S* 114).

115. *On the clustering of states based on the pattern and structure of consumption* :

The paper is concerned with the clustering of states based on the pattern and structure of consumption as revealed by NSS data on household consumption expenditure. Some defined notions of the pattern and structure of consumption have been used to characterise the states, and distances between states have been obtained under three simple schemes of calculations. A novel rule has been devised for working out clusters given the matrix of all possible distances between the states. (*S* 115).

116. *Changes in occupational pattern and industrialisation in India* (1901-1961) :

The paper deals with broad occupational distribution of population in India from 1901 to 1961. Strictly speaking, this refers to the industrial distribution of labour force and population and not occupational distribution as we understand it today. The distinction was introduced first in Great Britain in 1921 but we have not yet been able to introduce it in our census classification. This appears to be mainly due to the unorganised nature of economic activities which makes it very difficult to demarcate the labour force by detailed occupational classes. In this paper, we have made a modest attempt to study the changes in occupational distribution of labour force as a whole in the sense stated above, vis-a-vis, the industrial development of the country during the period from 1901 to 1961. Main objective is to study the economic factors responsible for a more or less static pattern of occupational distribution of labour force as revealed through census reports of these periods, in spite of the growth of modern industries in the country. (*S* 116).

117. *Long-term changes in the national income of India since* 1871 :

The papr is concerned with long term changes in the national income of India since 1871. It is emphasised that economic growth is a complex phenomenon and its proper comprehension requires knowledge of its various aspects. The paper gives an idea of the

possible lines of research based on national income information that would help one to quantify several aspects of the economic growth of the country, with illustrative data for a number of fields. (*S* 117).

118. *Why discontinue the N.S.S. crop survey?* :

Currently, two alternative estimates of area and yield of major crops are available in India, one by the Union Ministry of Food and Agriculture (MFA) and another by the National Sample Survey (NSS). The NSS undertook crop estimation work from 1957-58 onwards because of serious defects in the Ministry's estimates.

The present paper seeks to examine the methods followed in the two series for arriving at the estimate and the agencies utilised for collecting and processing respective data. While no fault has been found with the NSS method or its data collecting mechanism, the defects in the Ministry's estimates on account of which NSS started crop survey work continue to exist even now. The paper concludes that the resources of the NSS should be further augmented so as to meet the ever increasing demand for more objective and reliable estimates specially for determining pricing, import and distribution policies as also for national planning purposes. (*S* 118).

119. *Economic activity in Kanpur region : present pattern and prospective dimension* :

This paper deals with the micro-analysis of economic aspects of Kanpur Region which is comprised of Kanpur city and eight surrounding districts. Analyses are mainly on demographic aspects, level of development, consumption pattern and demand projection, regional income and techno-economic aspects of important industries of the region. (*S* 119).

120. *Sprinkler irrigation* :

The paper discusses the typical situations where sprinkler irrigation is useful in India. Mention is made about the chief merits and some of the limitations. Types of sprinkler system, their layouts, system operation and care, and the cost are described. (*S* 120).

121. *Establishing irrigation programme* :

The bulletin is designed to serve as a manual for research workers engaged in proper utilisation of water resources in agriculture. Soil, plant, climatic, management, economic and water supply factors determining suitable irrigation schedules are discussed. Use of evapotranspiration rates, irrigation guides, generalised or unique consumptive-use curves and irrigation scheduling board in scheduling irrigation programmes is mentioned. (*S* 121).

122. *The effects of different levels of nitrogen and phosphorus on growth and yield of linseed* :

Effects of different levels of nitrogen and phosphorus on growth capable characters and linseed yield are discussed. Optimum dose of nitrogen was found to be 33.9 Kg/ha and the net profits for this dose was Rs. 50.3 Kg/ha. Application of different doses of phosphorus did not reveal a significant difference in crop yield. (*S* 122).

123. *A review of estimates of capital formation in India* :

This paper was concerned with a survey of the available estimates of capital formation in India. The survey was preliminary in character and was by way of introduction to a deeper analysis which was intended to be taken up later. One major object of this paper

was to present comparable estimates of capital formation by different authors for similar periods and note their dimensional comparability and plausibility.

It appeared from an adjusted comparable table that the investment rate grow from 6 or 7 per cent in 1948-49 to about 8 or 9 per cent in 1952-53; it then declined to a level of 5 to 6 per cent for the years 1952-53 and 1953-54; finally it rose quickly to about 11 per cent or more by 1956-57 and in the subsequent years, the rate of growth was somewhat slower. (*S* 123).

124. *A study of possible effects of wage-incentives in sugar and jute industries in India :*

Wage-incentive schemes have already been tried to raise productivity in Indian industries. In view of this, an attempt is made to study the relationship between wage per man-hour and output per man-hour in sugar and jute industries in India for the years 1957 and 1958 with the help of SSMI data. (*S* 124).

125. *Structure of Indian economy : inter-industry flows and pattern of final demands* 1964-65.

The structure of Indian economy for the year 1964-65 is presented by way of an input-output table. This table is prepared at 1960-61 producer's prices. Almost the entire portion of the material outputs arising out of agriculture and manufacturing industries have been covered by the table. Railways and motor transport have also been represented in the table. There are certain sectors of the economy, like services, for which the direct estimates of output as well as the distribution of these outputs are not available. Such sectors have been left out while preparing the table. The part of the economy covered has divided into 77 sectors. In terms of value added the coverage is about 67 per cent of the entire economy.

A sectorwise comparison has been made with National Income Estimates prepared by Central Statisical Organisation. Different official and non-official sources have been utilized to get the inputs and outputs of different sectors. (*S* 125).

126. *Some topics related to land tenure problems in India :*

The genesis of land tenure problems lies in the distinctiveness of the unit of ownership and the operational holding. The continuing growth of population adds permanance to the problems. In an analysis of the problems of land tenure, three aspects, e.g., over population, the operation holding and land ownership emerge as the topics for discussion. Over population has its effect felt in all the rungs of the ladder from landless labourers through tenancy to large landowners. The outcome of population pressure is lack of incentives among the tenants and lack of desire for investment among large owners. There is a greater proportional of rented area in small holdings. The incidence of mixed holdings emphasises the network of tenurial relationship, as also the preponderance of a fragmented economy of small parcels. A large farm is not a large one in India—a size deflator operates through the scale of holding sizes. The average ownership holding is less than the holding which can provide a subsistence minimum. That the pressure of population is immense can be gauged from the fact that in a scheme where below subsistence level is not to be tolerated and each household is granted a subsistence holding, a substantial proportion of households in most of the States gets excluded. (S 126).

127: *On Houthakker's relation between the Pareto distribution and the Cobb-Douglas production function with special reference to jute industry in India :*

Houthakker has demonstrated that if the 'input-output distribution' for a set of firms is assumed to be of a generalised Pareto type, the aggregative production function for the industry is of the Cobb-Douglas form. In this paper, it has been pointed out that the use of the phrase 'Pareto Distribution' is confusing. The functional form assumed is not that of a Pareto type. Secondly, the total of capacities of different firms as a function of two ratios has been called the 'input-output distribution', when in effect, no probability distribution is meant. The empirical evidence based on the data of the Jute Industry suggests that Houthakker's assumption of the functional form of the total capacities may not be realistic for many industries. An alternative function, broadly fitting in with the realities, has been suggested. With this alternative function, the aggregative production under certain assumptions have been found to be also of a Cobb-Douglas type. (*S* 127)

XIII. Theoretical Physics and Electronics

128. *Some remarks on possible weak interaction of photons :*

From the view-point that photons can interact weakly with neutrinos, the status of neutral lepton currents in weak interactions has been discussed. Also it is shown that the photon-mediated weak processes are free from certain difficulties like unitarity catastrophe and non-renormalizability encountered in current-current coupling theory or in usually considered vector boson theory of weak interactions. (*S* 128).

129. *Gauge invariance photon mass and weak interaction of photons :*

It is argued that photons can interact weakly with neutrions. From this view-point, it has been shown that this weak interaction property of photons introduces an indirect relation between gauge invariance and vanishing rest-mass of photons. (*S* 129).

130. *Possible weak interaction of photons and emission of neutrinos from stars :*

From the point of view that photons can interact weakly with neutrinos as proposed in an earlier note, the astrophysical implications of this interaction are investigated. The energy loss rates for the pair-annihilation process $\bar{\nu}+e^{\pm}\to+^{-}$ and the photon-photon process $\gamma+\gamma\to+^{-}$ are obtained using this weak interaction property of photons. The neutrino-luminosity due to the pair-annihilation process is estimated according to the present theory and is compared with that calculated on the basis of the current-current coupling theory. Some theoretical aspects of the assumed photon-neutrino weak coupling are also discussed. (*S* 130).

131. *Tensor polarization of deuterons following elastic scattering of protons (II) :*

In this paper, the contributions of the non-central force terms (spin orbit and tensor forces) to the recoil deuteron spin tensor moments are calculated, which shows that the spin-orbit term contributions are at least an order of magnitude smaller than the leading tensor term contributions. Considering these and the contribution of the deuteron quadrupole moment Q, the second rank spin tensor moments are expressed in the form

$$< T_{kq} > = a \sin 2\varepsilon_1 - \frac{c}{Nb}\,\bar{\partial}\,(D)\;T^2 - bQT^2 + O\,\bar{\partial}(P) + \frac{3}{2}(D)T^2$$

where $T^1T^2T^3$ are purely momentum dependent tensors, $a\ b\ c$ are energy dependent coefficients evaluated numerically in the paper from 1 to 10 MeV. The steep variation of a with energy facilities analysis of experimental data for the 3 nuclear Nar phase shifts in reasonably narrow ranges of energy. (*S* 131).

132. *Polarization of nucleons elastically scattered on deuterons :*

The spin-orbit interaction in nucleon -nucleon scattering at low energies is studied by analysing experimental data on nucleon polarization in elastic scattering of nucleons on deuterons using the impulse approximation, which is seen to prove an elegant interpretation of the observed angular distributions of polarization from energies as low as 0.99 MeV extending up to about 25 MeV. Estimates of appropriate phase shift combinations in P, D and F partial waves are obtained using least square fits. (*S* 132).

133. *Photo production of neutral pions on Li :*

The differential cross-sections for photo production of neutral pions on Li leading to the ground as well as the first two excited states are calculated using impulse approximation and the photoproduction amplitudes of Chew *et al.* taking exactly into consideration the contributions of the spin dependent amplitudes. The relative contributions of the spin-independent and spin-dependent terms to the differential cross-sections are presented separately which shows that the contributions of the spin-dependent terms are comparable to the contributions of the spin-independent terms mainly in transitions leading to excited states. However, comparison with available elastic production data at 166 Mev leads to best χ^2 fit using oscillator wave function for a value $r_0 = 1.4$ of the nuclear radius parameter, which changes to $r_0 = 1.2$ if the spin-dependent contributions are neglected. (*S* 133)

134. *Sum rule for particle reactions on nuclei :*

A generalised sum rule for particle reactions on nuclei is derived which is applicable in particular to electron scattering. An important feature of this result is that it distinguishes between two nucleon correlation funotions in the singlet and triplet states and also quadrupole correlations in the triplet state. Further the sum rule involves proton-proton, neutron-neutron and proton-neutron correlations in the case of processes with no charge exchange and proton-neutron correlations only in charge exchange processes. The possibility of determining these correlation functions from experiments is discussed. (*S* 134).

135. *Charge exchange reactions of elementary particles on* H_3 and He_3 :

It is shown that cross-section measurements for elementary particle reactions involving charge exchange on the nuclei, H_3 and He_3 in which the final nuclear states are unobserved could lead to estimates of the admixture of the D states in the nuclear wave functions. (*S* 135).

136. *Polarization phenomena in deuteron-nucleon scattering* :

This paper presents theoretical results for tensor and vector polarization of deuterons and polarization of nucleons in nucleon-deuteron scattering. The relevance of this problem to discuss the spin-orbit and tensor forces in nucleon-nucleon scattering is examined. The sensitivity of the results to possible phase difference between the s and d states of the deuteron is discussed. (*S* 136).

Annexure : 1 List of President, Vice-Presidents, Office-Bearers, Members of Council, Governing Body and Members of the Committees of the Council and Governing Body

President : Professor S. N. Bose, F.R.S., D.Sc., F.N.I., National Professor.

Honorary Vice-President : Dr. C. D. Deshmukh, D.Sc., *(former President).*

Vice-Presidents : 1. Professor D. R. Gadgil, M.A., M.Litt; 2. Shri Pitambar Pant, M.Sc.; 3. Dr. S. R. Ranganathan, M.A., D.Litt, *(Hony)*, F.I.A., National Professor; 4. Shri Vishnu Sahay, Governor of Assam and NEFA; 5. Shri P. C. Sen; 6. Professor D. N. Wadia, M.A., D.Sc., F.G.S., F.R.G.S., F.N.I., F.R.S., National Professor.

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Additional Vice-Chairmen : 1. President, Bombay Branch : Shri S. K. Wankhede (1967-68); 2. Chairman, Kerala Branch : Professor Samuel Mathai (1967-68); 3. President, Mysore State Branch : Shri K. G. Katwey (1967-68).

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Government nominees on the Council (Rule 6.1(b) (I)) : 1. Cabinet Secretary (Shri D. S. Joshi) or his representative; 2. Joint Secretary, Ministry of Finance, Department of Expenditure, Government of India, (Shri A. P. V. Krishnan); 3. Director, Central Statistical Organisation and ex-officio Joint Secretary, Department of Statistics (Dr. Uttam Chand).

Co-opted Members (Rule 6.1(c)) : Dr. T. R. Seshadri, F.R.S.; 2. Dr. Atma Ram, D.Sc.; 3. Shri Arun Kumar Dutt.

Ex-officio Members (Rule 6.1(d)) : Secretary of each local branch :* 1. *Bombay Branch :* Shri P. K. Bhowmick (1967-68); 2. *Kerala Branch :* Dr. (Miss) A. George (1967-68); 3. *Mysore State Branch :* Professor Srinagabhushana (1967-68).

* Branch Chairmen's names shown under Additional Vice-Chairmen.

Governing Body of the Research and Training School : 1967-68

1. Shri K. P. S. Menon, Chairman (*ex-officio*); 2. Professor P. C. Mahalanobis, Honorary Secretary (*ex-officio*); 3. Dr. C. R. Rao, Director, Research and Training School (*ex-officio*); 4. Shri Dinesh Bahl, Managing Director, Capital Private Ltd., (*Associated Chambers of Commerce of India*); 5. Dr. S. N. Sen, M.A., Ph.D., Vice-Chancellor, Calcutta University (*Indian Economics Association*); 6. Shri B. M. Thapar, (*Federation of Indian Chambers of Commerce and Industry*); 7. Joint Director, (Dr. M. K. Ganguli) Central Statistical Organisation, (*Government of India*); 8. Joint Secretary (Shri A. P. Krishnan), Ministry of Finance Financial Adviser to the Department of Statistics), (*Government of India*); 9. Professor (S. S. Srikhande, F.N.I., Head of the Department of Mathematics, University of Bombay, (*National Institute of Science of India*); 10. Shri V. G. Pandharkar, Economic Adviser, Economic Department, Reserve Bank of India, (*Reserve Bank of India*); 11. Dr. C. S. Patel, M.Sc., Ph.D. (Leeds), Vice-Chancellor, M. S. University of Baroda, *Inter University Board of India, and Ceylon*); and 12. Dr. Bhabatosh Dutta, M.A.,Ph.D., Secretary to the Government of West Bengal, Education Department; 13. Dr. B. R. Seshachar, D.Sc., F.N.I., Dean, Faculty of Science, University of Delhi; 14. Shri Jagjit Singh, M.A., F.R.S.S., General Manager, South Eastern Railway; 15. Dr. B. P. Adhikari, M.Sc., (Cal.), Dr. es.Sc. (Paris); 16. Shri Partha Ray; 17. Shri S. Basu, M.Sc., F.N.I., 18. Shri Pitambar Pant, M.Sc., Member, Planning Commission, Government of India (*Council of the Indian Statistical Institute*).

List of Members of Different Committees : 1967-68

Finance Committee of the Council

1. Chairman of the Institute (*ex-officio*) or his nominee; 2. Secretary of the Institute (*ex-officio*) or his nominee; 3. Director of the Research and Training School (*ex-officio*) or his nominee; 4. Dr. B. P. Adhikari; 5. Dr. N. Das; 6. Dr. Bhabatosh Dutta; 7. Shri S. Dutt; 8. Dr. B. S. Minhas; 9. Shri Partha Ray (*Member-Secretary*) or in his absence a person nominated by the Secretary or the Chairman or Vice-Chairmen to make such nomination; 10 & 11. Two representatives nominated by the Government of India—Cabinet Secretary (Shri D. S. Joshi) or his representative and Joint Secretary, Ministry of Finance (Shri A. P. V. Krishnan).

Finance Committee of the Governing Body

1. Chairman of the Institute (*ex-officio*) or a Vice-chairman, authorised by him; 2. Secretary of the Institute (*ex-officio*) or in his absence, a Joint Secretary; 3. Director, RTS (*ex-officio*) or a Joint Director, if any, in charge of RTS; 4 & 5. Two representatives of the Government of India (Dr. M. K. Ganguli and Shri A. P. V. Krishnan); 6. Representative of the Reserve Bank of India on the Governing Body (Shri V. G. Pandharkar); 7 & 8. Two representatives to be elected by the Governing Body from amongst themselves—Dr. B. R. Seshachar and Dr. B. P. Adhikari.

Journal Committee of the Institute

1. Dr. S. N. Bose, F.R.S., National Professor and President of the Institute; 2. Shri D. B. Lahiri; 3. Dr. B. S. Minhas; 4. Dr. Sujit Kumar Mitra; 5. Jogabrata Roy; 6. Dr. Amartya Sen; 7 & 8. Editors of *Sankhyā* (*ex-officio*); 9. One representative of the

Governing Body of the Research and Training School—Dr. S. S. Srikhande; 10. One member to be nominated by the Secretary of the Institute in consultation with the Director of the Research and Training School; 11. Dr. J. Sethuraman, *Editorial Secretary* and 12. Shri A. Mahalanobis, *Secretary*.

Examination Committee of the Institute

1. Dr. B. P. Adhikari, 2. Dr. K. S. Banerjee, Additional Director, State Statistical Bureau, West Bengal, 3. Shri Debabrata Basu, F.I.A., Assistant Manager (E.D.P.), L.I.C. Division, 4. Dr. P. K. Bose, Professor of Statistics, Calcutta University, 5. Shri N. C. Chakravarti, 6. Dr. (Miss) A. George, Professor of Statistics, Trivandrum University, 7. Dr. V. S. Huzurbazar, Professor of Mathematics and Statistics, Poona University, 8. Professor V. B. Kamath, Personnel Manager for Training & Development, The West Coast Paper Mills Ltd., 9. Professor D. B. Lahiri, 10. Dr. B. S. Minhas, 11. Dr. S. K. Mitra, 12. Professor M. Mukherjee, 13. Dr. M. N. Murthy, 14. Professor P. N. Phutane, 15. Dr. B. Ramachandran, 16 & 17. Two representatives of the Governing Body of the Research and Training School (Dr. Nirmal Chakravarti, CSO, and Shri S. Raja Rao), 18. Shri J. M. Sengupta, 19. Dr. G. R. Seth, IARS, ICAR, and 20. Shri S. Sengupta, *Member-Secretary*.

BOMBAY BRANCH: 1967-68

Honorary President: Shri S. K. Wankhede

Honorary Vice-President: 1. Professor C. N. Vakil, 2. Shri R. G. Saraiya, 3. Dr. N. S. R. Sastry, 4. Dr. C. Nanjundayya.

Honorary Secretary: Shri P. K. Bhaumick

Honorary Joint Secretary: Professor P. N. Phutane

Honorary Treasurer: Dr. M. N. Vartak.

Members of the Council: Dr. R. L. N. Iyengar, 2. Professor V. B. Kamath, 3. Professor N. S. Ramaswami, 4. Shri S. V. Barkar.

MYSORE STATE BRANCH: 1967-68

President: Shri K. G. Katwey,

Vice-President: Shri H. C. Ramanna

Secretary: Professor Srinagabhusana

Joint Secretary: Shri C. Ananthapadmanabha Setty.

Treasurer: Shri M. V. V. Raman.

Executive Committee Members: 1. Professor R. Natarajan, 2. Shri H. S. Narayana Rao, 3. Shri V. Narayana, 4. Dr. M. V. Jambunathan, 5. Shri P. S. Narayana, 6. Professor M. Narayana Iyengar.

KERALA BRANCH: 1967-68

Chairman: Professor Samuel Mathai

Secretary and Treasurer: Dr. (Miss) A George.

Members: 1. Dr. R. Krishna Pillai; 2. Shri S. Janardhana Iyer; 3. Shri P. S. Janardhanan Nayar.

Annexure 2 : Important Items of Business Transacted in Meetings of the Council and Governing Body of the Research and Training School.

2.1. Meetings of the Council

1. 3 *May* 1967 : (1) Consideration of the Review Committee report; (2) amendment of bye-laws relating to membership subscription.

2. 19 *August* 1967 : (1) Consideration of reports of the Governing Body of the Research and Training School regarding (a) award of degree of M.Stat. and B. Stat., (b) award of certificates for automatic data processing systems, and (c) results of all-India Professional Statistical Examinations (2) remuneration of auditors for 1967-68; (3) appointment of auditors for 1966-67; (4) consideration of bye-laws for the election of workers' representatives to Board of Trustees of the Indian Statistical Institute General Provident Fund; (5) sanction of expenditure relating to setting up of Sankhya Yantra Private Ltd.; (6) nominations for election to different offices of the Institute; (7) categorisation of the staff; (8) consideration of bye-laws relating to the Board of Trustees of the Institute; (9) consideration of and proposal for the allotment of a Honeywell Computer to the Institute; (10) modification of bye-laws relating to membership subscription; (11) amendment of Prospectus of the Research and Training School; (12) consideration of the allegation regarding map binding expenditure; (13) additional rent compensation for *Gooptanibas*; and (14) consideration of the report of the Deshmukh Committee which was set up for advising the Chairman and the Council of the Institute on the report and recommendations of the Review Committee set up by Government under Section 9(1) of the Indian Statistical Institute Act (the item being a lengthy one, the meeting was adjourned to the next day, i.e., 20 August 1967).

3. 20 *August* 1967 : (1) Consideration of the report of the Deshmukh Committee and the report of the Review Committee (continued from the previous meeting held on 19 August 1967); (2) nomination for the election of the President, Vice-Presidents and Vice-Chairmen. The Committee which was set up by the Council in its meeting of 19 August 1967 for considering the question of nomination for election to different offices suggested that National Professor S. N. Bose should be nominated for election as President in place of Shri Y. B. Chavan and the Council agreed; (3) a delegation of the Indian Statistical Institute Workers' Organisation, which wanted to know about proposals of categorisation, job security in the event of reorganisation of the work of the NSS, was received by the Council.

4. 27 *September* 1967 : (1) Fixation of the date and time for the Annual General Meeting; decided to be held on 30 October 1967 at the City Office of the Institute; (2) election of Vice-Presidents; (3) confirmation of amendment of bye-laws relating to membership subscription; (4) confirmation of bye-laws relating to the election of representatives of member-subscribers to the Board of Trustees of the Indian Statistical Institute General Provident Fund; (5) implementation of the decisions of the Council relating to the recommendations made in the Review Committee's report; (6) consideration of the question of perpetuating memories of certain persons; (7) payment of additional dearness allowance to the staff; (8) reporting about discussions held with the Working Group headed by Sri V. G. Pandharkar set up by the Government for considering the recommendations of the Review Committee about the National Sample Survey; (9) discussions about a semi-official publication in which the ISI-JU Electronic Computer Project featured.

5. 9 *October* 1967 : Consideration of the question of confirmation of proceedings of the meetings of the Council held on 19 and 20 August and 27 September 1967 (in which mainly the question of recommendations of the Review Committee and of the Deshmukh Committee was dealt with) and their conformation.

6. 28 *October* 1967 : (1) Consideration of report from Governing Body regarding award of M.Stat. degrees and Diploma in Statistical Quality Control and allied techniques; (2) consideration of auditors' report, audited statement of accounts, audited balance-sheet for the year ending 31 March 1967; (3) consideration of revised budget estimates for 1967-68 and tentative budget proposals for 1968-69; (4) consideration of draft Annual Report for 1966-67 for being submitted to the Annual General Meetig; (5) categorisation of staff.

7. 12 *February* 1968 : (1) Appointment of Committees: (a) Finance Committee (b) Journal Committee (c) Examinations Committee; (2) election of Council's representatives onthe Governing Body of the Research and Training School; (3) cooption of (i) Dr. T. R. Seshadri, F.R.S., Emeritus Professor and Head of the Department of Chemistry, University of Delhi; (ii) Dr. Atma Ram, Director-General, Council of Scientific & Industrial Research; (iii) Shri Chanchal Sarkar, Director, Press Institute of India, as members of Council; (4) consideration of reports from Governing Body regarding award of (i) (a) Ph.D. degree (b) M.Stat. degree, (ii) diploma in (a) Computer Science (b) Demography, (c) Econometrics and Planning, (d) Operations Research and (e) Statistical Quality Control and (iii) All-India Professional Examinations held in November 1967; (5) consideration of banking arrangements in outlying stations at (a) Bombay (b) Baroda (c) Coimbatore and (d) Madras; (6) felicitation to Professor P. C. Mahalanobis and Dr. C. R. Rao on their receiving the award of Padma Bibhushana and Padma Bhushana respectively; (7) report about the discussion between Government and the ISI representatives regarding report of the Review Committee; (8) appointement of advisory committee for revision of Memorandum of Association, rules etc. of the Institute; (9) consideration of question of integration of Statistical Quality Control activities with the Research and Training School (10) consideration of supplementary proposals regarding categorisation; (11) report regarding the offer of printing equipment by the USSR Academy of Sciences; (12) utilisation of printing machinery received by the Indian Statistical Institute through the UNTAA (13) authority for sanctioning loan from surplus of the Indian Statistical Institute General Provident Fund under Rule 27 (ii) of the Provident Fund Rules; (14) report about (a) membership of Committee for suggesting policy regarding perpetuation of the memory of deceased workers etc., (b) alleged misappropriation in connection with the binding of C.S. maps of the Library.

2.2. Meetings of the Governing Body of the Research and Training School

1. 19 *August* 1967 : (1).Consideration of the recommendations of relevant Committees of the RTS for (a) award of M.Stat. and B. Stat. degrees (b) award of certificates for automatic data processing systems and (c) results of All-India Professional Statistical Examinations; (2) appointment of auditors for 1967-68; (3) bye-laws for election of workers' representatives to Board of Trustees; (4) categorisation of staff; (5) allotment of Honeywell Computer to the Institute; (6) modifications of bye-laws relating to membership subscription; (7) amendment of prospectus of Research and Training School; (8) consideration of the report of Deshmukh Committee which was set up for advising the Chairman and the Council of

the Institute on the report and recommendations of the Review Committee set up by Government under Section 9(1) of the Indian Statistical Institute Act (the item being a lengthy one, the meeting was adjourned to the next day, i.e., 20 August 1967).

2. 20 *August* 1967 : Consideration of the report of the Deshmukh Committee and the report of the Review Committee (continued from the previous meeting held on 19 August 1967).

3. 28 *October* 1967 : (1) Consideration of recommendations of the relevant Committees of the Research and Training School regarding the award of M.Stat. degree and diploma in Statistical Quality Control and allied techniques; (2) consideration of the auditors' report, audited balance-sheet and statements of accounts for the year ending 31 March 1967; (3) revised budget estimates for 1967-68 and tentative budget proposals for 1968-69; (4) consideration of draft Annual Report for 1966-67; (5) categorisation of staff.

4. 12 *February* 1968 : (1) Consideration of the recommendations of the relevant Committees of the Research and Training School for the award of (i) (a) Ph.D. degrees (b) M.Stat. degrees (ii) award of diplomas in (a) Computer Science (b) Demography (c) Econometrics and Planning (d) Operations Research (e) Statisical Quality Control and (iii) results of Professional Examinations; (2) representatives of Governing Body on Committees (a) Finance Committee of the Governing Body (Dr. B. P. Adhikari and Dr. B. R. Seshachar—re-elected), (b) Examinations Committee (Dr. Nirmal Kumar Chakravarti of CSO and Shri S. Raja Rao—elected), (c) Journal Committee (Dr. S. S. Shrikhande—elected), (3) felicitation to Professor P. C. Mahalanobis and Dr. C. R. Rao on their receiving the award of Padma Bibhushana and Padma Bhushana respectively (4) report about the discussion between Government and the Indian Statistical Institute representatives regarding report of the Review Committee; (5) appointment of advisory committee for revision of the Memorandum of Association, Rules etc. f the Institute; (6) consideration of the question of integration of Statistical Quality Control activities with the Research and Training School; (7) consideration of supplementary proposals regarding categorisation; (8) authority for sanctioning loans from surplus of Indian Statistical Institute General Provident Fund under Rule 27 (ii) of the Provident Fund rules; (9) reports about (i) membership of Committee for suggesting policy regarding perpetuation of memory of deceased workers and (ii) alleged misappropriation in connection with the binding of O.S. maps of the Library.

INDIAN STATISTICAL INSTITUTE

Annexure 3 : Admission to Courses

3.1. Research and Training School

sl. no.	courses	number		
		applied	appeared in selection tests	admitted
	I. *Full-time Courses*			
1.	Research courses leading to registration for the Ph.D. degree	90	80	42
2.	Research/Project Assistant	—	—	
3.	Research scholar/fellow	—	—	
4.	M.Stat. 1st year	361	255	23
4.1	M.Stat. 2nd year (by promotion)	—	—	*39
5.	B.Stat. 1st year	289	226	22
5.1	B.Stat. 2nd year (by promotion)	—	—	11
5.2	B.Stat. 3rd year (by promotion)	—	—	6
5.3	B.Stat. 4th year (by promotion)	—	—	16
6.	Statistical Officers' Course (jointly with the Central Statistical Organisation, New Delhi	—	—	20
7.	Courses on Automatic Data Processing Systems :			
7.1	Three-month Course on Electronic Data Processing System for sponsored candidates	25	—	18
7.2	Automatic Data Processing System	60	17	4
8.	International Statistical Education Centre (selected by the International Statistical Institute)	38	—	31
9.	Specialised course in applied statistics leading to Diplomas			
9.1	Econometrics and Planning	6	2	1

*Including 5 direct admissions (by thesis)

sl. no.	courses	number		
		applied	appeared in selection tests	admitted
9.2	Demography	4	3	3
9.3	Statistical Quality Control	90	52	24
9.4	Computer Science	89	54	8
10.	Short-duration individual training for officers on deputation	—	—	3
11.	Documentation Research and Training	—	—	5
12.	Summer Course (Advanced) for Statisticians	70	31	25
	Full-time Courses : Sub-total of admissions	—	—	301
	II. *Part-time and Evening Courses*			
1.	One-year Evening Course in Statistics, Calcutta, September 1967–August 1968	119	72	26
2.	Elementary Techniques of Computations, Calcutta, September 1967–March 1968	83	25	21
3.	Statistical Computation, Calcutta, March 1968–August 1968	—	—	7
4.	One-year Evening Course in Statistics, Delhi, (in collaboration with the Central Statistical Organisation), September 1967–August 1968	210	81	36
5.	One-year Course in Statistics :			
5.1	Bangalore : September 1967–August 1968	75	53	24
5.2	Bombay : September 1967–August 1968	37	30	20
5.3	Hyderabad : September 1967–August 1968	41	31	18
5.4	Madras : September 1967–August 1968	25	25	25
5.5	Trivandrum : September 1967–August 1968	26	26	12
	Part-time and Evening Courses : Sub-total of admissions	—	—	189
	All Courses : Total admissions	—	—	490

3.2. STATISTICAL QUALITY CONTROL UNITS

unit	general courses	no. of participants	in-plant courses	no. of participants	special courses	no. of participants
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Bangalore			1. In-plant course on SQC at Hyderabad Allwyn Metals Ltd. for inspectors-duration-8 days on 10, 11, 13, 14, 17, 18, 20 and 21 July 1967	15		
			2. -do- for Engineers, duration-8 days during 1-11 August 1967	10		
			3. -do- for Executive Trainees-8 days on 28, 29 and 30 December 1967	15		
			4. In-plant Course on SQC at Mysore Paper Mills Ltd., on 29, 30 and 31 May 1967 and 1, 2 and 3 June 1967	24		
			5. In-plant Course at Bharat Electronics for Technical Assistants of SQC Group and Works Inspection on 8-18 and 30 May 1967, 5, 9, 14, 18, 22, 24 and 30 June; 7, 10, 12, 14, 17 and 21 July 1967; 10, 18, 23 and 31 August 1967 and 1, 12 September 1967	7		
			Sub-total	81		
2. Baroda			1. Course on SQC at Gujarat State Fertilisers for Senior and Middle Management-duration-1 February to 17 May 1968	35		
			Sub-total	35		
3. Bombay			1. Course on Network Analysis and Linear Programming at the Naval Dockyard, Bombay for Production and Planning Department Personnel on 9 November 1967	40	1. Course on SQC at Chief Inspectorate of Armaments for Inspectors-duration-11 September 1967 to 22 September 1967 and 23 October to 25 October 1967	30

Unit	General courses	No. of participants	In-plant courses	No. of participants	Special courses	No. of participants
(1)	(2)	(3)	(4)	(5)	(6)	(7)
3. Bombay			2. Course on SQC and OR at Naval Dockyard for Foreman and Technical Officers-duration-6 to 11 November 1967	40	2. Course on SQC at Ordnance Factory, Ambarnath, and Machine Tool Prototype Factory, Ambarnath, for Technical Officers-duration-15 to 28 March 1968	20
			3. Course on Industrial Experimentation at Hindusthan Lever for Research Department personnel-duration-29 January to 3 February 1968.	15	Sub-total	50
			4. Repeat Course on Industrial Experimentation at Hindusthan Lever for Research Department personnel-duration-19 to 24 February 1968	15		
			Sub-total	110		
4. Calcutta	1. Course on SQC in collaboration with NPC for industrial personnel-duration-5 days in July 1967	12	1. In-plant Course on SQC at Air-conditioning Corporation for Management personnel-duration-July-August 1967	15		
			2. Appreciation Course on SQC at Air-conditioning Corporation for Technical personnel-duration-1-27 February 1968.	22		
			3. Course on Basic Techniques of SQC at Air-conditioning Corporation-commenced on 19 March 1968	20		
			4. In-plant Course on SQC at National Co. Ltd., for management, appreciation, programming-duration-November 1967 to February 1968	25		
			5. Course on Basic Techniques of SQC at National Co. Ltd., for technical personnel during January 1968	31		
			Sub-total	113		