INDIAN STATISTICAL INSTITUTE

THIRTY-SEVENTH ANNUAL REPORT

April 1968—March 1969

203 BARRACKPORE TRUNK ROAD
CALCUTTA-35

AN STATISTICAL INSTITUTE

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Government nominees on the Council (*Rule* 6.1(b) (*I*)): 1. Cabinet Secretary (Shri B. Sivaraman), 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)): 1. Mr. Justice A. K. Mukherjee, Bar-at-Law, 2. Shri G. Basu, B.A., F.S.A.A., F.C.I.S., F.C.A., F.C.I.W.A.; 3. Shri Shyamal Krishna Ghosh; 4. Dr. Deb Kumar Bose, M.A., Ph.D.

Ex-officio Members (*Rule* 6.1(d***)): *Secretary of each local branch*: 1. *Bombay Branch*: Shri P. K. Bhowmick (1968-69); 2. *Kerala Branch*: Dr. (Miss) A. George (1968-69); 3. *Mysore State Branch*: Professor Srinagabhushana (1968-69).

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* died on 15 June 1969.

** Resigned—reported to the Council meeting of 15 March 1969.

*** Branch Chairmen's names shown under add

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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 subject 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 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 which 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 1968-69 started with 79 life members (including 5 honorary life members), 7 institutional members and 354 ordinary members on the roll. During the year, 40 ordinary members and one institutional member were enrolled and 3 ordinary members became life members. Three ordinary members and one institutional member resigned and, according to information available to the Institute, one life member and one ordinary member died. At the end of the year, therefore, the total membership was 475 consisting of 81 life (including 5 honorary life members), 387 ordinary and 7 institutional members.

It may be mentioned that the Institute has not been able to maintain contact with a very large number of its members specially those who were elected in earlier years, mostly because the members did not keep the Institute Office informed about their changes in address. Correspondence sent to their registered addresses were either returned by the post office or not replied to in many cases. During the last two years, a systematic attempt has been made to ascertain the present addresses of members, particularly those who are in arrears of subscription for more than two years, because Rule 3 of the Institute Rules deprives such members of the rights and privileges of membership. It has been possible to maintain contact with a good number of members and some of them have also paid their arrears. Attempts have, however, not been completed and are proposed to be carried out during the current year also. After completion of this work, proposals would be put up to the Council for terminating the membership of those who are either in arrears for several years or whose addresses etc. cannot be ascertained. The Council's permission would then be sought for revising the total number of members, on the basis of the latest available information.

Seventynine sessional members and 168 student members were enrolled during 1968-69, compared with 88 sessional and 109 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 and the adjourned Annual General Meeting were held respectively on 31 October 1968 and 20 December 1968, to transact the business specified in the constitution. The meeting held on 31 October 1968 dealt with the election of the Chairman, Vice-Chairmen and members of Council, consideration of the auditors' report and audited statement of accounts for 1967-68 and balance-sheet as at 31 March 1968, consideration of the Annual Report for 1967-68, confirmation of Statute 5.1 under Rule 13 of the Institute, consideration of the report regarding (*a*) the annual general meeting and the general meeting dated 30 October 1967 and 24 January 1968 respectively, (*b*) action taken in respect of the report of the Review Committee, the appointment of auditors for the term 1968-69.

Owing to certain reasons, there was some delay in placing the final accounts before the auditors. As a result, the audited report for the term 1967-68 and the balance-sheet as at 31 March 1968 could not be considered in the aforesaid meeting held on 31 October 1968. The meeting was, therefore, adjourned to 20 December 1968 at the new City Office of the Institute at 27B Camac Street, Calcutta-16. This meeting adopted the auditors' report with audited statement of accounts and balance-sheet for the year ended 31 March 1968 submitted by Messrs. Price Waterhouse, Peat & Co., earlier approved by the Governing Body of the Research and Training School and the Council of the Institute and the Finance Committees of the Governing Body and of the Council.

The election of the office-bearers was due this year, except that of Shri S. Dutt, I.C.S. (*Retd.*), Vice-Chairman.

The names of the President, Vice-Presidents, Chairman, Vice-Chairmen and other office bearers and members of the Council after the election on 31 October 1968 are given in *Annexure* 1.

The auditors' report, audited statement of accounts for the year 1968-69 and the balance-sheet as at 31 March 1969, submitted by Messrs. Price Waterhouse, Peat & Co., are given in *Annexure* 7.

2.3. *Meetings of the Council:* The Council of the Institute met 11 times during the year on 18 April, 23 July, 18 August and its adjourned meetings held on 19 August, 26 August, 14 October, 28 October, 30 October, 19 December 1968, 15 March and its adjourned meeting held on 24 March 1969, together with another meeting of the same date.

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 30 October and 19 December 1968, 15 March and its adjourned meeting held on 24 March 1969.

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 Committees:* The Finance Committee of the Council and the Finance Committee of the Governing Body of the Research and Training School met on 28 October and 18 December 1968 to consider the auditors' report, audited statement of accounts and balance-sheet as at 31 March 1968, revised budget estimates for 1968-69 and the tentative budget proposals for 1969-70.

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

2.7. *Institute's 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 Training 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 an Officer on Special Duty, with headquarters at Delhi.

Shri P. Ray continued to work as Joint Secretary and Administrative Officer throughout the period.

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: 1. Shri Sankar Chatterjee, M.Sc. (Applied Geology, Jadavpur): 19 December 1968; 2. Shri Asru Chowdhury, M.Sc. (Applied Geology, Jadavpur): 1 October 1968; 3. Shri S. R. Das, M.Sc. (Pure Physics, Calcutta): 24 April 1968; 4. Dr. Partha N. Mukherjee, M.A. (Sociology), Ph.D., (Patna University): 9 April 1968; 5. Dr. M. G. Nadkarni, M.Sc. (Math. Bombay), Ph.D., (App. Math., Brown University, U.S.A.): 29 August 1968.

During the year, the Institute secured the services of the following volunteers under the British Overseas Volunteer Scheme : 1. Miss Pamela Jean Page : joined on 23 August 1968 ; 2. Miss Ann Laura Kirby : joined on 7 November 1968.

The following volunteers, who had joined in 1967, left during the current year : 1. Miss Elizabeth Mary MacNicol left in June 1968 ; 2. Miss Jennifer Margaret Uden left in December 1968.

Planning, Delhi : 1. Dr. Pranab K. Bardhan, M.A. (*Econ.*), Ph.D. (Cantab) : 13 February 1960 ; 2. Dr. Peter Philip, B.A. (*Hons. Econ.*), Ph.D. (Stanford, U.S.A.) : 11 November 1968 ; 3. Dr. S. D. Tandulkar, M.A. (*Econ.*), Ph.D. (Harvard, U.S.A.) : 13 September 1968.

2.9. *Resignations and Retirements :* The following members of the staff left the Institute on the dates mentioned : 1. Dr. Somesh Dasgupta, (*RTS*) : 31 August 1968 ; 2. Dr. M. K. Dutta Chowdhury, (*Planning, Delhi*) : 1 June 1968 ; 3. Dr. S. K. Gupta (*RTS*) : 1 May 1968 ; 4. Dr. C. G. Khatri (*RTS*) : 1 July 1968 ; 5. Dr. A. Mathai, (*RTS*) : 1. January 1969 ; 6. Shri Provat K. Mitra, (*Electronics*) : 2. September 1968 ; 7. Shri Vinod Prakash, (*Planning, Delhi*) : 12 September 1968 ; 8. Dr. C. R. K. Prasar, (*Planning, Delhi*) : 30 June 1968 ; 9. Shri Biswajit Roy (*Library*) : 4 April 1968.

The following workers retired on the dates mentioned : 1. Shri Jogen Chowdhury, (*Central Stores*) : 1 July 1968 ; 2. Shri S. C. Dasgupta (*Estate Office*) : 1 July 1968.

2.10. *Obituary :* We are sorry to record that Shri Mohanlal Ganguli, B.A. (Cal.), B.Sc. (*Stat.*) (London), (*NSS Department*), passed away on 14 January 1969 at the age of about sixty. He joined the Institute in 1930 after his return from England. A few years later, he joined the Indian Jute Mills Association as a statistician, and worked there for a number of years. He returned to the Institute in January 1956 and stayed here till his death. He served the Institute in many ways during his long association with it.

We are also sorry to record that Shri Ushanath Banerjee, M.A., (*NSS Department*) passed away on 16 February 1969. He had been in the Institute since 1955 and was only about 47 years old at the time of his death.

2.11. *Review Committee :* It was noted in the Annual Report of 1967-68 that in respect of matters other than the National Sample Survey, a discussion was held with the Government representatives on 6 January 1968, in which agreement was reached in many matters.

Subsequent developments are briefly mentioned below :

(1) There was some differences regarding the record notes of discussions of 6 January 1968 prepared by the Government and the Institute Administration wrote to the Government suggesting certain amendments.

(2) The Pendharkar Working Group which had been set up by the Government early in 1967 in connection with the examination of recommendations regarding the reorganisation of the National Sample Survey, which information became known to the Institute in August 1967, submitted their report to the Government, a copy of which was received towards the end of 1967-68. The Council set up a committee, under the chairmanship of Dr. Nabagopal Das, to examine this report. The Das Committee's report was considered by the Council on 18 April 1968 and the relevant extract from the proceedings of the said meeting was forwarded to the Government under No. C 653 dated 6/7 May 1968.

(3) A second discussion took place in Delhi on 3 June 1968 between the representatives of the Government and the ISI in connection with the NSS issue. This meeting was attended by Shri D. S. Joshi, Cabinet Secretary, Shri D. C. Das, Secretary, Department of Statistics, Shri T. P. Singh, Secretary, Ministry of Finance, Dr. I. G. Patel, Special Secretary, Department of Economics Affairs, Shri M. R. Yardi, Additional Secretary, Ministry of Home Affairs, Shri A. P. V. Krishnan, Joint Secretary (L & R), Ministry of Finance, Shri S. P. Pande, Chief Director, National Sample Survey, Shri V. R. Rao, Director, Computer Centre and Shri S. P. Jain, Deputy Secretary, Department of Statistics, representing the Government; Dr. C. R. Rao, Director, Research and Training School, Shri D. B. Lahiri and Shri N. C. Ghosh, NSS Division, Dr. B. S. Minhas, Head, Planning Unit, Delhi, and Shri P. Roy, Joint Secretary, representing the Indian Statistical Institute.

(4) The Government representatives wanted to know the nature and dimension of a Survey Research and Project Wing in the event of the NSS work being transferred from the Institute.

(5) The Institute representatives could not get any idea about the nature of the future organisation of the NSS, in case the Government decided to transfer the NSS work from the Institute.

(6) A copy of the record note of discussion was received from the Government on 12 June 1968. As the views of the Institute representatives were not adequately recorded in some respects, necessary amendments were submitted to the Government on 17 June 1968.

In this connection, it may be mentioned that with regard to the differences relating to record note of discussions as stated in sub-paras (1) and (6) of paragraph 2.11 above, Shri S. P. Jain, Deputy Secretary, Department of Statistics (who represented the Cabinet Secretary in the meeting of the Council dated 18 August 1968) informed the meeting that it was not considered necessary to make any amendments as the notes were records of informal meetings. But this position was not accepted by the Council and the Chairman expressed the hope that Government would consider the matter further, and agree to have the views of both sides recorded in a way acceptable to both sides.

(7) The Institute has already implemented some of the decision of the Council in respect of certain recommendations of the Review Committee and of the Deshmukh Committee. The matters on which no settlement could be reached were discussed in detail in the Council meetings of 18 April and of 18 and 19 August 1968 and the views of the Council of the Institute have been intimated to the Government.

(8) A letter was received from the Government on 16 December 1968, enclosing a statement regarding the Government action relating to the Review Committee's recommendations. The Council of the Institute which met on 19 December 1968 noticed that in respect of a number of items tabled before the Parliament, the Government had accepted the suggestions, etc. of the Council, while in certain cases the matters are still under consideration of the Government. It was decided that those matters should be brought up for consideration of the Council which the Institute administration considered necessary after a careful examination of the statement.

(9) The tabled question, Government's recommendations etc. were examined in detail by the Institute administration and notes relating to those recommendations of the Review Committee which were not found acceptable by the Institute were placed before

the Council meetings of 15 and 24 March 1969. These were very carefully gone into in those meetings and the Council took certain decisions in respect of a number of important points (e.g., formation of the executive committee, merging of funds etc.) but consideration of other points had to be deferred.

Further developments will be reported in due course.

3. Honours and Awards

Professor P. C. Mahalanobis was awarded the Durga Prasad Khaitan Memorial medal by the Asiatic Society for the year 1968, for conspicuously important contributions in the field of statistics.

Dr. C. R. Rao was awarded the Meghnad Saha gold medal of the National Institute of Science for the year 1969 for outstanding contributions in a branch of science. He was appointed member of (*i*) the Committee to enquire into the overall functioning of the Council of Scientific and Industrial Research, and (*ii*) the Committee on Science and Technology.

Shri S. K. Bakai (*Geological Studies*) was admitted to the degree of Doctor of Science (D.Sc.) on his thesis "Stratigraphy of the coastal Gondwana and post-Gondwana rocks near Ellore (Eluru), West Godavari District, Andhra Pradesh, with special reference to Raghavapuram mudstones" based on the research work done in the Geological Studies Unit.

Shri Deb Kumar Dutta Mazumdar was elected a member of the Sectional Committee, Section of Statistics, Fifty-seventh session (1969-70), Indian Science Congress. He was also elected a member of the Association for Input-output Research, Gokhale Institute of Politics and Economics, Poona.

Dr. S. L. Jain (*Geological Studies*) was invited as an expert member for the selection committee for the appointment of a Reader in the Allahabad University in July 1968.

Professor S. K. Mitra (*Electronics*) acted as the Chairman, Fourth Session, Seminar on Computation, organised by the Institution of Telecommunication Engineers (Calcutta Centre) on 24 November 1968.

Shri Kanti Bhusan Pakrasi (*Anthropometry*) was awarded the D.Phil (Sc.) degree of the Calcutta University in May 1968, on the basis of research work in anthropology at the Institute.

Dr. J. Roy (*Computer Science*) was elected an ordinary member of the International Statistical Institute.

Dr. Supriya Sengupta (*Geological Studies*) was elected to the Council, International Association for Mathematical Geology, at its foundation meeting at Prague.

4. Conferences and Scientific Tours Abroad

Dr. C. R. Rao left Calcutta on 9 June 1968 for abroad to attend meetings and conferences. He participated in (*i*) the meeting of the Expert Group on Assessment of Acceptance and Use-effectiveness of Family Planning Methods convened by the ECAFE at Bangkok, Thailand (11-21 *June* 1968), and (*ii*) the Second International Symposium on Multivariate Analysis held at the Wright State University, Dayton, Ohio, U.S.A. (17-22 *June* 1968).

Dr. and Mrs. C. R. Rao went to Moscow on 22 September 1968, on invitation from the U.S.S.R. Academy of Sciences, and stayed in the U.S.S.R. up to 18 October 1968. During this period, Dr. Rao visited the Presidium of the U.S.S.R. Academy of Sciences and the Institute of Peoples of Asia on 23 September, the Ethnographic Institute (with Professor Mahalanobis) and the Economic Institute on the 24th, the Computer Centre and the Moscow University (Statistical Institute headed by Academician Kolmogorov) on the 25th, Steklov Institute of Mathematics and the Soviet Academy Publishing House on 26 September 1968.

Dr. Rao visited Tashkent, Samarkhand and Bhukara from 27 to 30 September. He had discussions with Professor Sirazuddinov, Rector, University of Tashkent, and Professor Sarimsakov, Minister of Education, and visited the Institute of Mathematics and the Institute of Oriental Studies of the Uzbekistan Academy of Sciences. He gave a lecture on 'Recent investigations on least square theory' at the Tashkent University.

During 1-3 October, he was at the 'Academic city' near Novosibirsk, where the Siberian branch of the Soviet Academy of Sciences is located. He visited the Institute of Geology, Institute of Economics and the Institute of Mathematics and had discussions with Academician Sobolev.

During 4-6 October, he was back in Moscow for further discussions with some scientists of the Academy of Sciences.

Dr. C. R. Rao left for Leningrad on the 6th and stayed there up to the 13th. He met Academician Linnik and his colleagues and participated in the seminars arranged at the Leningrad University. He gave lectures on (*i*) Robustness of least square estimators, (*ii*) Characterization of multivariate normality, (*iii*) Decomposition theorem of a vector variable and (*iv*) Statistical thinking. He also met Professor Vistelius and had discussions with him on geological research at the Institute of Mathematics.

He returned to Moscow on the 14th morning and stayed there till the 17th. At Moscow, he gave a lecture at Kolmogorov's Statistical Institute on 'Characterization of random variables in linear structural relations' on the 14th, at the Steklov Institute of Mathematics on 'Generalised inverse of singular and rectangular matrices' on the 15th and at the Economic Institute on 'Robustness of least square estimators' on the 16th.

Shri R. L. Brahmachary (*Embryology*) visited Uganda and Kenya from July to September 1968. During the period, Shri Brahmachary worked at the Makerere University Laboratory on Embryonic Information Transfer and at the Nairobi University.

Dr. B. C. Das (*Biometry*) and Dr. Rhea S. Das (*Appraisal*) left for London on 5 September 1968 and returned to Calcutta on 27 October 1968. In London, they had a series of conferences at the General Register Office regarding arrangements for a special listing of the Hospital In-patient Enquiry (England and Wales) data with Dr. A. M. Adelstein, Chief Medical Statistician, Dr. G. B. Hill and Dr. W. A. Wilson, Senior Medical Statisticians. They also discussed the analysis of hospital data and its use in planning health services, as well as the possible interchange of research personnel, with Professor H.F.L. Logan and Dr. J. S. A. Ashley, London School of Hygiene and Tropical Medicine, with Mr. Gordon McLachlan, Director, Nuffield Provincial Hospitals Trusts, and with Barbara Duncum, Nuffield Foundation. They registered for and attended the Twelfth Annual Meeting of the Society for Social Medicine, at the Imperial College, London.

Dr. B. C. Das also discussed gerontological research with Dr. Alex Comfort, MRC Research Unit on Aging, University College, London. Dr. Rhea S. Das had discussions on psycholinguistics and psychophonetics with Professor D. B. Fry, Department of Phonetics, University College, London, and Professor Alec Rodger, Department of Occupational Psychology, Birkbeck College, London. They visited the Research and Intelligence Unit, Scottish Home and Health Department, Edinburgh, and had discussions with Dr. J. Donnally, Senior Medical Statistician, Dr. Keith Hope, Statistician on the special case listing of the Scottish Hospital In-patient Enquiry. In Edinburgh, Dr. Rhea S. Das visited the Donaldsons' School for the Deaf, and discussed research on language development in deaf children with Dr. G. W. C. Montgomery, research psychologist.

They proceeded to Basel, Switzerland, to give lectures and participate in research discussions as visiting research scientists with Professor F. Verzar, Director, Institute for Experimental Gerontology. After completing this assignment, they proceeded to Geneva for discussions at the World Health Organisation on international health statistics, with particular reference to hospitalization data. At the W.H.O., they met Dr. W. P. D. Logan, Director, Health Statistics, Dr. M. Grais, Chief, Dissemination of Statistical Information, Dr. N. Junghalwalla, Director, Public Health Services, and Dr. R. F. Bridgman, Chief, Organization of Medical Care.

On the invitation of Professor Djordje Kostic, Director, Dr. Rhea S. Das visited the Institute for Experimental Phonetics and Speech Pathology, Belgrade, Yugoslavia, where she participated in research and completed a paper on children's verbal responses to phonetically different auditory stimuli, and completed spectrographic and palatographical data collection for an outline of Bengali phonetics. Dr. B. C. Das carried out an analysis of oil seeds on the nuclear magnetic resonance (NMR) analyzer at the Institute for the Application of Nuclear Energy in Agriculture, Veterinary Medicine and Forestry, Belgrade-Zemun.

Professor T. A. Davis (*Crop Science*) left for Jogjakarta (Indonesia) on 6 September 1968 to participate in the F.A.O. Conference on Cocoonut Production, Protection and Processing (9-19 *September*). He presented the following three papers at the conference:

1. Bilateral symmetry in the leaves of *Cocos nuciference* L. 2. Vegetative apomixis in coconut and other palms. 3. Morphology and physiology of coconut pneumatophores. He was on tour for five weeks in Indonesia, Malaysia and Thailand. In Indonesia, apart from participating at the FAO Technical Conference on Coconut (at Jogjakarta), he delivered a lecture on 'Clonal propagation in the coconut' at the Gadjamada University, Jogjakarta. He also delivered a lecture on the 'Possibilities of effecting vegetative propagation in the oil palm' to the executive staff of the United Plantations (Malaysia). At Bangkok, Professor Davis participated, on invitation, in the ECAFE sub-Regional Consultations on Regional Plan Harmonization: Coconut Products and Oil Palms and gave an account of the significance of the foliar arrangements in the coconut and oil palms.

Professor D. B. Lahiri (*National Sample Survey*) left for the U.S.A. on 19 April 1968 and attended, on invitation, the Symposium on Survey Sampling organised by the University of North Carolina at Chapel Hill on 24 April 1968.

Dr. S. K. Mitra (*RTS*) left Calcutta for Budapest, Hungary, on 16 October 1968 for a six-week visit under the Indo-Hungarian Cultural Exchange Programme. He visited the

following institutions in Budapest : Central Statistical Office, Karl Marx University, Technological University, Mathematical Institute of the Hungarian Academy of Sciences and also the universities at Szeged and Debrecen. He delivered lectures at some of the places.

Professor R. Mukherjee (*Sociology*) left India on 5 June 1968 to attend the UN.E.S.C.O. Seminar on Social Research Methods held from 24 June to 2 August 1968 in Copenhagen, on an invitation from the Danish National Institute of Social Research. Professor Mukherjee delivered two lectures at the seminar on "Experiences from Sample Surveys in India" on 10 and 11 July 1968.

Between June and September 1968, Professor Mukherjee visited several other European countries, besides lecturing at the Danish National Institute. In response to long-standing invitations, he visited other places, such as the Institute of Comparative Social Research at Cologne, International Social Science Council of Paris and the Institute of the Peoples of Asia, Moscow. His visit to the Cologne University was widely covered on 3 July 1968 by the West German newspaper *Saarbrucker Zeitung*. He returned to India on 16 September 1968.

On an invitation from the Research Centre on Social and Economic Development in Asia, the Institute of Economic Growth, Professor Mukherjee attended a meeting held in Bangkok on the "Survey of social trends in Asia : working group" held from 10 to 14 March 1969. He left India on 10 March and returned on 15 March 1969.

5. Study Tours and Assignments Abroad

Dr. D. Basu (*RTS*) left for the USA to accept a visiting professorship at the University of New Mexico from 1 July 1968.

Dr. L. S. Bhat (*Planning and Regional Survey Unit, New Delhi*), was on a visiting appointment in the Department of Geography, Australian National University, Canberra, for one academic year. He left for Canberra on 15 March 1968 and returned to Delhi on 16 November 1968. During this period, he visited universities and research organisations for lectures and held discussions on land systems analysis and regional survey and planning.

Dr. Bhat went to Bangkok on 8 January 1969, at the invitation of the ECAFE, to work as a consultant for the preparation of a manual on regional planning. An outline of the project was finalised during his stay there. He returned to Delhi on 7 February 1969.

Dr. D. K. Bose joined the Planning Unit, Calcutta, on 9 September 1968, after spending one year at the Iowa State University, USA.

Dr. S. W. Dharmadhikari (*RTS*) rejoined on 1 August 1968, after spending two years at the University of Arizona, USA.

Dr. E. V. Krishnamurthy (*RTS*) left for Israel in January 1969 to accept a visiting fellowship at the Seizmann Institute of Science, Rehovoth, Israel, for one year from 1 January 1969.

Shri T. Krishnamurty (*RTS*) joined the Lever Brothers, Bombay, from 1 March 1969, for one year.

Shri A. N. Nankanna (*Statistical Quality Control*) was selected as one of the delegates from India to attend the training course on installing a quality control system in an industry organised by the Asian Productivity Organisation (A.P.O.) in Tokyo, from 22 January to 24 February 1969. He left India to reach Tokyo on 21 January 1969 and returned to Bangalore on 6 March 1969.

Shri N. Narayana (*Statistical Quality Control*) proceeded to the U.S.A. on a nine-month United Nations fellowship programme for undergoing training in operations research at the Johns Hopkins University. He left India on 17 September 1968.

Dr. Tapan Roy Chowdhury (*Geological Studies*) left for Britain on 21 November 1968 to accept an appointment at the University College, London, to assist Dr. Pamela Robinson in her research project on "Triassic Vertebrate Faunas from Britain and India", financed by the Natural Environmental Research Council of Britain. On the way, he stayed in the U.S.S.R. for ten days (21-30 *November*) as a guest of the U.S.S.R. Academy of Sciences. During this period, he visited the Paleozoological Institute of the Academy in Moscow and had the opportunity of examining the excellent Russian collection there. He had extensive discussions with Russian colleagues on the significance of the similarities between the fossil faunas of the U.S.S.R. and India. Dr. Roy Chowdhury also visited the Zoological and Geological Institutes of the Academy in Leningrad.

Shri K. Sankaranarayan (*National Sample Survey*) rejoined in May 1968, on the expiry of his short study tour in Canada, under the Colombo Plan, for training in survey methods, including the analyses of non-sampling errors in censuses and surveys.

Shri Sugata Sen Gupta (*Geological Studies*) was awarded a Commonwealth Fellowship for higher studies in Geology at the Imperial College of Science and Technology, London. He left for London on 18 September 1968.

Dr. J. Sethuraman (*RTS*) left for the U.S.A. on 18 September 1968 to accept a visiting professorship at the Florida State University.

Dr. K. R. Shah (*RTS*) left for Canada on 23 September 1968 to accept a visiting professorship at the Waterloo University.

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 worked at the United Steel Co., Sheffield, on operations research projects.

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 :

Rhea S. Das (*Appraisal*), Sudhir Ranjan Das (*Anthropology and Human Genetics*), Prabhat Ranjan Pal (*Biochemistry*), Bhupendra Chandra Das (*Biometry*), Subodh Kumar Roy (*Botany*) Jogabrata Roy (*Computer Science*), Trupapur Antony Davis (*Crop Science*) Manapadom Venkateswarier Raman (*Demography*), Deb Kumar Bose (*Economic Research*),

Ratan Lal Brahmachary (*Embryology*), Sohan Lal Jain (*Geology*), Monimohan Mukherjee (*National Income Research*), Durgaprasad Bhattacharya (*Pre-Census Population Studies*), Sibabrata Chatterjee (*Psychometric Research and Service*), and Ramkrishna Mukherjee (*Sociology*).

Subodh Kumar Roy was the Dean of Studies, Asoke Maitra was in charge of training at the International Statistical Education Centre, Sujit Kumar Mitra was in charge of the Summer School, and B. Ramachandran in charge of the evening courses at Calcutta and the branches of the Institute.

1. The research work of the Institute during the year 1968-69 is embodied in 170 papers sent for publication in journals. A complete list of these papers and abstracts are given in *Annexure* 5 and the Research Summary. A selected list of topics on which research was carried out, from the wide variety of subjects covered in these papers, is given below.

1.1. *Mathematical statistics and probability:* Generalised inverses of matrices, theory of least squares, multivariate analysis, characterisation of univariate and multivariate normal distributions, sampling over two occasions, comparison of sampling with and without replacement, marginal function of finite stationary Markov chains, characteristic functions, and generalised stable laws.

1.2. *Mathematics and numerical analysis:* Analytic and co-analytic sets, discrete Borel spaces, repeated interchange graphs, powers of trees and other graphs, characterisation of graphs, connected graphs, and radix-conversion of numbers.

1.3. *Natural sciences:* Age-related behaviour of blood characteristics, planning of hospital services from age-specific mortality data, studies on spirality and genetic improvement of the coconut, bilateral asymmetry of flowers and plants, dermatoglyphics and hairy pinnae in Indian population, vomerine teeth of Ceratodus from the Maleri formation, stratigraphy of the upper Gondwana formations of the Pranhita-Godavari valley, sieving and settling techniques for sand analysis, chain exchange reactions of elementary particles, and deuteron polarisation in nucleon-deuteron scattering.

1.4. *Economics, demography and sociology:* Productivity and earnings in Indian manufacturing industries, demand projection of cereals, estimation of all-India birth and death rates, life tables for Assam, and diachronic and synchronic aspects of social change.

1.5. *Psychometry:* Semantic differential measurement, inter-relationship among Serbo-Croation vowels, child response to auditory stimuli, confidence interval for the score, construction and development of non-language test of verbal intelligence and interest patterns of the inmates of a house of detention.

Courses: A new diploma two-year evening course in statistical quality control and operations research was started during the year in Madras and Bombay, while new subjects were added for specialization at the M.Stat level. The research and training courses conducted by the Research and Training School in 1968-69 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. *Specialized Course in Applied Statistics leading to Diplomas*

   3.1 Bio-statistics.

   3.2 Demography.

   3.3 Econometrics and Planning.

   3.4 Large Scale Sample Surveys.

   3.5 Operational Research and Allied Techniques.

   3.6 Quantitative Genetics.

   3.7 Statistical Quality Control.

4. *Summer Course in Statistics.*

5. *Training Courses in Statistics*

   5.1 Statistical Officer's Training Course (jointly with the Central Statistical Organisation, 8/9 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 Bangalore, Bombay and Madras (by the Branch offices) and Calcutta.

   6.5 Elementary Techniques of Computations, Calcutta.

   6.6 Statistical Computations, Calcutta.

   6.7 Diploma Course in Statistical Quality Control and Operational Research, Bangalore and Madras.

7. *Electronic Computer Courses*

   7.1 Three-month Intensive Course on Programming and Applications.

   7.2 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 admission 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 1968 at eight centres: Bombay, Calcutta, Delhi, Hyderabad, Madras, Trivandrum, Varanasi and Waltair. The selection of candidates to the courses were made by committees with representatives from 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 Programme for statisticians was started eight years ago for the benefit of university teachers and research workers desiring to utilize their summer holidays for advance studies and research. Its eighth session was conducted during May/June 1968 at Calcutta. The course, devoted to Coding Theory and Combinatorial Mathematics, was attended by 28 teachers and scholars from universities and research organizations.

Besides the staff members of the Research and Training School, Dr. P. K. Menon, Director, Joint Cipher Bureau, Government of India, Professor S. S. Shrikhande, Department of Mathematics, University of Bombay, and Kenan Professor R. C. Bose, University of North Carolina, USA, gave lectures at the Summer Course.

6.3. International Statistical Educational Center (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 Twentysecond Term functioned under a Board of Directors with Professor P. C. Mahalanobis as Chairman.

Twentyeight trainees from eleven 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.

The Government of India awarded a total of 23 fellowships for the foreign trainees in the Twentysecond Term, under the Technical Co-operation Scheme of the Colombo Plan (20), and the Special Commonwealth African Assistance Plan (3). There was one trainee outside the Colombo Plan or SCAAP for the regular course and two more trainees came from Iran for the special course.

The Twentysecond Term opened on 1 July 1968. 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 Organisation and Procedures. As in the previous terms, a six-week training in governmental statistics was given at the Central Statistical Organization, New Delhi,, during October-November 1968. From February 1969 up to the end of April 1969, 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 last four months, general lectures were also given on Probability Theory, Vital Statistics and Demography, Sampling Theory, Statistical Distributions, Inference, Large Scale Sample Survey 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

Professor S. H. Khamis, a visiting professor at the ISEC, delivered a course of lectures on Index Numbers, during the term.

In the final examinations, 26 trainees of the Regular Course came out successful and were recommended Certificates of Merit, while 2 were recommended Certificates of Attendance.

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.

INDIAN STATISTICAL INSTITUTE

I. The following scientists visited the Institute on invitation and worked for fairly long periods during the year 1968-69. The duration of the visit is mentioned within brackets against each name.

1. Professor George Akerlof, University of California, Berkeley, U.S.A. (17 *August* 1967–4 *September* 1968) did research work in the Planning Unit, Delhi, on macro-economics and project evaluation. He also participated in the teaching programme of the Institute in Delhi.

2. Dr. L. B. Alayev, Institute of Peoples of Asia, USSR Academy of Sciences (16 *January*–27 *December* 1968), came to India for research work on the Indian village community.

3. Dr. Erik Balslev, Institute of Mathematics, University of Sparkeo, Arhus C., Denmark (10 *December* 1967–20 *March* 1968), came on a travelling fellowship. *Series of seminars:* Differentiable manifolds and differential geometry.

4. Dr. A. L. Batalov, Institute of Peoples of Asia, USSR Academy of Sciences (16 *January*–17 *July* 1968), is an expert in Indian industrial development. He visited many important places to study industrial location in India. *Lecture:* Some problems of industrial development. (*Mysore State Branch*).

5. Professor C. B. Bell, Department of Mathematics, University of Michigan, U.S.A. (16 *August*–5 *September* 1968). *Lectures:* Some approaches to non-parametric testing.

6. Professor N. M. Blake, Australian National University, Canberra, Australia (1–22 *December* 1968), an expert in the diagnosis of disorders in the immunoglobulin system, advised the research staff of the Anthropometric and Human Genetics Unit in carrying out some blood tests. *Seminar:* Immuno-electrophoretic studies in serum proteins.

7. Professor Raj Chandra Bose, Kenan Professor, Department of Statistics, University of North Carolina, U.S.A. (1 *June*–25 *July* 1968). *A course of lectures:* Recent developments in coding theory (at the Eighth Summer School). *Series of seminars:* (i) Characterisation of a class of regular graphs, and (ii) Pairs of orthogonal latin squares, one of which is cyclic.

8. Dr. N. E. Brushlovsky, Vice-Director, Nauka Publishing House, USSR Academy of Sciences (13 *February*–6 *March* 1968). He had discussions with Professor P. C. Mahalanobis regarding the gift of printing machinery from the U.S.S.R. Academy of Sciences.

9. Professor Zlenek Frolik, Charles University, Prague; Czechoslovak Academy of Sciences (18–23 *October* 1968). *Course of* 10 *lectures*: Analytic sets in topological spaces.

10. Professor David V. Glass, London School of Economics and Political Science, University of London (1 *March*–20 *April* 1968 and 23 *January*–0 *March* 1969), had discussions at the Planning Unit, Delhi, on problems relating to economics and urban studies and also with the staff members of the Demography Unit on the questionnaire to be employed in the Calcutta Fertility Survey. He had a series of discussions in the N.S.S. on the technical and operational aspects of demographic survey.

11. Mrs. Ruth Glass, Director, Research Centre for Urban Studies, University College, London (1 *March*–20 *April* 1968 *and* 23 *January*–9 *March* 1969), had discussions at the Planning Unit, Delhi, on problems relating to economics and urban studies and also with senior staff members of the Institute on the organisation of a Seminar on India's Social Situation.

12. Dr. J. M. Juran, Dean of American Consultants on Quality Control (7–28 *December* 1968), conducted his well-known courses on the management of quality control for five days each at Bangalore and Agra. He had several group discussions with the top managements in Bangalore, Bombay, Calcutta, Delhi and Madras and also delivered lectures on his concept of breakthrough in quality as well as the management of quality control. He had discussions with technical officers of SQC Units of the Institute in different parts of the country. He also visited some industrial establishments. The new concepts he expounded have stimulated a number of managements to revamp their quality control programmes.

13. Dr. S. H. Khamis, Chief, Trade and Prices Branch, Statistics Division, Food and Agricultural Organisation, United Nations, Rome (17 *January*–28 *February* 1969), came as a visiting professor at the International Statistical Education Centre, Calcutta. *Lectures* : (i) Index numbers, and (ii) Properties of the incomplete gamma function and other related topics, I and II.

14. Dr. R. L. Kirk, John Curtin School of Medical Research, Australian National University, Canberra, Australia (14–24 *April* 1968), came on his second visit during the year. He gave seminars on the problems of human genetics during his earlier visit in December 1967 for two weeks. Dr. Kirk initiated, during the year, some projects on human genetics, involving the study of patterns of haptoglobin, transferring of human blood serum and placental enzyme like alkaline phosphatase by electrophoretic methods.

15. Professor T. C. Koopmans, Cowles Foundation for Research in Economics; Department of Economics, Yale University, U.S.A. (2–22 *February* 1969), worked in the Planning unit, Delhi, as a visiting professor. *Two lectures* : Efficient allocation and valuation of resources. *Seminars* : (i) Optimal economic growth with variable discount rate, the Leontief-Westfield discussions reconsidered, (ii) Choice of an optimality criterion for economic growth, and (iii) What good are economic models ?

16. Professor Djordje Kostic, Director, Institute for Experimental Phonetics and Speech Pathology, Serbian Academy of Sciences, Belgrade, Yugoslavia (27 *December* 1968 –22 *March* 1969), was invited to develop some new lines of precepts in linguistics. He conducted a seminar on Bengali Acoustic Phonetics organised by the Indian Statistical Institute during 19-20 February 1969. *Lecture* : Some aspects of multilingualism in Yugoslavia.

17. Professor Stephen A. Marolin, Harvard University, Cambridge, U.S.A. (12 *September* 1967–9 *September* 1968), undertook research on the optimal use of irrigation water, and also participated in the teaching activities of the Institute in Delhi.

18. Dr. P. K. Menon, Director, Joint Cipher Bureau, New Delhi (20 *May*–7 *June* 1968). *A course of lectures* : Modern algebra (at the Eighth Summer School).

19. Professor Joseph Putter, Head, Division of Statistics and Experimental Design, Volcani Institute of Agricultural Research, Israel (17 *August*–12 *October* 1968).

Lectures: (i) Estimating the result of a selection, (ii) Maximum likelihood estimators of multivariate variance components, and (iii) Non-existence of an unbiased estimate of a density for a sample of size one.

20. PROFESSOR J. N. K. RAO, Department of Statistics, TEXAS A & M University, U.S.A. (10 *July* 1968–13 *September* 1969), joined the Institute at the beginning of the academic term 1968. (i) *Series of lectures*: Special topics in sample surveys and Bayesian inference (for the senior M. Stat. students specialising in biostatistics), (ii) *Seminars*: Estimation of parameters in econometric models and some problems in sample surveys.

21. DR. M. M. RAO, Professor of Mathematics, Carnegie-Mellon University, Pennsylvania, U.S.A. (26 *September* 1968–9 *February* 1969), joined the Institute as a visiting professor and spent one academic term. *Seminars*: (i) Statistical inference in stochastic processes, and (ii) Orlicz spaces with applications to decision theory.

22. Dr. P. L. ROBINSON, University College, London (2–17 *September* 1968), visited the Institute for the first time in 1957. She had been coming periodically since then to advise the workers of the Geological Studies Unit. During her visit in the current year, she had discussions with the staff of the Geological Studies Unit regarding research problems and the field programme for the 1968-69 season.

23. PROFESSOR S. S. SHRIKHANDE, University of Bombay (18 *May–5 June* 1968). *Lectures*: Introduction to coding theory (at the Eighth Summer School).

24. PROFESSOR A. B. VISTELIUS, Head, Laboratory of Mathematical Geology, Institute of Mathematics, USSR Academy of Sciences (25–28 *July* 1968; 5 *March–4 June* 1969), worked on a research project with the help of the Geological Studies Unit and visited some areas in this connexion. He was the main speaker at a course of lectures on mathematical geology, attended by several Indian specialists in the field and organised by the Indian Statistical Institute from 21 March to 14 May 1969.

25. DR. THOMAS, E. WEISSKOFF, Harvard University, Cambridge, U.S.A. (24 *September* 1966–27 *July* 1968), worked as a visiting professor in the Planning Unit, Delhi. He did research on planning models and input-output analysis with special reference to import substitution. He also gave a seminar on domestic savings and foreign exchange constraints and participated in teaching activities.

26. DR. (MISS) ELIZABETH WHITCOMBE, Social Sciences Research Council, United Kingdom (19 *June* 1968–14 *March* 1969), carried out research on land reforms and rural development in joint collaboration with the Social Sciences Research Council and the Indian Statistical Institute, at the Planning Unit, Delhi.

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

1. DR. P. K. BHATTACHARYA, Arizona University, U.S.A. (6 *September* 1968). *Lecture*: Estimation of density and its applications.

2. DR. K. A. BUSH, Department of Mathematics, Washington State University, U.S.A. (5–8 *January* 1969). *Lecture*: (i) Hadamard matrices and finite projective planes, (ii) Estimation and perfect samples.

3. DR. RAUL CALVIMONTES, Director, National Scientific and Technical Documentation Centre, Bolivia (4–9 *February* 1969): *Lecture*: Documentation service in Bolivia (*DRTC, Bangalore*).

4. Dr. S. S. Chitgopekar, Florida State University, U.S.A. (4–6 *August* 1968). *Lecture* : Continuous time Markovian sequential control processes.

5. Professor P. J. Clarinbold, Research Leader, Computer Group, Division of Animal Genetics, Australia (31 *August*–5 *September* 1968). *Lectures* : (i) Operating systems for computers, and (ii) Conversational computing, with special reference to statistics.

6. Academician G. M. Dobrov, Division of Science of Science Investigations, Mathematical Institute, Ukraine SSR Academy of Sciences, Kiev (25 *April* 1968). *Lecture* : Science of Sciences (*DRTC, Bangalore*).

7. Professor H. D. Evans, Harvard Economic Research Project, Harvard University, U.S.A. (19 *December* 1968). *Seminar* : Effects of protection in a general equilibrium frame-work (*Planning Unit, Delhi*).

8. Professor S. P. Franklin, Institute of Technology, Carnegie, U.S.A. (9–12 *August* 1968). *Lecture* : Sequential spaces.

9. Professor Herbert Grubel, University of Pennsylvania, U.S.A. (25 *January* 1969). *Seminar* : Economics of the brain drain. (*Planning Unit, Delhi*).

10. Dr. Worren Hall, Director, Dry Lands Research Institute ; Professor of Engineering, University of California, U.S.A. (1 *February* 1969). *Seminar* : A dynamic programming approach of water among power generation and irrigated crops.

11. Dr. S. P. Lapage, Curator, National Type Culture Collection, Central Public Health Laboratory, London (30 *October* 1968). *Lecture* : Use of computer for identification of bacteria.

12. Dr. Goutam Mitra, Council of Economic and Industrial Research, U.K. (23–25 *September* 1968). *Three lectures* : Integer programming.

13. Professor K. H. Pfeffer, Director, Social Research Centre, University of Müenster, Federal Republic of Germany (10–14 *March* 1969). *Lectures* : (i) Can there be a special sociology of developing nations ? and (ii) Seminar on special methods of field research in developing nations (two lectures).

14. Dr. P. K. Sen, University of North Carolina, U.S.A. (12 *September* 1968). *Lecture* : Non-parametric procedure in randomized block design.

15. Dr. J. N. Srivastava, Colorado State University, U.S.A. (17–21 *December* 1968). *Three lectures* : Optimal balanced fractional factorial designs.

16. Mr. R. W. Steel, Department of Geography, Liverpool University, U.K. (17 *December* 1968). *Seminar* : Regional and economic geography and its relevance to planning. (*Planning Unit, Delhi*).

17. Dr. P. V. Sukhatme, Director, Division of Statistics, Food and Agriculture Organisation (4 *February* 1969). *Lecture* : Nature of the protein problem in India (*Bombay Branch*).

18. Dr. Joseph Tar, Architect and Economist, Chief, Main Department for Investment and Building Industry, Central Statistical Office, Budapest, Hungary (29 *January*–7 *March* 1969). *Lectures* : (i) Economics of the building industry (*DRTC, Bangalore*), (ii) Statistical systems in Hungary (*Bombay Branch*).

III. The following are some of the visitors from abroad who came to the Institute for short periods during the current year on different assignments. The date of visit is mentioned within brackets against each name.

1. Dr. Janos Av, University of Economics, Budapest; adviser in methodological problems in the Agricultural Division, Hungarian Central Statistical Office, Budapest. (31 *October*, 4 and 11 *November* 1968).

2. Dr. Dietrich Michael Bergmeier, Economist, Reconstruction Loan Corporation, Federal Republic of Germany. (25 *October* 1968).

3. Mr. M. Bolgar, Chief Engineer, H. and D. Department, Hungarian Ministry of Metallurgy and Machine Industry, Budapest, Hungary. (12 *September* 1968).

4. Professor D. Bogue, Department of Sociology, University of Chicago, U.S.A. (25 *October* 1968).

5. Major-General Sardjan Brujic, Chief Controller, Quality of Materials, Yugoslavia. (15 *March* 1969).

6. Mrs. Dorothy S. Cooke, Chief, International Research Branch,, National Centre for Health Statistics, Public Health Service, U.S.A. (25 *June* 1968).

7. Dr. W. H. Cope, Bureau of Health Services, U.S. Public Health Service, Washington, U.S.A. (25 *June* 1968).

8. Dr. Ralph Diaz, U.N. Asian Institute of Economic Development and Planning, Bangkok, Thailand. (20 *December* 1968).

9. Dr Edwin Driver, Professor of Sociology and Anthropology, University of Massachusetts, U.S.A. (20 *August* 1968).

10. Dr. I. I. Egorov, Economist, Institute of Peoples of Asia, USSR Academy of Sciences, Moscow. (16 *April* 1968).

11. Dr. Abdel Mequid El-abid, Head, Central Training Organisation; Minister-in-charge of Manpower, United Arab Republic (19 *February* 1969).

12. Dr. John R. Everett, President, New School for Social Research, New York, U.S.A. (21 *November* 1968).

13. Dr. D. K. Ghosh, Economic Development Branch, ECAFE (13 and 16 *May* 1968).

14. Mr. M. Hassan Habbal, Chief of Statistics Section, Minister of Agriculture, Damascus, Syria (14–17 *December* 1968).

15. Dr. Reuben Hill, Director, Family Study Centre; Professor of Sociology, University of Minnesota, U.S.A. (23 *July* 1968).

16. Dr. J. I. Hoffman, Geological Institute, Freiberg Mining Academy, Freiberg, German Democratic Republic. (22 *November* 1968).

17. Mrs. Hiroko Kano, Deputy Programme Officer, International House of Japan; Secretary, India-Japan Round Table Conference. (11–13 *November* 1968).

18. Dr. P. Meera Khan, Department of Human Genetics, Institute voor Anthropogenetics, Leiden, Federal Republic of Germany. (20-23 *November* 1968).

19. Dr. G. Kolmalova, Institute of Asian Studies, USSR Academy of Sciences, Moscow. (17 *June* 1968).

20. Dr. S. A. Kuzmin, Chief, Laboratory of Economic Mathematical Models of Developing Countries, Central Institute of Economics and Mathematics, USSR Academy of Sciences. (23 *September* 1968). He had also visited the Institute for over two months in April-June 1967 for discussions on economic and mathematical problems.

21. Mrs. G. Lajos, Deputy Director, Market Research Institute, Budapest, Hungary. (13 *December* 1968).

22. Professor A. T. A. Learmonth, Department of Geography, Australian National University, Canberra, Australia. (*Planning Unit, Delhi*). (27 *November*-8 *December* 1968).

23. Mr. Kenjiro Matsutani, Institute of Asian Economics Affairs (*Ajia Keizai Kenkyusho*), Tokyo, Japan. (29-30 *November* 1968).

24. Mr. Heinrich Meier, Deputy Minister, Planning Commission, German Democratic Republic; Vice-President, German South East Asian Society. (8 *May* 1968).

25. Sri Moni Nag, Research Anthropologist, International Institute of Human Reproduction; Assistant Professor of Anthropology, Columbia University, U.S.A. (23 *July* 1968).

26. Mr. Koiki Okata, Secretary, Japan Committee for Studies on Economic Development in India and Japan, Tokyo, Japan. (15-28 *November* 1968).

27. Dr. B. Ramamurthy, Regional Statistician (Retired), United Nations, presently assisting the UN Secretariat in setting up an Institute of Statistics and Applied Economic Research for the East African countries. (24-26 *October* 1968).

28. Dr. Bhim S. Savara, Chairman of Department, Child Study Clinic, University of Oregon Dental School, Oregon, U.S.A. (2 September 1968).

29. Dr. Borislav Savich, International Labour Organisation, United Nations Expert. (7 *June* 1968).

30. Dr. C. W. Schwabe, Consultant for training in Veterinary Public Health, South East Asia Regional Office, World Health Organisation. (28 *August* 1968).

31. Dr. Randall L. Thompson, Science Representative, National Institute of Health, New Delhi. (13 *May* 1968).

32. Dr. Daniel Thorner, Ecole Pratique des Hautes Etudes, Paris, France. (20 *December* 1968-3 *March* 1969).

33. Mr. Danilo S. Tolentino, Budget Assistant, Asian Productivity Organisation, Tokyo, Japan. (13 *August* 1968).

34. Dr. F. Vogel, Director, Institute of Physical Anthropology and Human Genetics, Heidelberg, Federal Republic of Germany. (5-6 *May* 1968).

35. & 36. Mr. E. Bryan Waide and Mr. Basil Kavalsky, International Bank of Reconstruction and Development, Washington D.C., U.S.A. (15 *May* 1968).

37. Dr. John M. Wynne, Vice-President, Organisations Systems, Massachusetts Institute of Technology, Cambridge, U.S.A.(22 *July* 1968).

8. Professional Examinations

Professional Examinations : The following professional examinations were held during the year: Statistician's Diploma (SD; May, November 1968), Statistical Field Survey Diploma (SFSD; November 1968 only), Computer's Certificate (CC; May, November 1968), Punched Card Machine Operator's Certificate (PCMOC; May 1968 only).

The examinations for the May 1968 session were held from 17 to 30 May and the examinations for the November 1968 session were held from 19 to 30 November.

The professional examinations were held in 1968 in the following centres : Bombay, Calcutta, Delhi Giridih, Lucknow and Madras. Due to a lack of sufficient response, no centre was opened at Bangalore and a centre was opened at Hyderabad only for the examination held in May 1968.

The Statistician's Diploma examination continued to attract the largest number of candidates. The next in the list has always been the Computer's Certificate examination, but with a substantially lower number of registrations. The candidates for the other two examinations have been distressingly small in number for sometime past. Consequently, the Punched Card Machine examinations were held only once a year in May and the Statistical Field Survey examinations only in November.

Statistician's Diploma Examination : During 1968, 159 candidates (90 in May; 69 in November) had registered, compared to 183 (99 in May; 84 in November) in 1967. Twentyfour candidates (15 in May; 9 in November) were absent in all the papers for which they had registered themselves in 1968, compared with 25 (14 in May; 1 in November) in 1967. Of those who finally appeared in 1968, 95 candidates (50 in May; 45 in November) passed on one or more papers, while 70 candidates (40 in May 30 in November) passed in one or more papers in 1967.

Statistical Field Survey Diploma Examination : Two candidates who had registered also appeared and passed in one or more papers in November 1968. Two candidates had appeared and passed in November 1967.

Punched Card Data Processing Diploma Examination : The examination was not held in May or November 1968, as no candidates participated. In 1967, only 1 candidate passed in May and 2 passed in November.

Computer's Certificate Examination : Twentynine candidates (15 in May; 14 in November) had registered for the examination in 1968, compared with 17 (11 in May; 6 in November) in 1967. Only 2 candidates failed to appear in any paper in 1968 (2 in May; nil in November), as against 1 only in May 1967. Of the candidates who finally appeared, 17 (7 in May; 10 in November) passed in one or more papers in 1968, compared with 11 (6 in May; 5 in November) who passed in one or more papers in 1967.

Statistical Field Survey Certificate (Junior and Senior) Examinations : The scheduled examinations in November 1968 for the Junior and Senior Certificates could not be held as candidates were not available. In 1967, there was only one candidate for the Senior Certificate and none for the Junior Certificate examination.

Punched Card Machine Operator's Certificate Examination : Only 2 candidates registered, appeared and passed in one or more papers of this examination in May 1968. Examinations were not held in November 1968, according to the decision of the Examinations Committee to reduce the frequency of the examinations and to hold them only once a year during the May session. In 1967 also there had been no candidate for the May examination, and only one candidate for the November examination.

Candidates qualifying for Diplomas and Certificates : The total number of candidates, who having completed the entire Statistician's Diploma Examination, qualified themselves for the award of Diplomas was 13 (9 in May; 4 in November) in 1968. In 1967, the corresponding figure was 10 (3 in May; 7 in November).

Statistical Field Survey Diploma : There has been no candidate in 1968, but only one candidate was successful in 1967.

Punched Card Data Processing Diploma : No candidate qualified in 1968; 3 candidates (1 in May; 2 in November) had qualified in 1967.

Computer's Certificate Examination : Only 2 candidates (1 in May; 1 in November) qualified for the Computer's Certificate in 1968. In 1967 also, 2 candidates (2 in May; nil in November) had passed.

Statistical Field Survey Examination : No candidate qualified for the Senior Certificate in 1968; 1 candidate qualified for it in 1967. No candidate appeared or qualified for the Junior Certificate Examination in 1967 or in 1968.

Punched Card Machine Operator's Certificate Examination : One candidate only qualified in the certificate examination in May 1968; there was, however, no candidate in May or November 1967.

Award of Diploma : On the basis of the 1967-68 professional statistics examination results, 14 candidates were declared eligible for the award of the Diploma (10 SD; 1 SFSD and 3 PCDPD). These awards were made at the Sixth Convocation of the Indian Statistical Institute held on 12 February 1968. As against this, 13 candidates, all of whom had sat for the Statistician's Diploma examination, were declared eligible for the award of diplomas on the basis of the professional statistics examination results of 1968-69.

The list of successful candidates under different categories during May and November 1968 examinations are given in *Annexure* 4.

9. Planning and Economic Research

The Planning Division in Calcutta and the Planning Unit in Delhi were placed administratively in the Research and Training School from December 1967. 1. As a step towards the reorganisation of the activities of the Planning Division at Calcutta, a National Income Research Unit was formed in May 1968, with Professor M. Mukherjee as the technical and administrative head. 2. An Economic Research Unit, with Dr. D. K. Bose as the administrative head, was formed in September 1968. 3. A Pre-census Population Studies Unit under Shri D. Bhattacharyya was also formed in September 1968.

9.1. *National Income Research Unit (N.I.R.U.)*: The work included research in the field of national income and allied topics and other activities. A brief research summary is given separately. A list of papers published and sent for publication is given in *Annexure* 5.

The National Income Research Unit participated in teaching subjects in the RTS and the ISEC which have a special bearing on national income. Arrangements were also made for the specialisation of ISEC students and for research work leading to dissertation for workers already qualified for the M.Stat. Research supervision continued to be an activity of the Unit.

A number of foreign scientists and eminent scholars visited the Unit during the year and held discussions on technical matters.

M. Mukherjee, G. S. Chatterjee and B. Dey attended the Sixth Conference of the Indian Association for Research in National Income and Wealth held at Bangalore from 3 to 5 May 1968 and presented papers. M. Mukherjee served as the rapporteur in one of the sessions. He was elected president of the Association to succeed Dr. V. K. R. V. Rao and G. S. Chatterjee was elected a member.

M. Mukherjee attended the meeting of the Working Group on State Income at the Central Statistical Organisation, New Delhi, on 8 and 9 August 1968. He attended the Fiftysixth Session of the Indian Science Congress held at Bombay from 31 December 1968 to 10 January 1969 and presented two papers.

G. S. Chatterjee attended the Eighth Indian Econometric Conference held in Bombay from 16 to 18 January 1969 and presented a paper. He acted as chairman in one of the sessions of the conference.

M. Mukherjee, G. S. Chatterjee, B. Dey and B. Roy attended the Seminar on India's Social Situation held at the Indian Statistical Institute (Calcutta) from 27 January to 1 February 1969 and M. Mukherjee presented a paper.

9.2. *Economic Research Unit (E.R.U.)*: The unit shouldered the bulk of the responsibility of teaching economics, econometrics and planning in the courses of the RTS and the ISEC. The courses includes 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. Particular mention may be made of the specialization course in planning and econometrics for the second-year M.Stat. students and also of the Diploma Courses in Planning and Econometrics. Apart from organising lectures and practical lessons in the above courses, arrangements were made for intensive specialization for the ISEC students and for project work leading to dissertations for the M. Stat. second year and diploma course students. Research supervision was another important activity of the Unit.

Research work in the E.R.U. covered various fields of econometrics and applied economics. A brief research summary is given separately. Eight papers were published or sent for publication (*Annexure* 5) and four papers submitted to scientific conferences. In all, fourteen technical papers were brought out by members of the Unit during the year.

With the help of colleagues from other departments of the Institute, S. Naqvi and some workers of the E.R.U. shouldered the main responsibility for organising a Seminar

on India's Social Situation held at the Institute from 27 January to 1 February 1969. The E.R.U. also helped in organizing the Eighth Indian Econometric Conference held at the Reserve Bank of India, Bombay, in January 1969.

Professor Ashok Rudra, Visva-Bharati University, became associated with the research work of the E.R.U.

The following distinguished visitors gave lectures or seminars during this year: 1. Professor R. K. Hazari, University of Bombay, on 'Economic Controls in the Public Sector', 2. Professor Louis Davin, University of Liege, Belgium, on 'A Case for Regional Economy,' 3. Shri E. M. S. Namboodripad, Chief Minister of Kerala, on 'Alternative Approach to Economic Planning in India', and 4. Shri K. P. Ghosh, on 'Social and Economic Conditions in India'. Members of the staff also gave seminars on econometric models and on the performance of the Indian economy during 1967-68.

S. Naqvi participated in the Gandhi Centenary Seminar organised by the Indian Institute of Advanced Study, Simla, October 1968; T. Maitra, in the Eighth Indian Econometric Conference at Bombay, January 1969; and R. K. Lahiri, in the Seminar on India's Social Situation, January-February 1969.

9.3. *Pre-census Population Studies Unit*: The Unit was formed in September 1968 to conduct studies on the pre-census population of India up to 1872 when the first Indian census was conducted. Material on population estimates as well as on factors that determine the movement of population will be collected from all possible sources, published and unpublished. These materials will be edited and published in eight volumes—one relating to the period up to 1800 and one for each decade from 1801 to 1871. The first volume relating to the period, 1820-30, entitled *Report on the Population Estimates of India*, was published in 1965.

The work on the second volume relating to the period, 1811-1820, with additional material for 1820-1830 continued during the year. The data on regional census enumeration were collected from the National Archives of India, Maharashtra Archives, Madras Record Room, West Bengal Archives and India Office Library, apart from those from published sources. The volume is being prepared for the press. The work is being conducted in collaboration with the Registrar-General, India, and the volumes will be published in the Census of India series.

On the basis of data already collected, a preliminary series of population estimates was constructed for each decennial point from 1801 by Provinces and States, on the basis of a Unit area of undivided India as in 1941. The series was connected with the Census series up to 1961.

The work on territorial changes continued as a part of the population studies. A historical atlas, to show the territorial changes of India, is under preparation for the period 1811-1830. Old maps are being collected and drawn and thereafter superimposed upon the latest map of the relevant region of India.

9.4. *Planning Unit, Delhi*: The research work done during the current year, at the Planning Unit, Delhi, falls into seven broad fields: 1. studies on the structure of Indian economy; 2. planning models; 3. estimation of response functions relating crop yields

to irrigation and fertilizers; 4. economics of irrigation and power projects; 5. studies in international trade theory and policy, 6. econometrics of consumer demand; and 7. econometric methodology.

In fields 1, 2 and 6, this Unit has a long tradition of research. The extension of the research effort in fields 3, 4, 5 and 7 has been a new feature of the work during the past year.

In the field of planning models for India, and the supporting studies on the structure of Indian economy, the research effort during 1968-69 was directed towards 1. the improvement of the data base for planning models by constructing more disaggregated (up to 130 sectors) input-output table, 2. the formulation of planning models for large sectors, such as agriculture, and 3. the construction of planning models particularly suited for investigating the savings-supplementing role of foreign assistance, in addition to the import financing aspect stressed in the presently available multi-sectoral models.

Some work on the estimation of response functions relating crop yields to fertilizer use, done in earlier years, was continued during 1968-69. In the studies of the relationship between crop yields and the amount as well as timing of water application, however, fresh ground has been broken. A methodological paper based on the results of this research is being prepared.

The studies of the economics of irrigation and power projects are focussed on the Bhakra system. Among other things, investigations have been made on the possibilities of generating more firm power from Bhakra and this study is nearly complete. This is a major study of its kind anywhere and the problem under investigation is one of considerable national importance for the operation of reservoirs for the purposes of irrigation and power supplies. A brief description of the "Tubewells for More Firm Power from Bhakra" is as follows:

In some months during the year, water releases for irrigation from the dam are far in excess of water required for generating the committed firm power. The generating capacity of the system is not the limiting factor. However, the additional power that could be generated, given the present release pattern of water for irrigation, would be available only in some months. At present, there is no demand for this secondary (seasonal) power. The proposed scheme of the Unit would use this secondary power to operate State-owned, deep tubewells for pumping underground water into the canals. This would reduce the water release from the dam. Water thus conserved would be available in later months of scarcity for irrigation as well as for more firm power. Trade-offs have been worked out between firm power levels of irrigation (as represented by a scalar called "Reservoir Factor" (RF), which has a value of 1.0 when irrigation demands are fully met) for different tubewell capacities. The calculations of the Unit, for instance, show that when firm power level of 300 megawatts is supplied with certainty, then Reservoir Factor of .913 can be supplied with a confidence level of 70%. With the installation of 2,000 cusecs of tubewell capacity, however, 365 MW of firm power can be supplied and the same RF with the same level of confidence is assured. These 365 MW of firm power can be obtained in an alternative manner by providing thermal backing to Bhakra. The tubewells scheme, however, is cheaper by Rs. 3 crores, as compared with the thermal backing. If, however, only 1,000 cusecs of tubewell capacity are installed, then the firm power level of 354 MW could be achieved and this would represent a saving of Rs. 7 crores, compared with the provision of 54 MW of additional firm power through thermal backing.

Research in International Trade Theory was another new feature of the Planning Unit's work during the year. This research was concerned with two different aspects of tariff theory and policy.

One line of research consisted of an investigation of the effects of differential tariffs (on capital and consumer goods) on resource allocation, income distribution and trade flows. The motivation for this investigation was to bring tariff theory closer to the facts of tariff practice in developing countries.

A second line of theoretical inquiry consisted of a close examination of the concept of Effective Protective Rate (EPR), which has figured very prominently in the recent literature on tariffs. The EPR concept takes into account the fact that tariffs are imposed not only on final products but also on imported intermediate goods. The computations of EPR's for a larged number of production processes in a number of countries are available in the literature and these computations show that EPR's can differ substantially from the nominal tarriffs on final products of these processes. And, furthermore, the making of these processes according to EPR's may have no correlation with the ranking based on nominal tariffs. It has been claimed that the ranking of processes on the basis of EPR's is the relevant ranking predicting domestic resource shifts among processes when a tariff structure is imposed.

In a recent paper of the Planning Unit, it has been shown that the claims of EPR theory rest on the strong assumption that imported inputs are used in fixed proportion with output in each process. It is further established in this paper that when realistic substitution possibilities between domestic factors and imported inputs are admitted, there cannot exist any definition of EPR based on technical coefficients and prices of imported inputs that can be used to predict domestic resource movements in response to a tariff structure. This is a very important theoretical result which has obvious implications for tariff policy.

Econometrics of consumer demand based on NSS data has been a subject of continuing interest in the work of this Unit for a long time. During 1968-69, the Unit's work related to two important questions in this area, namely, (i) the economics of family size in household consumption, and (ii) the behavioural difference of rural households with respect to cash and non-cash components of consumer expenditure. A major, new result of the latter enquiry is that cash outlays act as an inventory adjustment mechanism, whereas non-cash expenditure indicates a habit formation process.

In the field of econometric methodology, difficulties and pitfalls of one of the approaches to approximating the moments of the unknown small sample distribution of estimates of parameters of a set of stochastic equations were investigated.

9.4.1. *Regional Survey Unit, Delhi* : The Unit's research work in the field of regional analysis during 1968-69 was concerned with spatial patterns in selected sectors of the economy, disparities in levels of developments and consumer behaviour in different regions, preparation of maps for planning and Central Place Model and its application to regional physical planning.

In collaboration with the Department of Human Geography, Delhi University, the Unit organied a symposium on regional planning on the occasion of the 21st International Geographical Congress held in India during November-December 1968. Five papers were contributed by the workers of the Unit.

Symposium on Regional Planning: The symposium was organised at Delhi from 22 to 26 November 1968 jointly by the Department of Human Geography, Delhi University, and the Regional Survey Unit, Indian Statistical Institute, New Delhi, as a part of the various sessions of the Twenty-first International Geographical Congress (IGU). The following workers of the Regional Survey Unit contributed papers and participated in the discussion.

i) Dr. L. S. Bhat. "Regional development and national planning in India" (organiser).

ii) Shri M. N. Pal. "Use of principal components in regional analysis."

Twenty-first International Geographical Congress (IGU): The Congress was held at Delhi during 1-8 December 1968. The following workers contributed papers and participated in the sectional meetings.

i) Dr. L. S. Bhat. "Regional physical complexes for agricultural land-use planning in India."

ii) Shri M. N. Pal (with Dr. V. L. S. Prakasa Rao and Shri V. K. Tewari). "A technique of ranking central places and determining linkages (presented to the IGU Symposium on Quantitative Methods in Geography in the Mysore University).

iii) Shri B. N. Das. "Evaluation of regional potential in foodgrain production in India."

Dr. L. S. Bhat was one of the speakers on 'Regions for planning' at a special session of the Commission on Economic Regionalisation which met concurrently with the IGU Seminars.

Twenty-eighth Annual Conference, Indian Society of Agricultural Economics: The Conference was held at Coimbatore from 23 to 24 December 1968. Dr. T. N. Srinivasan attended the conference as rapporteur in the session on "Economics of high yielding varieties programme."

Eighth Indian Econometric Conference: The Conference was held at Bombay from 16 to 18 January 1969 and the following workers attended and contributed papers.

i) Dr. T. N. Srinivasan. "A note on approximations to finite sample moments of estimators whose exact sampling distribution is unknown."

ii) Dr. Peter Philip. "Differential tariffs resource allocation and income distribution."

iii) Dr. Suresh D. Tendulkar. "Econometric study of monthly consumption expenditures in rural Uttar Pradesh."

iv) Shri S. C. Srivastava. "Profits variability of profits and firm size in cotton textiles industry."

Symposium on India's Social Situation: The Indian Statistical Institute organised the symposium in Calcutta from 27 January to 1 February 1969, with a view to evaluate the trends in Indian economic and social development since independence. Shri M. N. Pal attended and contributed a paper on "Differential regional development and consumer behaviour in India."

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 and twenty-third rounds of the regular National Sample Survey and the Annual Survey of Industries for 1966 and 1967 were in operation during the year. 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 this year's programme. A new survey on small-scale manufacturing industries was initiated in the twenty-third round. Special (QT) schedules were prepared by copying down selected important results.

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

(a) 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 the field enquiries;

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

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

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

The processing and tabulation work covered data collected in the seventeenth to twenty-third rounds of Socio-economic Surveys, the Annual Survey of Industries, 1964 to 1966, 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 three and a half lakhs, the number of cards punched was about 66.6 lakhs and there were about 2.9 crore card passages.

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

The field work of the twenty-second round (NSS) in West Bengal was completed in June 1968 and that for the twenty-third round which commenced in July 1968 is still in progress. The survey for Farm Practices was 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 29 items of end-results committed to be delivered to the Government of India according to the Programme of NSS Processing Work for 1968-69, 21 items were duly completed and delivered to the Government within the period under review.

The preliminary work on planning and sample designing for the twenty-fourth round of the NSS has already been taken up. The time standards obtained on the basis of an analysis of the earlier round time-records were used in programming for the twenty-fourth round.

The sample selection for the Annual Survey of Industries (ASI), 1967, was completed and the processing of the investigator's time-records for the ASI is in progress.

The joint study by the Indian Statistical Institute and the Registrar-General's Office undertaken in 92 West Bengal villages to study the response error in birth and death reporting was continued. A new pilot study on employment and unemployment was taken up during the year.

Seminars and Conferences : One well-attended seminar of general interest was undertaken by the NSS staff members.

Shri Deb Kumar Dutta-Mazumdar presented a paper each at the following :

(i) Sixth Conference, Indian Association for Research in National Income and Wealth, Bangalore, 4-5 May 1968.

(ii) Symposium on Statistical Methods in Economics, 56th session, Indian Science Congress, 3-9 January 1969.

(iii) Seminar on Trends of Socio-economic Change in India : 1871-1961, Indian Institute of Advance Study, Simla. Shri Mazumdar also served as a rapporteur at one of the sessions.

(iv) Eighth Indian Econometric Conference, Bombay, 16-18 January 1969.

Training : Training programmes in survey techniques were arranged for the research apprentices of the RTS, statistical officers from Government departments and the trainees of the International Statistical Education Centre (ISEC) and the UN, UNAID, FAO and other fellowship holders. A specialisation course in large-scale surveys was conducted for the ISEC trainees. Regular classes on sampling theory were taken for the M.Stat I, ISEC and officer's training courses of the RTS.

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

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

Seventeen NSS draft reports, approved for printing, were revised in the light of the comments received from the Central Statistical Organisation (CSO) and finalised versions of the reports were submitted to the Government for printing. Nineteen draft reports were prepared and submitted to the Government of India during the year (*Annexure 6*).

Eleven draft reports, prepared by different State Governments on the basis of the NSS State sample data forwarded to the Institute by the CSO, were examined and the Institute's comments on them were communicated to the CSO during the year (*Annexure 6*).

The staff members prepared sixteen technical papers and six working papers during the year.

Special Studies Unit : The following developmental studies were carried out during the period.

(a) During June-December, special land utilisation and yield surveys covering the major crops of the autum and winter seasons were carried out in the southern regions of West Bengal to study the merits of two different sampling designs, both at the first and second stages of sampling. Twentyeight investigators forming two parties surveyed the two sets of sample villages (first-stage units) drawn according to two different probabilities. In each sample villages, two sets of second-stage units were selected for a land utilisation study, one with equal probability and the other with probability proportional to size. One set of first-stage units was kept common for both the autumn and winter seasons, whereas for the other set a fresh sample was selected for the winter season. A similar survey was carried out during 1967, the results of which showed a specific trend in the estimates based on different samples drawn according to different designs. The experiment was repeated in 1968 to study this particular trend.

(b) During the spring season of 1968-69, a type study was carried out in 90 villages to study the migration pattern of rural households, their changes in occupation, dressing habits, etc. An attempt was made to collect data of the related households of the sample households through the samples to see how far the data thus collected is reliable.

(c) In order to study the eye-estimated proportion of area under specified crop against actual measurement of that area, experiments were carried out in a set of fields in Giridih, Bihar, during November 1968 and in Dhaniakhali, West Bengal, in February 1969. The repeated observations of the same fields by different investigators were done independently and it was followed by actual measurements of the fields by the triangulation procedure.

11. Appraisal Division

A programme of fundamental linguistic research in collaboration with the Institute for Experimental Phonetics and Speech Pathology, Belgrade, Yugoslavia, was initiated during the period. The first results from this programme of research were presented by Visiting Professor Djordje Kostic, Director, Institute for Experimental Phonetics and Speech Pathology at an Invitational Seminar on Bengali Acoustic Phonetics, 19 and 20 February 1969. The Seminar was inaugurated by National Professor Suniti Kumar Chatterji, and attended by research workers in linguistics, phonetics, and allied disciplines from institutions in the Calcutta area. The work on three projects within the programme was completed : a phonetic approach to adult literacy courses in the Bengali language; an outline of the acoustic structure and articulation of Bengali speech sounds; and a comparison of English and Bengali phonetics, serving as a guide to English pronunciation.

A research project on the estimates of probabilities of hospitalization according to age, sex, and diagnosis, and their use in planning hospital services was undertaken jointly with the Biometry Research Unit, under the sponsorship of the U.S. Public Health Service. Through the co-operation of the General Register Office, London, and the Scottish Home and Health Department, Edinburgh, samples of hospital records have been obtained for statistical analysis.

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 Instru-*

ments in 1965. 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 computer was commissioned by the Union 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 were designed and constructed in the ISI machine shop.

The performance of the computer improved considerably during the year, after the addition of a voltage-stabiliser. An order for the teleprinter equipment for the VHF data link was placed with the Hindusthan Teleprinter Ltd.

Four M. Tech. students from the Department of Radio Physics and Electronics, Calcutta University, took three months' practical training in computer technology in the electronics laboratory. Three B.E. students from the Jadavpur University also underwent six weeks' training.

Research: Both theoretical and experimental research was conducted and among the 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 Magnetic Core Memory Module.

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 the work in the Documentation Research and Training Centre (DRTC) during the year included the following:

Training of students: All the five students admitted to the 1967-68 course were declared eligible to receive the Associateship in Documentation, after the completion of their course on 31 December 1968. Two students secured distinctions. Five students were admitted to the 1968-69 course which commenced on 15 April 1968. The students of both courses worked in the Hindusthan Machine Tools Ltd., Bangalore, to gain practical experience of rendering reference service in an industrial library. They also had the benefit of a course of lectures on the use of computers in document finding system delivered by teachers from the International Computers Ltd., Bangalore Division.

Training in documentation : The training of persons in advanced methods of documentation was continued. The application of different techniques to the teaching of subjects in documentation was continued to be experimented upon. The practice of Time and Motion Study was introduced for the first time and the students were helped to make such a study in respect of a specific job in the library.

Research work : The main subjects in which research was done were : 1. Classification, 2. Cataloguing, and 3. Use of Computer in Document Finding.

Publications : The staff contributed sixty articles to periodicals in library science during the period. A list of articles published and sent for publication in Indian and foreign journals is given in *Annexure 5*.

The preparation of the *Colon Classification*, Ed. 7, has been taken in hand.

The papers contributed to the D.R.T.C. Seminar (6), 1968, were brought out as a 600-page mimeographed volume. The proceedings part of the volume is in preparation.

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

Seminars and lectures : The Sixth All-India Seminar on Documentation, held from 15 to 19 December 1968, was inaugurated by Dr. D. Narayanamurthy, Director, Indian Plywood Research Association The subjects discussed were : (i) Theory and Practice of Abstracting, (ii) Developments in Classification, and (iii) Technique of Teaching Documentation. Twentyfive propositions arising out of the 28 papers accepted for the seminar were discussed in the group meetings and plenary sessions. About 100 delegates, from documentation centres in industries and research institutions in India, participated. There were five foreign delegates.

Twenty visiting professors from India and abroad delivered lectures at the D.R.T.C. during the year. Five talks were delivered by the DRTC staff in other organisations.

Liaison with other institutions : The DRTC staff collaborated actively with the Indian Standards Institution in the formulation of the draft Indian standard for the abbreviation of titles of periodicals and the Indian standard for the library catalogue card.

The members of the staff participated actively during the year in (i) the refresher course in library science arranged by the Madras Library Association, (ii) Fifth IASLIC Seminar (Session on Problems of Personnel in Specialist Libraries), (iii) Symposium on Science as a Profession, organised by the Scientific Workers' Association and Science and Technology Society, Kanpur, at which six papers were presented by the DRTC staff and (iv) Production of Textbooks Sub-Committee, Indian Standards Institution.

Seven organisations consulted the DRTC in the planning and organisation of their documentation services.

Library : During the period, the library received 234 books, 199 reports/reprints and 24 periodicals.

Thirteen propositions were discussed at the meetings of the Library Research Circle held in the D.R.T.C. Twelve weekly colloquia were also organised.

The Board of Studies, D.R.T.C., met on 21, 22 and 26 December 1968 and considered the relevant sections of the DRTC prospectus and syllabus for 1968-69.

14. Library

The central library at Baranagar has now a collection of 1,21,958 books and bound journals, 32,028 reprints, monographs, specialised technical reports and also a large collection of maps, microfilms and photoprints. The library also received 2,508 current periodicals —835 were received on subscription; 1,008 on exchange basis and 665 as gift. The branch libraries at Bombay, Bangalore, Baroda, Cochin, Coimbatore, Delhi, Giridih, Madras and Trivandrum are co-ordinated with the central library service to serve the researchers, students and staff working at those centres.

Membership : The total membership of the library increased from 1,929 to 2,004, including 1,650 research and other staff members of the Institute, students attached to the RTS, 151 outside student members, 65 sessional members, 38 Institute members and 131 casual readers who were given special permission to use the library during the year.

Acquisition : During the year, 3,689 books were selected and processed for acquisition and 2,215 books were received against orders. The library also acquired 480 official records, received 271 books on exchange basis and 500 books as gift. During the period, 132 new periodicals were received in the library, of which 51 periodicals were on subscription, 41 on exchange basis and 40 as gift. The subscriptions to seven periodicals were discontinued. The library added back-runs of six periodicals to its collection. The library continued the book-exchange arrangement with several institutions and acquired scientific and technical publications in different languages, particularly in Russian and Japanese.

Accession : The library accessioned 5,089 books. Of these, the number of books purchases was 4,356 (this figure includes books received against orders placed in previous years and books received on composite subscription); 271 books were received on exchange basis and 462 books were received as gift. The library also accessioned 496 official reports.

Technical Processing : The library classified 1,489 books and 28 official reports and catalogued 2,699 books and 28 official reports. The numbers of book classifications and catalogue cards revised were 153 and 837 respectively. During the period, 2,447 reprints were catalogued and added to the reprints collection; 17,610 cards were filed and 671 additional copies of books were added to the collection of the library. The library also processed and indexed 1,476 files, 12,300 maps and 1,589 newspapers. The technical processing of 4,000 books and research documents of the late Professor W. A. Shewhart which Mrs. Shewhart had donated to the Institute library was also taken in hand.

Circulation : During the year 27,017 books and 10,207 journals were issued on reference and 13,011 books on lending. Besides, 1066 official reports, 377 maps, 472 newspapers and 56 old files were issued for reference use. The library sent 554 books to the branch libraries. In the inter-library loan transactions made with 34 local and out-station libraries, the library borrowed 85 books, while it lent out 78 books.

Reference and Bibliographic Service : The library issued documentation lists, reading lists on different subjects and compiled three bibliographies. 2,080 short and long-range reference questions were answered during the period.

Publications : The library continued to bring out regularly the (i) List of Selected Periodicals, (ii) Index to Statistical Literature, and (iii) the Monthly Bulletin.

Translation Service : The Translation Unit provided research workers with translations from foreign languages. During the period, 25 documents were translated, of which fourteen were from Russian, six from Japanese, three from Spanish and two from French. The subjects covered and the numbers of documents on each subject translated were: biology-6, sociology-1, probability theory-1, SQC-2, economics-3, palaeontology-4, and letters and sundry correspondence-8. The number of pages of translation from Japanese was 158; from Russian, 253; from Spanish, 30; and from French, 9. Oral translations were also provided to the specialists on demand.

Photography and Reprographic Service : During the year, the Photography Unit provided 802 photographs and prepared 210 slides for the scientific departments of the Institute. The Reprography Unit and the Photography Unit together microfilmed 6,286 pages of reading material and also provided 5,953 pages of photoprints. The library extended its reprographic service to fourteen overseas organisations including the Friendship University, Moscow; Institute of Oriental Studies, Moscow; Central Economic-mathematical Institute, Moscow, and the Research Branch, Ministry of Rural Development, Zambia. To supplement its reprographic service, the library had placed an order with a foreign concern for Xerox Copier (Model 1358) and Dagmar Microfiche equipment including one Reader and one Twin Combi Reader Printer and the equipment was received in February 1969. Arrangements have been made to install and commission the equipment early.

Circulating Library : The collection of the workers' circulating library came to 23,256 books, and the total membership was 1,008. During the year, the circulating library added to its collection 676 books, of which 123 books were in English, 394 in Bengali, 57 in Hindi, 43 in Urdu, 59 in Oriya, and discarded 177 books from its collection. The circulating library issued, during the year, 40,129 books and sent 167 books to the Giridih library.

Conference and Seminar : Shri J. Saha, Chief Librarian and Shri C. V. Subba Rao, Senior Technical Assistant, attended the Fifth IASLIC Seminar held at Durgapur, from 7 to 9 October 1968 and contributed papers. Shri J. Saha participated in the DRTC Seminar at Bangalore in December 1968 and also delivered a series of lectures at the DRTC on 'Information handling systems in the USA'.

15. Statistical Quality Control (SQC)

The SQC Division of the Institute was established with the primary object of fostering the growth and development of the use of SQC and allied techniques in industrial and other establishment 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 Division which promotes the use of modern quantitative methods for economic production of quality goods by industries, has at present nine operating units located in important industrial centres of the country, viz., Bangalore, Baroda, Bombay, Calcutta, Coimbatore, Delhi, Madras and Ernakulam, with a sub-unit in Trivandrum, through which its activities are carried out. A special Training and Promotional Unit is located in Calcutta. The work of the SQC Units is organised through a comprehensive programme under the following broad classification: (i) promotion, (ii) training, (iii) plant service, and (iv) research.

The promotional activities during the year were conducted through participation in and the organisation of seminars, discussions, meetings, conferences, pilot surveys and in-plant demonstration projects, and serving on expert bodies in the field etc., as in previous years. Four top management seminars were also organised in Bombay, Calcutta, Delhi and Madras. Dr. J. M. Juran, Dean of American Consultants on Quality Control, and a well-known international authority, who had been invited by the Institute as a visiting professor took a leading part in the management seminars. He stayed in India from 7 to 28 December 1968.

Intensive training programmes and appreciation courses were conducted for industrial and other organisations at different levels. For arousing plant-wide consciousness, special attention was paid to the organisation of in-plant training courses, specially designed to suit the individual plants.

The plant services to a variety of industries were aimed at organising integrated quality control systems.

The Training and Promotional Unit located in Calcutta continued its programme of work, viz., the running of the whole-time, one-year post-graduate diploma course in SQC and OR, the organisation of special training courses, circulation of literature and the publication of the monthly news-letter, *QC News*.

In addition to the evening course in SQC and OR at Madras, another part-time post-graduate diploma course in SQC and OR of two years' duration was started at Bombay.

Two top-level training courses organised at Agra and Bangalore, on the "Management of Quality Control" were conducted by Dr. J. M. Juran, Dean of American Consultants on Quality Control.

Promotional Activities: The technical officers of the Division gave 70 lectures and talks to industrial and management personnel, members of professional bodies and other institutions. The units organised 7 seminars and symposia; they also sponsored and attended 36 seminars and conferences jointly with other industrial and professional bodies like the National Productivity Council, Institution of Engineers, local Productivity Councils, Textile Association of India, Indian Dairy Research Institute, Indian Dairy Science Association and the Institute of Telecommunication Engineers. Four top-management seminars were also organised in Bombay, Calcutta, Delhi and Madras and Dr. J. M. Juran took an active part. Two special seminars on "Quality control and reliability in electronic equipment" and on "Quality control in milk and milk products" were organised in Bangalore. Two other seminars on standardisation, and total quality control in small-scale industries, were organised in the Baroda region. The technical officers also paid 122 promotional visits to plants, carried out 16 pilot surveys and issued 24 promotional reports.

Publications: *QC News*: The monthly news-letter *QC News*, issued by the Division to disseminate knowledge in the practical applications of quality control and advances made in the field, continued to receive appreciation from industrial people all over the country and from overseas. Two special issues of the news-letter were brought out to mark the inauguration of the courses in SQC and OR in Madras and Bombay. There are now over 1,000 regular readers of the news-letter which serves as an excellent medium to spread the message of quality control at a practical level.

The units published 9 technical papers and prepared 19 special training and other manuals pertaining to industries. A list of the technical papers published and sent for publication is given in *Annexure 5*.

The proceedings of the Fourth All-India Conference on Quality Control in Madras, December 1967, were brought out in an attractive volume of 170 pages.

Two booklets, "Application of Quality Engineering and Operational Research in Indian Industry" and the "Application of SQC and OR Techniques in Industry" were specially released during the inauguration of the diploma courses in SQC and OR at Madras and Bombay. A manual in Tamil, "Quality and You" was brought out in connection with the operator training programme in the T. I. Cycles, Madras. The Division also brought out a booklet giving brief particulars of the training programmes and plant services offered by the units.

Training : The effective training of technical personnel at different levels which has been the sheet anchor of the development of SQC in the country was continued vigorously during the year. In pursuance of this vital task, the units conducted during the year 18 basic courses and 4 special courses which were attended by 510 persons. Twenty-seven in-plant courses of different levels were attended by 645 plant personnel. The in-plant courses which are spread over a time and include project works as an integral part of the course are unique and have proved to be the most successful means of organising for quality in companies in India.

At the request of the Ministry of Defence, Government of India, in-plant training courses were organised at the Cordite Factory, Aruvankadu, Ordnance Factory, Ambarnath and the Ordnance Factory, Khamaria.

In the wholetime post-graduate courses for diploma in SQC and OR, specially devised to train engineers, technologists, scientists, and statisticians in statistical quality control to a level of professional competency, and conducted by the Training and Promotional Unit in Calcutta, 31 students were under training in the last batch, of whom 11 were deputed by defence organisations and one came from a public sector industry. The candidates from the earlier courses have been well-employed by the industries as well as by the SQC units.

To meet the persistent demand from industry for personnel trained in SQC and OR, a specially devised one-year post-graduate evening course in SQC and OR was started in Madras from 25 March 1968. Only 30 candidates, mostly working engineers and technologists were admitted, out of 230 who had applied. The course, specially designed as a part-time evening course to encourage employed executives to undergo training, serves an important need in industry. It is planned to develop this evening programme into a full-fledged post-graduate diploma course spread over two years. Another two-year evening course for the post-graduate diploma in SQC and OR for the working engineers and technologists was started in Bombay on 7 September 1968. Thirty-three candidates were admitted to the course, which is similar in content to the one-year day-time SQC diploma course in Calcutta.

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 15 new apprentices commenced training during the period. The field training for 65 students of the SQC diploma course was also organised and supervised by the units.

The unit 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.

A welcome development has been the introduction of SQC as an elective subject in the final years of the B.E. course at the University College of Engineering, Bangalore. The teaching faculty is being provided for the present by the Division, which had made the suggestion.

A feature of the year was the organisation of two training courses in Agra and Bangalore on Management of Quality Control, by Dr. J. M. Juran, Dean of American Consultants on Quality Control. The two courses, attended by 107 top executives from a large number of industries, public and private, from all over India, added a new dimension to quality control programmes.

Intensive fourteen-week refresher course on operations research: A special advanced course on operations research was organised, utilising the services of external experts in the subject, for technical officers of the SQC Division. Seventeen candidates selected from the units participated in the course, which involved instruction in theory, as well as actual practical application in industrial concerns.

The detailed list of training courses is given in *Annexure* 3. The total number of technical personnel covered by all these courses is 1,155, compared to 751 in the previous year.

Plant Service: Service on a regular membership basis was rendered to 78 plants during the year. While the service was extended to 24 new plants, it was withdrawn from 22 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, cement glass, mining, transport services, and other miscellaneous industry both in the private and public sectors. The depth of service was intensified in several enterprises and efforts were oriented more towards organising for quality in plants and training people for the purpose than towards the solution of ad-hoc problems.

Over 354 technical reports were submitted to the plants on the projects taken up in member organisations.

Staff: At the end of the year, the Division had on its roll 62 technical officers and 5 investigators-cum-computers, compared to 54 technical officers and 5 investigators-cum-computers last year. The new recruits were selected from the students who successfully completed the M.Stat/post-graduate diploma course in SQC-OR of the Institute and had undergone a special one-year training in the units as apprentices.

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

Liaison with Other Organisations: The SQC Units continued to work in close co-operation with organisations like the Indian Standards Institution, National and Local Productivity Councils, Institute of Production Engineers, Small Scale Industries Service Institute, Management Associations, Operations Research Societies, Universities, Indian

Dairy Research Institute, and other Government and scientific agencies. The programme of collaboration included participation in seminars, conferences, training programmes, contribution of papers, organisation of special courses and similar programmes.

Research : In spite of the exacting demands of training and promotional work, the technical staff have contributed to the growth of knowledge in the field of SQC. They are continuously evolving new approaches, modifying old methods or devising new formulae etc. to meet the challenge of the varied types of problems faced by them in their plant work. Based on this applied research, they have contributed a number of papers. A list of papers published and sent for publication is given in *Annexure* 5. The technical staff will be encouraged to undertake more research in the future by reducing their load of routine work.

16. Family Planning Research Unit

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

Survey : The following programme was undertaken :

(i) the fourth annual fertility re-survey of the Calcutta city project population with with KAP component was completed. The tabulation work is over and a report is being prepared;

(ii) the second fertility-cum-KAP re-survey of married employees in the Indian Statistical Institute and the first attitude-knowledge survey of the single workers were undertaken. The data are being processed;

(iii) a special study on the family life and fertility control of non-white collar workers in a research institute was completed and the report mimeographed;

(iv) the verification and checking of the Hooghly Second Fertility Survey data is nearly completed;

(v) a report on oral contraception was sent for publication.

Action Programme Development : The action programme included discussions, household contacts and clinic visits. The field trial of oral contraception formed the major part of the programme.

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

17. Publications

The following were published during the year :

Sankhyā : The Indian Journal of Statistics : Volume 30, Series A, Parts 1, 2, 3, 4; Volume 31, Series A, Part 1; Volume 30, Series B, Parts 1 & 2, 3 & 4.

The Research and Training School issued 72 technical reports in mathematics and statistics, 4 in physics and 58 in the natural sciences, during the year.

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

SM 68-1	Some recent advances in coding theory	..R. C. Bose
M 69-1	Markov processes	..Paul Andre Meyer, *translated* by M. N. Sastry
M 67-6	Technical aspect of design, National Sample Survey	..P. C. Mahalanobis, D. B. Lahiri *et al*

Samvadadhvam : The House Journal of the Indian Statistical Institute, Vol. 7, Nos 2–4.

18. Visitors

Over 400 visiting scientists and other visitors from India and abroad (from 26 foreign countries and international organisations) came to the Institute during the year.

19. Construction and Maintenance of Buildings

Apart from the usual maintenance, repairs and minor works, the Engineering Unit completed the addition and alteration works in the main building, 203 Barrackpore Trunk Road, in connection with the installation of the Honeywell Computer.

The following works were in progress :

(a) partition and allied works for the ISI city office, second floor, 27-B, Camac Street, Calcutta-16;

(b) building and steel works in connexion with the installation of a passenger lift at the GSU Building;

(c) miscellaneous works for the existing five-storied GSU Building, 153 G. L. Tagore Road, and the existing five-storied building No. 1 at 205 B. T. Road.

(d) the construction of flats, and other miscellaneous works in building No. 2 at 205 B. T. Road;

(e) strengthening and addition and alteration works in the godown shed for NSS, 202 B. T. Road.

20. Branches

20.1. *Mysore State Branch :* There were 51 members of different categories at the end of the year. The office-bearers for the year 1968-69 were elected.

Admission Tests and Examinations : The selection tests for admission to the M.Stat., B.Stat. degree courses and SQC Diploma course etc. were held in Bangalore on 7 July 1968.

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 (one of the centres) on 2 February 1969.

The one-year's evening course in statistics of the Institute, started in Bangalore at the suggesion of the Branch, successfully completed the first year's programme. Ten candidates took the Part II Final Examination and 9 were successful. Twentyfive trainees were admitted to the session for 1969-70.

Seminars : The Branch was able to organise successfully the following two seminars calculated to promote the use of quality control techniques in industries, with financial assistance from the head office.

(i) Under the joint auspices of the Branch, the Institution of Telecommunication Engineers, Bangalore Centre, and the Indian Society for Quality Control, Bangalore Branch, a two-day seminar on Quality and Reliability in Electronics was held in Bangalore. The seminar was inaugurated by Dr. S. Bhagawantam, Scientific Adviser to the Minister of Defence.

Nearly 200 delegates from all over India representing defence organisations, electronics industry, and research laboratories participated in the seminar which discussed more than 40 papers, and made a number of recommendations.

(ii) Under the joint auspices of the Branch and the Indian Dairy Science Association (Southern Branch), a two-day seminar on quality control in Milk and Milk Products was held in Bangalore on 21 and 22 March 1969. Shri G. B. Shankar Rao, Minister for Veterinary Services, inaugurated. More than 90 delegates from all over India representing research organisations, public sector dairies and marketing organisations participated. The seminar discussed 58 technical papers and made a number of recommendations.

Visiting Scientists : Dr. J. M. Juran, Dean of American Consultants on Quality Control, delivered an interesting talk on Management of Quality Control on 19 December 1968.

Among other visiting scientists were the following :

1. Dr. A. L. Batalov, Institute of Peoples of Asia, USSR Academy of Sciences, gave a talk on "Some Problems of Industrial Development" on 17 April 1968.

2. Dr. P. R. Brahmananda, Professor of Monetary Economics, Bombay University, delivered a lecture on "Recession in Indian Industry" on 21 May 1968.

3. Shri K. S. Viswanathan, Deputy Zonal Manager (South Zone) International Computers (India) Private Ltd., Bangalore, gave a lecture on "Data Processing" on 16 November 1968.

20.2. *Bombay Branch :* A Council meeting, held on 6 February 1969, took up the separation of accounts from the head office accounts and approved the draft annual report. The Council meeting, held on 24 February 1969, accepted the resignation of Professor N. S. Rangaswamy. The names of the office bearers for 1968-69 were discussed. It was decided to start a short-term course in "Statistics for Management." A one-man committee, consisting of Professor U.G. Dabholkar, was appointed by the Council to prepare a syllabus for the course.

In its meeting of 11 March 1969, the Council confirmed the resolution passed in the earlier meeting.

Visiting Scientists : (i) Dr. P. V. Sukhatme, Director, Division of Statistics, Food and Agriculture Organisation, United Nations, delivered a lecture on 'Nature of the Protein Problems in India' on 4 February 1969. Professor M. L. Dantwala, Director, Department of Economics, University of Bombay, presided.

(ii) Dr. Joshep Tar, architect, economist and Chief, Main Department for Investments and Building Industry, Central Statistical Office, Hungary, gave a talk on the 'Statistical System in Hungary' to students of the evening course.

(iii) A symposium, on a report on 'The Social and Economic Conditions in India" submitted by Shri K. P. Ghosh, was organised by the Bombay Branch.

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* 5.2 and the R.T.S. Technical Report Number.

A. Statistics and Mathematics

1. *A software package for analysis of dispersion* :

The paper describes a software package for ICL 1900 series of computers for analysing the statistical data under a linear model. Given the model and linear hypothesis to be tested, it computes the relevant statistics. The mode of specification is general enough to comprehend a wide class of statistical analysis. The report is divided into two parts, the first part describing the statistical test and algorithms suitable for computers. The second part deals with systems and programming aspects of the software package.

For testing the hypothesis (i) $Z = MW+N$ or (ii) $CZV = 0$ under the model $E(X) = AZP$, where x is the observation matrix, A, P, C, V, M and N are known constant matrices and Z is the parameter matrix, the following three statistics are computed viz., (i) $t_1 = Se/Se^*$ (ii) t_2 = trace of $(S_hS_e^{-1})$ and (iii) t_3 = max. eigen value of $(S_hS_e^{-1})$ where s matrices are the error sum of squares and products matrices. (S1), Math-Stat/7/69.

2. *On a theorem of Rao on g-inverses of matrices* :

Let Λ, A_i and B_i, $i = 1, 2, \ldots, k$ be complex matrices of order $m \times n$, $m \times p_i$ and $n \times q_i$ respectively. Write $A = (A_1 : A_2 : \ldots : A_k)$ and $B = (B_1 : B_2 : \ldots : B_k)$. Consider the following statements :

(a) $A_i^* \Lambda B_j = 0$ for all i and j such that $i \neq j$

(b) $G = \Sigma\ B_i(A_i^* \Lambda B_i)^- A^*$ is a g-inverse of Λ,

where in (b) $(A_i^* \Lambda B_i)^-$ is any g-inverse of $(A_i^*\ \Lambda\ B_i)$.

(i) $R(A^* \Lambda B) = R(\Lambda)$

(ii) $\sum_i R(A_i^* \Lambda) = \sum_i R(A_i^* B_i) = R(\Lambda)$

In this paper, the following theorems are proved.

(1) (a) $\Longrightarrow$ (b) if and only if (i) holds.

(2) (b) $\Longrightarrow$ (a) if and only if (ii) holds. (S2), 47/68

3. *Estimation of linkage in presence of incomplete penetrance at both the factors* :

Penetrance is measured as the fraction of the individuals carrying the gene who are phenotypically different from the individuals of the population carrying the allel.

Estimation procedure of linkage between two genes, one of which has incomplete penetrance is already considered. The author considers the case where none of the genes are penetrating to the full extent. For backcross and intercross data tests of significance of the estimates of linage and penetrance coefficients are provided. A normal deviate test is suggested for testing the significance of the estimate of penetrance. (S3), 38/68.

4. *Parent-offspring correlation in an equilibrium population*

The main objective of the paper is to generalise Li's results (1954) on the same topic which was applicable for random mating alone. For a di-allelic autosomal character, the parent-offspring correlation is obtained under a general mating system. Expressions of the same were derived with one as well as two parental measurements. An expression, with special interest for plant population, is also established. Four tables are presented to check the theoretical results. (S4), Math-Stat/16/69.

5. *On a problem of critical path method* :

The paper discusses the problem of finding the minimum completion time of two identical projects, undertaken simultaneously by the critical path method. The solution to this problem is given under a restrictive condition. Such problems may arise in industry. The problem (and the solution to this) may be generalized in case of K identical projects. (S5), 21/68.

6. *Exchangeable processes which are functions of finite stationary Markov chains*

The following theorem is proved :

Theorem : *An exchangeable process which is a function of a finite stationary Markov chain is a regular function of a finite stationary Markov chain.*

In a previous paper (*Ann. Math. Stat.*, 34, 1033-1041), it was shown that the above theorem fails if the hypothesis of exchangeability is weakened to that of stationarity.

Let J be a finite set. Let $H(j)$ be the set of all vectors $\xi = \{\xi(\partial),\ \partial \epsilon J\}$ such that $\xi(\partial) \geqslant 0$ for all ∂ and $\xi(\partial) > 0$ for some ∂. Let $S(J)$ be the set of all finite sequences of elements of J. If $s = (\partial_1, \ldots, \partial_n) \epsilon S(J)$ and $\xi \epsilon H(J)$ then $s.\ \xi$ denotes the product $\xi(\partial_1) \ldots \xi(\partial_n)$. The main tool in the proof of the theorem can then be stated as follows :

Lemma : *Let $\xi_1, \ldots, \xi_n$ be distinct elements of $H(j)$. Then there exist n sequences $s_1, \ldots, s_n$ in $S(J)$ such that the $n \times n$ matrix $\|(s_i.\ \xi_j)\|$ is non-singular.* (S6), 31/68.

7. *A note on some inadmissible estimators.*

Hannan (*Sankhyā*, Series A, 28, page 197, 1966) has conjectured that any non-zero function of a minimal sufficient statistic is an admissible estimator of its expectation. In this note, we give examples to show that the conjecture is false both in the survey-sampling set-up and in the conventional set-up. (S7), 49/68.

8. *A note on exchangeable processes with states of finite rank* :

Conjectured that a finite-rank finite-state stationary process Y_n is a function of a finite stationary Markov chain. This conjecture has been disproved by Heller [*Ann. Math. Stat.*, 39, 938-946]. In this paper the author proves that, in the special case when Y_n is exchangeable, Gilbert's conjecture is correct. (S8); Math-Stat/9/69.

9. *Only linear transformations preserve normality* :

As every one knows, there are many non-linear transformations which preserve normality and some of these will be found in this paper. However, our aim was to prove the following conjecture of Basu : If under (μ_i, σ_i), X is normal with mean μ_i and variance σ_i^2 and $T(X)$ too is normal, $i = 1, 2$, then T is linear provided $\mu \neq \mu_2$ and $E_{\mu_1}(T) \neq E_{\mu_2}(T)$. We can prove this conjecture when T is $1-1$, this constitutes Theorem 3 which generalises

Theorem 1 of Basu and Khatri (Indian Statistical Institute Tech. Report No. 28/67). If T is not 1—1 the nearest result that we could prove is Theorem 2 : X is normal with mean μ and variance σ^2, suppose for $-\infty < \mu < \infty$ and $\sigma^2 = \sigma_0^2$ or σ_1^2, $T(X)$ is normal, then $T(X)$ linear.

This is still at an infinite distance from Basu's conjecture but much stronger than the corresponding result, Theorem 2 of Basu and Khatri (*Indian Statistical Institute Tech. Report* No. 28/67). Our techniques too are quite different from those employed in Basu and Khatri (*Indian Statistical Institute Tech. Report No.* 28/67). (S9), 53/68.

10. *Marginal sufficiency implies sufficiency* :

Suppose that $X_1, \ldots, X_n$ are independently distributed random variables and $T(X_1, \ldots, X_n)$ is a statistic sufficient for each X_i. Is T sufficient for $(X_1, \ldots, X_n)$? In other words, does marginal sufficiency imply sufficiency if $X_1, \ldots, X_n$ are independent ? The rather surprising answer to this question (given in Theorem 1) is yes, at least in the dominated case. (Of course, the answer is no if the X's are dependent.)

The problem arose in an unpublished paper of Dr. V. S. Huzurbazar who conjectured the correct answer. (S10), 54/68.

11. *On the proportion of observations above a sample mean* :

Let X_i, $i = 1, \ldots, n$ be independent random variables with the same distribution Function $F(x) = P_r\{X_i \leqslant x\}$. Let $\bar{X}_n = \left(\sum_1^n X_i \right)/n$ and P_n = number of X_i's above $\bar{X}_n$. David (*Ann. Math. Stat.*, 33, 1160-1166, 1962) proved the asymptotic normality of P_n when F is a normal distribution function. Using some elegant trick, Mustafi (*Ann. Math. Stat.*, 39, 1350-1353, 1968) has proved a similar result for bivariate normal distributions. We shall extend these results considerably by providing alternative proofs which dispense with the normality assumption on F. Moreover, in our proof we may consider—through we shall not do so for purposes of simplicity—instead of the sample mean $\bar{X}_n$ any U-statistic to which the central limit theorem of Hoeffding applies. (S11), Math-Stat/5/69.

12. *Some fibonacci relations* :

In this paper, the author has found the particular Fibonacci Numbers F_n which satisfy the relation $F_n = N$ where $N = nk$ and k is a positive integer. This amounts to finding those Fibonacci Numbers F_n which are exactly divisible by n. It is found that such numbers are possible only in the following cases :

(i) When n is of the form 5^r where r is zero or positive integer.

(ii) When n is of the 12t. In this, the following exceptions are observed :
(a) If t is prime other than 2, 3, $5F_{12t}$ is not divisible by 12t. (b) if t is an even multiple of 7, 23, F_{12t} is divisible by 12t but not for odd multiples of 7, 23. The author has worked out the numbers upto 628. (S12, Math-Stat/12/69.

13. *Neotric Index Numbers* :

The system of homogeneous equations

$$P_i = \sum_{j=1}^{M} a^i p_j q_j / \sum_{j=1}^{M} q_j,$$

$$c^j = \sum_{i=1}^{N} p_i q_i / \sum_{i=1}^{N} p_i q_i,$$

which defines a set of average prices p_i, $i = 1, 2, \ldots, N$ and a set of 'exchange rate' e^j, $j = 1, 2, \ldots, M$, for a given flow of N commodities during each of the M time periods, is utilized to define the set of price indexes P_{st} and quantum indexes Q_{st} through the equations

$$P_{st} = e^t/e^s \text{ and } Q_{st} = \sum_{i=1}^{N} p_{it}q_{it} \Big/ \sum_{i=1}^{N} p_{it}q_{is},$$

with s and t referring to the base and current periods respectively. The letters j, s and t may also refer to different localities, socio-economic groups or marketing stages within the same country. They may also refer to different countries, in which case P_{st} will be an 'exchange rate' for the country t with respect to country s. The index numbers thus defined happen to satisfy almost all the desirable index numbers tests. As a special case when $M = 2$, the resulting equation comparable with that of the Laspeyres and of the Paasche types is

$$P_{12} = \sum_{i=1}^{N} p_i^2 \Big/ \frac{q_i^1 q_i^2}{q_i^1 + q_i^2}$$

where the quantity weight coefficient for each commodity is proportional to the harmonic mean of the corresponding quantities for $j = 1$ and 2. Indications of the possible uses of the new system of index numbers and the results of two numerical examples are given. An advantage of the resulting index numbers is that they are based on a simple intuitive meaning of 'average price' and 'exchange rates' as indicated by the system of $M+N$ linear equations. (S13), Math-Stat/3/69.

14. *Some restricted partition functions : congruences modulo 7 :*

The results proved relate to the following restricted partition functions. The value of the function ${}^{49}p(n)$ is obtained by counting all the unrestricted partition functions excepting those which contain 49 or any multiple thereof as a part. Similarly ${}^{147}_{7}p(n)$ is obtained by counting all the unrestricted partitions of n excepting those containing any number of the forms $147n$ or $147n \mp r$ as a part.

The following congruences modulo 7 are proved.

(1) For 'almost all' values of n

(i) ${}^{49}p(n) \equiv 0$

(ii) ${}^{147}_{\ 56}p(n) \equiv -{}^{147}_{7}p(n-14)$

[There are two more congruences of type (ii)]

(2) For all values of n

(i) ${}^{147}_{7}p(7n+5) \equiv 0, \qquad 0 \leqslant \rho \leqslant 10.$

(ii) ${}^{147}_{56}p(7n+1)+{}^{147}_{7}p(7n-13) \equiv {}^{49}p(7n)$

[There are eight more congruences of type (ii)]

(iii) ${}^{147}_{70}p(49n+49)-{}^{147}_{70}p(7n+7) \equiv -{}^{147}_{56}p(49n+42)+{}^{147}_{56}p(7n)$

(There are two more result of type (iii)]. (S14).

15. *Some restricted partition functions : congruences modulo 3 :*

The following congruences modulo 3 are proved.

(1) For 'almost all' values of n

$${}^{3}_{1}p(n) \equiv {}^{27}_{9}p(n) \equiv {}^{81}_{18}p(n) = 0$$

(2) For all values of n

$$^{3}_{5}p(3n) \equiv {}^{3}_{5}p(3n+1) \equiv -{}^{3}_{11}p(3n+2). \quad (S15).$$

16 *Identities connecting elementary divisor functions of different degrees and allied congruences*:

It is proved that for any fixed n, (v stands for a pentagonal number, the sign depends upon the character of v),

$$\sum_{n-v} [\mp D(m)] = 0$$

where $D(m)$ stands for any of six prescribed functions involving the divisor function $\sigma_k(n)$. As illustration we have the two functions

(i) $7\sigma_1(m)-150m\sigma_3(m)+360m^2\sigma(m)$

(ii) $5\sigma_7(m)-294m\sigma_5(m)+3780m^3\sigma_3(m)-7560m^4\sigma(m)$.

It is understood that the terms $\sigma_k(0)$, $k = 1, 3, 5, 7$, if they appear in the above identities (which happens only when n is a pentagonal number), are given special values, e.g. $\sigma_5(0) = -1/7[3456n^4+576n^3+36n^2+n]$.

Several congruences are established. Some examples are

(i) $\sum_{n-v} [\mp\sigma_9(m)] \equiv 0 \pmod{2.3^2.5}$ where

$$\sigma_9(0) = -54n^6-90n^5+120n^3+25n.$$

(ii) $\sum_{n-v} [\mp\sigma_9(m)] \equiv 8370 \sum_{n-v} [\mp m\sigma_7(m)] \pmod{2^4.3^4.5.7}$

where $\sigma_9(0) = 1296n^6+2160n^4-3600n^3+2064n^2+16495n$.

(iii) $\sum_{n-v} [\mp m\sigma(m)] \equiv 0 \pmod 5$ where $0.\sigma(0) = -n^2+2n$. (S16).

17. *Coanalytic sets that are not Blackwell spaces*:

A measureable space (X, B) is said to be a *Blackwell space* if (i)B is separable (that is, countably generated and containing all singletons) and (ii) for every separable σ-algebra $C \subset B$, $C = B$. Blackwell has proved that every analytic set, equipped with its Borel σ-algebra, is a Blackwell space. It is shown in this note that there are coanalytic sets which are not Blackwell spaces. (S17), 41/68.

18. *On repeated interchange graphs* II:

For a connected undirected graph G without loops and multiple edges, the interchange graph (or line-graph) $I(G)$ is one whose vertices are the edges of G, any two vertices in $I(G)$ being joined by an edge if, and only if, the corresponding edges in G have a vertex in common. Repeated interchange graphs are defined by $I^{n+1}(G) = I[I^n(G)]$ $n \geqslant 1$. Denote by v_0, v_n the number of vertices in G, $I^n(G)$, and by e_0, e_n the number of edges in G, $I^n(G)$, respectively. It is shown that $e_1 > v_0$ and $v_{n+2} = e_{n-1} < e_n = v_{n+1}$ when $n \geqslant 0$, except in the following cases: (1) G is a chain, then $v_n = e_n+1 = v_n-n$ if $n \leqslant v_0$, and $v_n = e_n = 0$ if $n > v_0$, and $v_n = e_n = 0$ is $n > v_0$. (2) G is a cycle: then $v_n = e_n = v_0 = e_0$, $n \geqslant 1$, (3) G is the graph  : then $v_n = e_n = e_0$, $n \geqslant 1$; (4) G has exactly one vertex of degree 3, three vertices of degree 1, the rest being of degree 2 and $e_0 > 3$; then $e_1 = e_0 = v_0-1$ and $v_{n+2} = e_{n+2} > e_n = v_{n+1}$ when $n \geqslant 1$. Moreover, $v_2 = e_2 = v_0$ if G is the graph  , otherwise $v_2 < v_0$; (5) G has two vertices of degree 3, four of degree 1, the others being of degree 2, then $e_1 = v_0 = e_0+1$, $v_{n+2} = e_{n+1} > e_n = v_{n+1}$ when $n \geqslant 0$.

Thus, for example, graphs for which $e_m = e_n$, $\epsilon_n = v_n$ or $v_m = v_n$ for some $m > n \geqslant 0$ can easily be characterized. (S18), 40/68.

19. *Some partitions of, and the number of Borel fields on large finite sets* :

Let $P_{n,r}$ be the number of distinct partitions of a set S_n of size n into r nonempty subsets. Then $P_{n,r}$ is the number of Borel fields with r atoms on S_n. Let $f(n)$ be the total number of Borel fields on S_n. It is shown that, as $n \to \infty$, (a) if r varies so that $\lim_{n\to\infty} \frac{r}{n} = p \neq 0$, then $(n \log n)^{-1} \log P_{n,r} = 1-p$, and the convergence is uniform on any interval $\partial \leqslant p \leqslant 1, \partial > 0$; (b) $n^{-1} \log f(n) = \log n - \log n + O(1)$; (c) for any given n, let $P_{n,r}$ be maximum when $r = r_n$, then $n/r_n = \log n - 2 \log n + O(1)$, and $n^{-1} \log f(n) - \log P_{n,r_n} = 0(1)$. Moreover, in (b), $0(1) = -\gamma_n + O(1)$ where $1 \leqslant \gamma_n \leqslant 20$; and in (c), $0(1) = \partial_n$ where $0 \leqslant \partial_n \leqslant 2$. (S19), Math-Stat/13/69.

20. *Conditions for optimality and validity of simple least square theory* :

Let $(Y, X_n\beta, \sigma^2 I)$ denote a Gauss-Markoff linear model, where $E(Y) = X_n\beta$, $D(Y) = \sigma^2 I$ and β is a vector of unknown parameters. A simple least squares estimator (SLSE) of a parametric function $p'\beta$ is $p'\hat{\beta}$, where $\hat{\beta}$ is a value of β for which $(Y - X_n\beta)'(Y - X_n\beta)$ is a minimum.

In this paper, we investigate the conditions under which a SLSE, which is also a best linear unbiased estimator (BLUE) under the model $(Y, X_n\beta, \sigma^2 I)$, is a BLUE under the model $(Y, X\beta, \Sigma)$. Explicit representations for X and Σ when such a property holds are obtained. We also investigate the conditions on Σ under which the various results in the least squares theory based on the model $(Y, X\beta, \sigma^2 I)$, such as those relating to distributions of best estimators and residual sum of squares, test procedures, etc., remain valid for the model $(Y, X\beta, \Sigma)$. (S20), 30/68.

21. *Goodness of a fit of a compound multinomial distribution and allied problems* :

This paper deals with the problem of testing goodness of fit of a multinomial distribution, when the total number of possible observations (the sample size n) is on unobserved random variable with a known distribution. The data for analysis are the observed frequencies $0_1, 0_2, \ldots 0_k$ in k classes of the multinomial distribution with the corresponding class probabilities $\pi_1, \pi_2, \ldots, \pi_k$ adding upto a number strictly less than 1. Given a specified value to the random variable n, the conditional distribution of $0_1, 0_2, \ldots, 0_k$, $n - \Sigma 0_i$ is positive multinomial. Marginally $0_1, 0_2, \ldots, 0_k$ follow a compound multinomial distribution. Consider a hypothesis H_0 which numerically determines the class probabilities π_i and accordingly the vector of expected frequencies $E_1, E_2, \ldots, E_k$. It is shown that under certain conditions the hypothesis could be tested by a suitably constructed goodness of fit chi-square statistic, based only on the observables $0_1, 0_2, \ldots, 0_k$. The case of a composite hypothesis which determines the class probabilities only as known functions of certain unknown parameters is also considered. (S21), Math-Stat/10/69.

22. *On the concepts of best and admissible estimators in sampling theory* :

Some aspects of the concepts and definitions of admissibility as applied to theory of sampling from finite populations have been critically examined and possible definitions of best and admissible estimators have been enumerated. Definitions are given for a *best*, the best and uniformly best estimators and for admissible, essentially admissible and strongly,

admissible estimators. Using these concepts, the non-existence of *a best* and hence the best and uniformly best estimators, in the classes of all linear, all linear unbiased, all unbiased and all estimators has been demonstrated for fixed sample size designs in the first case and for any sample design in the other three cases. The inconsistencies and the possible inexactitude in the use of these definitions in the current literature on sampling have also been pointed out. (S22).

23. *Population census as the source of sampling frame in India* :

Importance of *small and compact area units* in facilitating census enumeration by minimising the chances of omission and duplication of persons and on the need for getting from the decennial population census a comprehensive area frame with suitable auxiliary information to enable efficient designing of numerous uni-subject and multi-subject sample surveys during the inter-censal period is focussed. It is emphasised that the enumeration blocks (EB's) to be formed within revenue villages and towns/cities should be distinct area units with identifiable and stable boundaries and that the basic census data should be provided for these units. The principles of forming EB's are clearly spelt out and it is suggested that at least notional (sketch) maps showing the boundaries of villages/towns and EB's are to be prepared. The special situations regarding forest areas, unsurveyed villages, urban fringes, etc. are also discussed. The types of basic data and auxiliary information that would generally be required is briefly discussed and the suggested proformae for presenting the census data at village/town and EB levels are also given. It has been pointed out that the proposed computerization of the census tabulation confined to a 10% sample of individual slips should not preclude the supply of the suggested basic information at village/town-and EB levels based on 100% census data. The problem of rural-urban classification at the time of the census has also been referred to with the suggestion to up-date this classification during the inter-censal period through annual bulletins covering the changes. The proposed scheme for giving a permanent house numbering throughout the country is briefly considered and a link up of house numbering with the need for having permanent area units with distinct boundaries is suggested with a view to facilitating the house numbering operation and the task of keeping them up-to-date. (S23)

24. *On structure of weakly stationary stochastic processes* :

For simplicity, the result below are stated for q-variate weakly stationary stochastic processes, $0 < q < \infty$, even though the results are valid for $q = \infty$. Notations and terminology is that of Wiener and Masani, Prediction Theory of Multivariate Stochastic Processes I, II and Part III of same paper by Masani.

Theorem 1 : *A q-variate weakly stationary stochastic process $(X_n)_{n=-\infty}^{\infty}$ is of rank m $0 \leqslant m \leqslant q$ is and only if for each*

$$X_n = X_n^1 + X_n^2 + \ldots + X_n^m + Z_n$$

where

(i) $X_n^i \perp X_m^j$ if $i \neq j$, $Z_n \perp X_m^i$ for all i,

(ii) *each $(X_n^i)_{n=-\infty}^{\infty}$ is weakly stationary purely non-deterministic of rank* 1,

(iii) $(Z_n)_{n=-\infty}^{\infty}$ *is deterministic, weakly stationary,*

(iv) X_n^i, Z_n *on for all* n.

Definition : $(X_n)_{n=-\infty}^{\infty}$ is called minimal of rank r if $Y_0 = X_0(X_0 m_0)$ is such that (Y_0, Y_0) is of rank m.

Theorem 2 : $(X_n)_{n=-\infty}^{\infty}$ *is minimal of rank* r *if and only if exactly* r *of*

$$(X_n^1)_{n=-\infty}^{\infty}, (X)_{n=-\infty}^{\infty} \ldots (X_n^m)_{n=-\infty}^{\infty}$$

are minimal of rank 1, *where* X_n^i *are as in Theorem* 1.

Theorem 3 : $(X_n)_{n=-\infty}^{\infty}$ *is minimal of rank* 1 *if and only if* X_n *is of the form* :

$$X_n = \begin{bmatrix} C_1 & Y_n \\ C_2 & Y_n \\ \vdots & \\ C_q & Y_n \end{bmatrix}$$

where $(Y_n)_{n=-\infty}^{\infty}$ is univariate minimal weakly stationary and $C_1, \ldots, C_q$ are complex numbers with at least one of $C_1, C_2, \ldots, C_q$ non-zero. (S24), Math-Stat/2/69.

25. *Tables of primitive polynomials* :

The set of all primitive polynomials which generate $GF(P^n)$ for $1024 < P^n \leqslant 2^{14}$ and $2 < P < 50$ are tabulated. A short critical review of the algorithms used earlier for similar tabulations is given in the report. The programming techniques involved are discussed and the relevant FORTRAN programmes are presented in the appendix. (S25), 26/68.

26. *Concerning the existence of "maximal" normal components for probability laws*:

D. Dugue pointed out that every one-dimensional probability distribution has a maximal normal component. Here we consider an example to show that an analogous result does not necessarily hold for higher dimensions. (S26).

27. *Some results on the comparison of sampling with and without replacement* :

Modified efficiency comparisons, which take into consideration the fact that the expected number of distinct units in a with-replacement sample need not be an integer, are made for the same expected cost between some unbiased estimators in simple sampling without replacement (srswor). These results are extended to two-stage sampling, interpenetrating sub-sampling and unequal probability sampling.

Assuming a guessed value c for the population mean $\overline{Y}$, satisfying $S^2 > N(\overline{Y}-c)^2$, where S^2 is the population mean square for the characteristic and N the population size, the usual estimator in srswor is improved. This improved estimator is shown to be better than that proposed by Pathak (Recent advances in sampling theory, Mimeo. Pub. No. SM65-04, RTS, Indian Statistical Institute, 1965) for srswor which also uses the same prior information. (S27), 45/68.

28. *A characterization of a class of regular graphs* :

The graph $G(l, n, m)$ is defined as follows : Take l disjoint sets $S_1, S_2, \ldots, S_l$ each with n elements. The vertices of $G(l, n, m)$ are all the (unordered) m-tuples of elements of $\bigcup_{i=1}^{l} S_i$ where any m-tuple contains at most one element from each S_i. Two vertices are joined by an edge if and only if the corresponding m-tuples have a common $(m-1)$-tuple The T_m graph, the L_2-association scheme and the cubic lattice graph characterized by Dowling, Shrikhande and Laskar are particular cases of this graph obtained by taking $n = 1$, $l = m = 2$, $l = m = 3$ respectively. In this paper, a characterisation of the graph $G(l, n, m)$ is obtained when $m \leqslant 5$ and $(l-m+1)n < \max\left\{1+\frac{3}{2}m(m+1), 2m^2-3m+5\right\}$. (S28), 25/68.

29. *On line graphs* :

A procedure for reducing the line graph of any connected graph to the line graph of a tree is given. Using this, a procedure for recognizing whether a graph H is a line graph and to find G such that $L(G) = H$ when it is a line graph is obtained. Necessary and sufficient conditions for a graph to be the line graph of the complete l-partite graph $K_{n_1, n_2, \ldots, n_l}$ are obtained. (S29).

30. *Existence of locally restricted undirected graphs* :

Necessary and sufficient conditions for the existence of an undirected graph with prescribed degrees $d_1, d_2, \ldots, d_n$ are deduced by simple considerations from the corresponding theorems of Gale, Ryser and Fulkerson for directed graphs. (S30).

31. *A characterization of the line graph of a BIBD with* $\lambda = 1$:

If D is a BIB design with parameters b, v, r, k, l, the graph $H(D)$ of D is the bipartite graph whose vertices are the $v+b$ treatments and blocks of D, two vertices of $H(D)$ being adjacent if and only if one is a treatment and the other is a block containing the treatment. The line graph $L(D)$ of D is the graph whose vertices are the edges of $B(D)$, two vertices of $L(D)$ being joined if and only if the corresponding edges of $H(D)$ have a common vertex, $G = L(D)$ has the following properties :

(1) the number of vertices in G is vr,

(2) G is regular of degree $4+k-2$,

(3) for an edge (x, y), (x, y) is $r-2$ or $k-2$ where (x, y) denotes the number of vertices adjacent to both x and y,

(4) if x, y are at distance 2, $(x, y) = 1$.

Let $vr = bk$, $v = 1+r(k-1)$ and $r > k \geqslant 2$. Then we prove that any graph G with no loops and no multiple edges) having the properties (1) to (4) is the line graph of a BIB design with parameters b, v, r, k, l provided $r-2k+1 < 0$. When $k = r$ a similar characterization has been obtained by Dowling and Laskar. The line graph of a finite affine plane was characterized in terms of the distinct eigen values of its adjacency matrix by Hoffman and Roy Chaudhuri (*Canad. Jr. Math.*, 17, 687-694, 1945). Taking $r = k+1$ in our theorem, we get another characterization of the line graph of a finite affine plane. (S31), 42/68.

32. *Remarks on analytic sets* :

The purpose of this note is to prove the following three theorems : Let I be the unit interval 0, 1 with A the σ-algebra generated by analytic sets, U the σ-algebra of universally measurable sets: $A \subset I \times I$ be an analytic set universal w.r.t. the analytic sets in I. Then Theorem 1 : A *is not countably generated*. Theorem 2 : $A \in U \times U$. Theorem 3: *Assuming the continuum hypothesis to be true*, $A \subset U$. Theorems much more general than 1 and 2 are also stated. (S32), 19/68.

33. *On Feller boundary* :

Given a measurable space (X, B) and a substochastic transform function $p(x, A)$ it is shown that the bounded harmonic functions form an abstract M-space and hence by invoking a theorem of Kakutani, the Feller boundary Γ is introduced. Then specializing to the case when X is countable, it is observed that Γ is totally disconnected. Following

Feller, a natural topology on $X \cup \Gamma$ is introduced justifying the terminology that Γ is a boundary of X. By a simple observation, the harmonic measures are calculated. It is also shown that one can represent the collection of bounded harmonic functions as the collection of essentially bounded functions of a certain measure space. Finally, it is shown that there do exist points on Γ corresponding in a natural way to bounded minimal harmonic functions. (S33), 24/68.

34. *Compactification of a totally ordered set* :

A new proof of the well-known result that 'any totally ordered sets can be embedded in a compact totally ordered set' is given. The main idea is simple and intuitive, and can be explained as follows : Consider the collection C of all closed subsets of X, the given totally ordered set. Including two elements of C in the same equivalence class if they seem to have the same supremum, look at the space X^* of equivalence classes. With a suitable order, X^* will give us the desired set. (S34), 28/68.

35. *On discrete Borel spaces and projective sets* :

Assuming the validity of the axiom of choice and continuum hypothesis, the following questions can be shown to have affirmative answers :

1. Is the product of discrete σ-algebras on the unit interval the discrete σ-algebra on the unit square ?
2. Is there any separable σ-algebra on the unit interval containing all its analytic sets ?
3. Is there any separable σ-algebra on the unit interval containing all its projective sets (generalised projective sets as defined by S. M. Ulam)? (S35), 37/68.

36. *On Borel structures* :

Following are the main observations given in this paper : (1) Every countably generated σ-algebra has a minimal generator. (2) There exist two separable σ-algebras on the unit interval whose intersection is not separable. (3) There are atomless σ-algebras on any uncountable set. Finally, applications of a theorem of Blackwell are given (S36), 43/68.

37. *On the axiom of determinateness and analytic sets* :

The object of this note is to treat systematically the generalized analytic sets introduced by S. M. Ulam. Some of the theorems are strengthenings of previous theorems of the author. Others will be consequences of the axiom of determinateness introduced by Jan Mycielski and H. Steinhaus. However, the study of the problems is far from complete. (S37), 52/68.

38. *Some characterizations of the multivariate normal distribution* :

The paper describes two recent lines of development in the characterization of the multivariate normal distribution.

Let $X_1, \ldots, X_n$ be n independent vector variables and $Y_i = A_{i1}X_1 + \ldots + A_{in}X_n$, $i = 1, \ldots, n$ be n linear functions with matrix coefficients A_{ij}. The conditions under which $E(Y_i \mid Y_1, \ldots, Y_n) = 0$ implies multivariate normality of X_i have been investigated when $n \geq 3$ and when $n = 2$. The general problem of investigating the conditions under which $E(Y_i \mid Y_1, \ldots, Y_n) = 0$, $i = 1, \ldots, p$, imply multivariate normality of X_i has been stated.

It is well known that if X is a multivariate normal variable, then it can be represented as AY, where A is a matrix and Y is a vector of independent $N(0, 1)$ variables. However, neither A nor the number of components of Y is unique. In fact $X = BZ$ will be alternative representation provided only $BB' = AA'$, admitting the possibility of the numbers of columns A and B being different. We consider the converse problem, and investigate the nature of non-uniqueness of linear structure of a vector variable, which restricts it to have a multivariate normal distribution. A general decomposition theorem of a random variable with a linear structure has been stated. (838), 22/68.

39. *Estimation of heteroscedastic variances in linear models* :

Let $Y = X\beta + e$ be Gauss-Markoff linear model such that $E(e) = 0$ and $D(e)$, the dispersion matrix of the error vector, is diagonal matrix with the i-th diagonal element as σ_i^2, the variance of the i-th observation y_i. Some of the σ_i^2 may be equal. The problem is to estimate all the different variances.

In this paper, a new method known as MINQUE (Minimum Norm Quadratic Unbiased Estimation) is introduced for the estimation of the heteroscedastic variances. This method satisfies some intuitive properties: (i) if S_1 is MINQUE of $\Sigma\, p_i\sigma_i^2$ and S_2 that of $\Sigma q_i\sigma_i^2$, then S_1+S_2 in MINQUE of $\Sigma(p_i+q_i)\sigma_i^2$, (ii) it is invariant under orthogonaltrans formation etc.

Some sufficient conditions for the estimation of all linear function of σ_i^2 are given. The use of estimated variances in problems of inference on the β parameters is briefly indicated. (839), Math-Stat/4/69.

40. *A multidisciplinary approach for teaching statistics and probability* :

The paper describes a multidisciplinary approach for teaching statistics and probability to first year students of an undergraduate course. Statistics may not be treated as a separate discipline but introduced as a body of techniques useful for research in other disciplines. Teaching has to be problem oriented rather than drilling the boys in the use of statistical techniques on what Fisher calls 'mock up data, for the use of students only'.

Some examples are given to show how probability concepts can be introduced and statistical methods taught in a natural way in relation to live research projects or in the study of the basic disciplines such as physics, chemistry and biology. Two projects, viz., population projection and genetics of sex determination, in discussing which a wide range of topics in statistics and elements of probability were introduced and taught in the first year of the B.Stat. course at the Indian Statistical Institute are described in some detail.

The suggested approach to teaching of statistics was motivated by the concept of statistics as a key technology as advocated by Professor P. C. Mahalanobis. (840). Math-Stat/14/69.

41. *Variance estimation with one unit per stratum* :

A new solution to the problem of variance estimation with one unit per stratum is presented. This method may lead to smaller bias in variance estimation, in many situations, that the methods of ' collapsed strata'. It requires that we can associate with the strata concomitant variables which are correlated with the strata means. Several numerical examples with one or two concomitant variables are considered. (841), Math-Stat/8/69.

42. *Some small sample results in ratio and regression estimation* :

Koop (*American Statistician*, 22, 29-30, 1968) has empirically shown that the customary approximate formula for the variance of the classical ratio estimator can grossly understate the true variance when the sample size, n, is small. However, he has considered only three populations and $n = 4$. In this note we provide some theoretical justification for this result as well as empirical evidence based on a wide variety of natural populations and sample sizes $n = 4, 6, 8$ and 12. We also show that the customary approximate formula for estimator of variance can lead to serious underestimation of the true variance when n is small. Further, we show that the true variance of the classical regression estimator can be grossly understated by the use of customary approximate variance formula when n is small. In fact, the true variance of the regression estimator can often be larger than that of the ratio estimator. We also show that the customary approximate formula for estimator of variance can lead to serious underestimation of the true variance of the regression estimator. (842), Math-Stat/15/69.

43. *Some results on sampling over two occasions* :

For sampling over two occasions from a finite population, under simple random sampling without replacement, Kulldorff's (*Rev. Int. Stat. Inst.*, 31, 24-57, 1963) estimator of the population total on the second occasion is shown to be more efficient than that of Pathak and T. J. Rao (*Sankhyā*, Series A, 29, 49-54, 1967), for the same expected cost. Extensions to unequal probability sampling are also considered. (843), 50/68).

44. *Pitman efficiencies of tests based on spacings* :

This paper is devoted to a comprehensive study of Pitman's asymptotic relative efficiencies (ARE's) of test based on spacings i.e., differences between successive order statistics. Such tests have been utilised for the goodness of fit problems on the line (see e.g. Pyke, JRSS, 1965) as well as on the circle (see Rao, J. S. 1969, thesis submitted to the Indian Statistical Institute). The limiting distributions of the empirical distribution functions of the 'normalised' and 'modified' spacings, in the sense of weak convergence of measures in an appropriate complete separable metric space, have been obtained under the alternatives of interest. Then appealing to the invariance principle, one immediately has the asymptotic normality of a large class of statistics which are symmetric in the 'normalised' and 'modified' spacings. In the process, several interesting results of independent interest concerning the empirical distribution functions of 'perturbed' random variables and 'randomly scaled' random variables are proved. ((844), Math-Stat/11/69.

45. *The cube of a tree* :

It is shown that the maximum number of edges in a connected graph G on n vertices with the coefficient of external stability greater than or equal to $k(\geq 3)$ is $[(n-k)(n-k+1)]/2$ and that the graph G which attains this maximum has maximum degree $n-k$ and there exists an independent set of $k-1$ vertices $x_1, x_2, \ldots, x_{k-1}$ such that $\Gamma x_i \Gamma x_j = \phi$ whenever $i \neq j$. When $n = 2k$, the extremal graph is shown to be unique. (845), 16/68.

46. *On higher powers of a tree* :

In this paper necessary conditions for a graph to be the $(2k+1)$-th power of a tree are proved. A criterion for a given graph $G = (X, U)$ to have a tree $(2k+1)$-th root is obtained in terms of the existence of a tree $2k$-th root of a partial graph on $X-E$ where E is the set of

all unieliqual vertices of G. Then a necessary and sufficient condition for a graph to be the sixth power of a tree is obtained. All graphs which have exactly one tree-sixth root are characterised. Finally, all graphs having a unique three-sixth root are characterised. Finally, all graphs having a unique tree-seventh root are determined. (S46), 23/68.

47. *The cube and the fourth power of a graph* :

The paper presents a solution to the problem of characterising graphs that have at least, one cube-root graph, one fourth-root graph. The characterisation is given in terms of existence of a set of complete subgraphs and a set of complete bipartite partial subgraphs of the given graph satisfying certain properties. (S47), 39/68.

48. *Randomly traceable diagraphs* :

A diagraph is called randomly traceable if the following procedure always results a Hamiltonian path : Start at any vertex x, at any stage proceed from a vertex y to ony vertex of Γy not yet encountered (if it exists). A diagraph G is called complete cyclically t-partite if its vertex set can be partitioned into $k\ (\geqslant 2)$ sets $A_1, A_2, \ldots, A_t$ such that (x, y) is an arc of G if and only if x belongs to A_i and y to A_{i+1} for some i, $1 \leqslant i \leqslant t-1$, or x belongs to A_t and y to A_1.

Theorem : *A diagraph G is randomly traceable if and only if it is either a symmetric circuit. a complete symmetric graph, or a complete cyclically t-partite graph with equal number of vertices in the t parts.* (S48), 46/68.

49. *On a problem of ore on maximal trees* :

A connected graph $G = (X, E)$ is said to have the property P if for every maximal tree T of G there exists a vertex a_T such that $d_T(a_T, x) = d_G(a_T, x)$ for every $x \epsilon X$.

Theorem : *A finite biconnected graph $G = (X, E)$ has the property P if and only if it is a cycle or a complete bipartite graph $K(V, X-V)$ with $|V| = 2$, and $|X-V| \geqslant 2$.*

Further, the structure of all finite connected graphs having the property P is determined. (S49), Math-Stat/1/69.

50. *On determining optimal investments in L.P. model* :

The importance of Linear Programming in determining optimal product mix is well established. Once the optimal product mix is obtained, the next problem of interest is whether the situation can be further improved by relaxing some of the restrictions. For example, more production may be obtained from a bottleneck operation by paying over time or buying some extra cost, etc. And the overall general problem that is of most importance to any industry is, how much extra investment should be made to get an optimal return and what should be the most profitable way of spending it. In this paper, the solution to this problem has been obtained by linear programming. It also gives a short-cut-technique for solving this problem of determining the optimal investment. Lastly, the paper discusses how the decisions on investments may vary with the variations in the interest rates. (S50) Math-Stat/8/69.

51. *On a problem of critical path method* :

The papor discusses the problem of finding the minimum completion time of two identical projects, undertaken simultaneously by the critical path method. The solution

to this problem is given under a restrictive condition. Such problems may arise in industry. The problem (and the solution to this) may be generalized in case of K identical projects. (S51), 21/68.

52. *Path through k specified nodes—a modified algorithm* :

In this note a modified algorithm has been developed for 'The routing problem with k specified nodes' (*Operations Research*, 14, 5, 1966). An error was pointed out by Dreyfus in Rand Report : RM-5433, PR, September 1967. The method is illustrated by an example. (S52), 14/68.

53. *Irreversible operations—a network analysis* :

In this paper, the authors intend to draw some conclusions regarding irreversible operations in terms of network analysis. It is observed that in the optimization problems, adding constraints either results in the same answer or makes it still worse. Three propositions are given in support of this observation and a theorem. In the end, constraints caused by unknown agencies are discussed. (S53), 33/68.

54. *Simulation studies for comparison of different estimators* :

Simulation studies permit comparison of different estimators under conditions of (a) known parameter values, and (b) no observational errors. In the present study, the empirical behaviour of the estimators commonly used in survey work is examined and compared in terms of their sampling variances by simulating the Bivariate Normal distribution, $N(Y, D|(80, 55)\Sigma)$ where

$$\Sigma = \begin{matrix} 225 \text{ or } 25 & \rho\sigma_Y\sigma_D \\ \rho\sigma_Y\sigma_D & 25 \end{matrix}$$

σ_Y, σ_D being the standard deviations of Y and D respectively and ρ, the coefficient of correlation between Y and D, ranging through values $-.8$, $-.3$, $+.3$, and $+.8$. (S54).

55. *An IPPS sampling scheme* :

For sampling with unequal probabilities without replacement, a scheme is given in this paper which yields inclusion probabilities proportional to size for all units in the population. This consists in selecting samples (of fixed number of distinct units) as a whole with pre-assigned probabilities, using Lahiri's method of selection. The scheme is applicable only if the sizes satisfy certain conditions. It is also shown that the Sen-Yates-Grundy variance estimator of Horvitz-Thompson estimator of total is always positive under a slightly stricter condition. An empirical study, comparing the present scheme (with Horvitz-Thompson estimator) with similar strategies, is also included. (S55).

56. *A note on A. K. Bose's paper* :

This note aims at providing an alternative method to prove some of the theorems proved by A. K. Bose in "Functions satisfying the weighted average property" (*Trans. Amer. Math. Soc.*, 118, 472-487, 1965) and to bring out the connections of the functions satisfying the weighted average property, into the light with the Brownian Motion.

First, a diffusion process has been attached to the differential operator which was introduced by A. K. Bose in his paper.

Further, it is shown that this diffusion process can be obtained from a sub-process of the Brownian Motion by Random Time Change. (S56), 27/68.

57. *Weak compactness of a set of translates of Wiener measure* :

A necessary and sufficient condition for a set of translates of Wiener measures, on the Wiener Space, to be weakly sequentially compact is derived in this paper. (857), Math-Stat/17/69.

58. *Error analysis for radix-conversion floating-point numbers* :

In digital computations, particularly in a multi-computer system, a numeric constant is usually subjected to a sequence of radix-conversions. These radix-conversion processes are accompanied by some rounding errors and these together with the inherent inexactness in representing the numeric constant with a finite number of digits in a radix give rise to a number of interesting problems. In this paper, the following two problems are considered using a simple error analysis approach.

(a) If a number x with m radix-p significant digits is converted to y in radix-q, how many digits are to be kept in y which are really meaningful ?

(b) If a number x with m radix-p significant digits is converted to y with a radix-q significant digits and then converted back to x^* with m radix-p significant digits then what are the necessary and sufficient conditions under which $x = x^*$ or x differs from x^* by one unit in the least significant place ? (858), 36/68.

59. *A note on multiple precision range transformations* :

Results pertaining to existence and choice of suitable multipliers for a class of range transformations of multiple precision floating-point numbers with integral mantissa are presented. (859), Math-Stat/17/69.

60. *Comparison of some ratio-cum-product estimators* :

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 variables y_0 and y_1. These estimators are given by

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

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*, Series B, 27, 321-28, 1965). 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. (860).

61. *On the utilization of an a priori value of the parameter in the estimation procedure* :

In this paper an estimation procedure is suggested which utilises the knowledge of an a priori value of the population parameter θ. The a priori value may be available from previous censuses or surveys or even expert guesses. The proposed estimator is given by $\hat{\theta}_e = \theta_0 + k(\hat{\theta}-\theta_0)$ where θ_0 is the a priori value, k is some constant and $\hat{\theta}$ is the usual unbiased estimator of θ. The optimum value of k which minimises the mean square error of $\hat{\theta}_e$ is found

to be $k_0 = \partial^2/(\partial^2+\epsilon^2)$ where $|\partial| = (1-\theta_0/\theta)$ and ϵ is the relative standard error of $\hat{\theta}$. In many cases, ϵ may be known in practice, especially when the survey is planned to achieve a specified precision but $|\partial|$ is always unknown. Hence an approximately optimum $\hat{\theta}_{e1}$ is obtained by using $k_{e1} = \partial_1^2/(\partial_1^2+\epsilon^2)$ where ∂_1 is an a priori value of ∂. $\hat{\theta}_{e1}$ is compared with $\hat{\theta}$ for estimating the true parametric value. A table showing the relative efficiency of $\hat{\theta}_{e1}$ as compared to $\hat{\theta}$ has been given for various values of ϵ, ∂ and ∂_1. The case when approximate values of both ∂ and ϵ are used, have also been discussed. Further, some special cases of $\hat{\theta}_\epsilon$ have been mentioned. Lastly, the case when $\hat{\theta}$ is biased for θ has been briefly discussed. (S61).

62. *Extremal connected graphs* :

It is shown that the maximum number of edges in a connected graph G on n vertices with the coefficient of external stability greater than or equal to $k(\geqslant 3)$ is $(n-k)(n-k+1)/2$ and that the graph G which attains this maximum degree $n-k$ and there exists an independent set of $k-1$ vertices $x_1, x_2, \ldots, x_{k-1}$ such that $\Gamma x_i \, \Gamma x_j = \phi$ whenever $i \neq j$. When $n = 2k$, the extremal graph is shown to be unique. (S62), 16/68.

63. *Turan's theorem for connected graphs* :

In this paper, it is shown that the minimum number of edges in a connected graph on n vertices with the coefficient of internal stability equal to k, is $r\binom{l+1}{2}+(k-r)\binom{l}{2}+k-1$ where $n = lk+r$, $0 \leqslant r < k$. (S63), 29/68.

64. *On total chromatic number of a graph* :

A total colouring of a graph is a colouring of its edges and vertices in such a way that no two adjacent elements have the same colour. The total chromatic number $T(G)$ of a graph G is the minimal number of colours in a total colouring of G. It was conjectured by M. Behzad that for any graph G, $T(G) \leqslant V(G)+2$, where $V(G)$ is the maximal valency of the vertices in G. We prove the conjecture for a class of graphs.

Theorem 1 : *If G is a graph with maximum degree 3 then $T(G) \leqslant 5$.*

Theorem 2 : *Let G be an s-graph such that any vertex is joined to at most three other vertices. Then $V(G)+1 \leqslant T(G) \leqslant V(G)+s+3$.* (S64), 32/68.

65. *Characterization of total graphs* :

The total graph $T(G)$ of a graph G is defined as the graph whose vertices are the vertices and edges of G, and in which two vertices are adjacent if and only if the corresponding elements (edges or vertices) of G are adjacent or incident. In this paper the author gives a characterization of total graphs, the total graph of a complete graph and the total graph of a cycle. The coefficient of internal stability of $T(G)$ is investigated. If $H = T(G)$ then G is unique up to isomorphism and an algorithm for determining G is given. (S65), 44/68.

66. *On the total graph of a directed graph* :

The total graph $T(G)$, of a directed graph G is defined as the graph whose vertices are the elements (vertices and arcs) of G, and in which two vertices x and y are joined by an arc from x to y if and only if x and y are vertices of G and are joined by an arc from x to y or x is a vertex of G and y is an arc incident out from x or x is an arc incident into some

vertex and y is an arc incident out from the same vertex. Two elements of G are adjacent if and only if they are joined by an arc in $T(G)$.

In this paper, directed connected graphs without loops are considered. For these graphs it can be proved that : if ϕ is an isomorphism between the elements of G and the elements of H (preserving adjacency) and if G is not a circuit then ϕ induces an isomorphism between the vertices of G and the vertices of H. From this theorem a number of interesting corrolaries are obtained.

Necessary and sufficient conditions for $T(G)$ to be Eulerian and Hamiltonian are obtained. And finally it is shown that, for chromatic number of $T(G)$, $\gamma(G) \leqslant \gamma(T(G)) \leqslant \gamma(G) + 2$ where $\gamma(G)$ is the chromatic number of G. (S68), 51/68.

B. Theoretical Physics and Electronics

67. *A model of Hadrons* :

A configuration scheme for mesons and baryons is proposed on the basis of the assumption that all internal motions are quantitised in units of $\frac{1}{2}\Gamma$ instead of Γ. Taking a triplet $\chi^1\chi^2\chi$-as the basic constituents where χ^i is a spin $\frac{1}{2}$ particle, it is considered that χ or a meson composed of $(\chi\,\chi)$ moves in a central field about a certain particle χ with orbital angular momentum $\frac{1}{2}\Gamma$. By adding more $(\chi\,\chi)$-systems, each of them having the same orbital angular momentum, certain configurations for mesons and baryons are achieved. On the basis of these considerations, it is found that internal quantum numbers like isospin, strangeness and baryon number are associated with the total or orbital angular momentum of the constituents. Also it is found tht this scheme can explain the mass-spectrum of strongly inter-acting particles and the 'equal spacing' rule in a very satisfactory way. Again, for reasons of symmetry under permutation of different mesic systems in a certain configuration, the scheme helps us to predict the exact number of mesons and baryons of a particular kind. It is found that the model allows exactly 8 and 10 members for $J^{\frac{1}{2}}$ and $J^{3/2}$ baryons having the same quantum numbers as predicted by SU_3-symmetry scheme. But for pseudoscalar (vector) mesons, apart from the Octet the present scheme suggests the existence of three other isosinglet mesons $D^+(F^+)D^0(F^0)$ and $D^-(F^-)$ (μ_D 725 MeV, μ_F, ϕ 1020MeV) having strangeness $+2, 0$ and -2 respectively. In case of a vector mesons, the member with $S = 0$ is identified with the well-known ϕ^0-meson. It is pointed out that the scheme also accommodates other sets of mesons and baryons including those of higher spin by altering a spin 0 mesic constituent by a spin 1 one or vice versa, or by adding other mesic systems in the S-state in a certain configuration. Finally, some remarks about the feasibility of taking muon triplet (μ^+, ν_m, μ^-) as the basic triplet, are made in view of the above scheme. (S.67).

68. *A direct interaction scheme for scattering for Hadrons* :

In view of the configuration scheme for hadrons proposed in an earlier paper, a direct interaction scheme for scattering processes of hadrons has been presented here. It has been suggested that various inelastic channels for scattering processes of hadrons can be interpreted in terms of stripping, knock-out or rearrangement type of collisions. Considering this, the angular distributions for the processes $K^- + p \rightarrow \Sigma^+ + \pi^-$ and $p + \pi^0 \rightarrow n + \pi^+$ have been derived. The former process has been considered to be a stripping reaction and the latter one to be a knock-out reaction. Finally, certain qualitative discussions on the implications of this direct interaction mechanism for scattering processes of hadrons and the agreement with experimental evidences have been made. (S68).

69. *Direct interaction scheme for scattering of Hadrons and some cross section relations* :

On the basis of the configuration scheme for hadrons as proposed in an earlier note and direct interaction scheme for various scattering processes, some high energy cross section relations have been derived. From our analysis, we predict $a(\pi^- p \to \pi^0 n) = a(k^- p \to k^0 n)$, $a_t(k^+ p) = a_s(k^+ n)$, $a_s(pp) = a_s(pn)$ which are in excellent agreement with experiments. Other predictions include $a(\pi^+ n \to \pi^0 p) = a(k^+ n \to k^0 p)$, $a(k^- p \to \Sigma^+ \pi^-) = a(k^0 p \to \Sigma^+ \pi^0) = a(k^0 - p \to \Sigma^+ p^-) = a(k^0 p \to \Sigma^+ p^0)$, the validity of which cannot be tested at the moment due to the lack of high energy data. A comparison with other models shows that the present scheme does not share certain inconsistencies which crop up in the quark model or in the Regge Pole model. Finally it is pointed out that the present model can also explain backward scattering and polarisation observed in various scattering processes in an unambiguous way. (S69).

70. *Weak interaction of photons and the possibility of a dynamical origin of electric charge* :

In a recent note, we have argued that photons can interact weakly with two component spinors such as neutrinos. Here it is shown that this weak interaction property of photons can help us to understand electric charge from a dynamical point of view provided we take photons as separate fundamental field quanta. (S70)

71. *Dynamical origin of charge, Muon decay and scattering of leptons* :

In the preceding note, it has been argued that if the photon-neutrino weak coupling exists, charge can be considered to be of dynamical origin. In view of this, a new description of leptons can be given and muon decay and scattering of leptons can be described as the effect of photon-neutrino weak coupling. It is shown here that the scheme gives muon decay probability equivalent to the result obtained in the current-current coupling theory. Again, in scattering processes, the scheme gives results in consistency with unitarity. This is a very significant aspect of the present scheme, as in the current-current coupling theory or in the vector boson theory, we have unitarity catastrophe at high energy. (S71).

72. *Theories of weak interactions and astrophysical evidence* :

It has been proposed in an earlier paper that photons can interact weakly with neutrinos. Assuming this photon-neutrino coupling, the effect of energy loss due to the pair-annihilation process and the photo-neutrino process on the evolutionary time-scales of a 15.6 $M_\odot$ star has been discussed. In the typical model of Hayashi, Hoshi and Sugimoto (HHS), the lifetimes for carbon burning and later phases have been calculated assuming the photon-neutrino coupling and is compared with the results obtained by HHS according to the $(e\nu)(e\nu)$ coupling. In case of $\gamma\nu\bar{\nu}$ coupling, the ratio of the number of blue supergiants (He-burning stars) to red supergiants (stars in C-burning and later stages) is found to be < 10 with the initial concentration of carbon $X_C = 0.5$, whereas according to the $(e)(e)$ coupling, the corresponding ratio is found to be nearly 33. According to astrophysical observations, this ratio is found to be nearly unity within a factor 1.5. It is noted that the result according to the $\gamma\nu\bar{\nu}$ coupling becomes significantly better in comparison with the $(e)(e)$ coupling. Also, in view of the uncertainities regarding the total luminosity in the red supergiant phase as well as the rate of $C+C$ reaction, we can consider the result obtained according to the $\gamma\nu\bar{\nu}$ coupling to be in reasonable range of proximity with the 'observed' value. From this, we argue that stars seem to 'favor' the photon-neutrino coupling theory than the current-current coupling theory of weak interactions. (S72).

73. *Weak interaction of Photons and the Photo-neutrino process* :

Assuming that photons can interact weakly with neutrinos, the cross section for the photo-neutrino process $e^- + \gamma \rightarrow e^- + \nu + \bar{\nu}$ has been calculated. From this, the rate of stellar energy loss has been derived and is compared with the result obtained on the basis of the current-current coupling theory. (S73).

74. *Testing of magnetic core memory systems* :

The design of an Information Processing System (IPS) such as a digital computer largely centres around the choice of the high speed level in which bulk storage of programme and data is accomplished, commonly known as inner memory, which in turn transfers its contents at intervals to or from a large and slower storage system. The present study comprises the testing, design and fabrication of coincident current magnetic core matrix memory with random access and destructive readout which at present is the most widely used high speed storage device.

An automatic control equipment for individual testing of memory cores that conform to the chosen characteristics and an experimental method for testing of memory planes designed and developed by the authors is presented very briefly in this paper. (S74).

75. *Some comments on speech analysis and synthesis for computer use* :

The research in this field comprised mainly construction of digital code patterns from human speech, without any loss of intelligence content, suitable for the use of computers. This leads us to the need for obtaining further insight into the anatomical and physiological aspects of generative and hearing processes. Analysis and synthesis of speech events are very important in that respect. The present paper deals with that end in view. (S75).

76. *Design details of an analyser-coder for speech recognition* :

The paper deals with design details and experimental results of an analyser-coder for construction of a digital code pattern from a human speech input suitable for the use of computers from which the intelligence content can be extracted without any human intervention. (S76).

77. *A model for spoken word recognition* :

Instead of the usual procedure of analysis of words as assemblage of phonemes in extracting intelligence, the model suggested by the authors implements a compact coding system directly from the analysis of speech acoustic parameters on the basis of "sample on change" scheme.

The vocabulary of the machine is taken to be finite with N number of different syllables i.e. N different cluster of points in the N-dimensional measurement space M. The primary classification is based on the premises that a constant likelihood ratio corresponds to a constant difference in the discrimant score Lr, and if the a-priori probabilities are $\pi_1, \pi_2, \ldots, \pi_N$ for the N groups then an individual is assigned to the group for which $Lr + \log \pi r$ is a maximum. The final classification is done by minimising the distance between the points of the same cluster while the total volume of the space is kept constant by some suitable permissible transformations discussed in the paper. The paper also explains the sampling scheme and the code format. (S77).

78. *System design of cost limited small computers suitable for Indian conditions* :

The paper gives the system design of a cost limited transistorised small computer incorporating microprogramming and stored logic concept, with a high speed core memory expandible upto sixteen thousand words (16K). With an 18-bit word format, and 1-bit parity check in memory, the machine will have 2K inner memory, zero/current page direct addressing and indirect addressing upto 16K. Input may be on punched tape through a teleprinter or high speed photo electric tape reader, and data output may include teleprinter, a high speed tape punch or magnetic tape units.

The machine will have memory reference instructions not exceeding 30, but total number of instructions can be more than 80. The machine will have 5 index registers in the core memory with 3, 36-bit and 2 single bit flip-flop registers with double length addition, subtraction and multiplication facilities. (S78).

79. *Studies on acoustic parameters for spoken word recognition systems* :

The importance of different acoustic parameters are discussed in the light of the spoken word recognition model suggested by the authors. (S79).

80. *Design of an experimental memory core plane tester* :

The design details of an experimental automatic control equipment for testing of memory planes that conform to the chosen characteristics and reliable operation is explained in the paper. (S80).

81. *On the probability distribution of rounding-off errors in difference tables* :

$$\frac{\Sigma(-1)^{s_0+s_1+\cdots+s_n}(x+2^{n-1}-\Omega)^{n+1}}{(n+1)!\ \omega_0\omega_1\omega_2\ldots\omega_n}$$

where ω_r = usual binomial coefficient $\binom{n}{s}$ and $\Omega = s_0\omega_1+s_1\omega_1+\ldots+s_n\omega_n$; the multiple summation is to be extended over all $s_0, s_1, \ldots, s_n$ having only two values 0 or 1, till $x+2^{n-1}-\Omega$ becomes negative.

The (2ν)-th moment $M_{2\nu}$ is the Bernoulli Polynomial of negative order of argument 2^{n-1}

$$M_{2\nu} = B_{2\nu}^{-(n+1)}(-2^{n-1}\,|\,\omega_0\omega_1\ldots\omega_n), \qquad \nu = 1, 2, 3, \ldots$$

$$M_{2\nu+1} = 0, \qquad \nu = 0, 1, 2, 3, \ldots$$

The variance $M_2 = \dfrac{(2n)!}{12(n!)^2}$

For large n the density distribution asymptotically approaches a normal distribution with variance $\dfrac{(2n)!}{12(n!)^2}$ and mean 0.

The rounding-off errors present in the tabular values of a function are naively assumed to be distributed uniformly between $+\frac{1}{2}$ and $-\frac{1}{2}$ units of the last place of decimal. Numerical analysts have long recognised that these errors are propagated in the differences but that the error in the n-th difference would never exceed times the bounds of errors present in the original tabular values. However, the exact probability distribution of the errors propagated in the n-th difference was not known though Comrie suggested an empirical distri-

bution based on his long experience in constructing mathematical tables. This empirical distribution has been used widely by numerical analysis for checking the accuracy of a mathematical table.

Starting from the assumptions that the round-off errors are distributed uniformly between $\pm\frac{1}{2}$ units of the last place of decimal and are stochastically independent, the exact probability distribution of the errors propagated in the n-th difference has been deduced. The distribution function is a truncated Bernoulli Polynomial of negative order of $(n+1)$-th degrees, which can be expressed in terms of the generalised Norlund differences.

The agreement between this exact distribution and the empirical distribution of Comrie is good. (S81).

82. *Deutron polarization in elastic nucleon-deuteron scattering* :

The importance of the deuteron D state to the discussion of deuteron polarization in elastic nucleon-deuteron collisions is examined. It is found that while the D state contributions could be neglected in the case of nucleon polarization and vector polarization of the deuteron, one has to be guarded in making the same approximation with regard to the tensor polarization of the deuteron. Here one has to properly assess the magnitude of certain D-state terms where the scattering could take place via the central spin-independent nucleon-nucleon force which might be of the same order or even larger at some energies than the purely S-state terms representing scattering via the spin-orbit or tensor terms of the nucleon interaction. (S82), Phy/3/68.

83. *Sum rule for particle reactions on nuclei* (II) :

A general sum rule for particle reactions on nuclei is derived. An important feature of this result is that it distinguishes between two nucleon correlation functions in the spin singlet and triplet states and also quadruple type correlations in the spin triplet state. Experimental measurements of differential cross section of various processes like electron scattering, neutrino absorption, pion scattering, photo and electro production of pions on nuclei at different angles and energies corresponding to a given value of the square of the momentum transfer to the nucleus are suggested to determine empirically the different types of correlations functions. An effect of deviations from charge independence is also considered. With target polarised nuclei, it is shown that higher order nucleon-nucleon correlations appear. (S83), Phy/4/68.

84. *Photoproduction of neutral pions on nuclei* :

The photoproduction of neutral pions on ^{9}Be, ^{12}C and ^{16}O of 166 MeV is discussed using the impulse approximation and the theoretical amplitudes of CGLN, (Nerends *et al* and Schwela). Best fits with experiment are obtained using oscillator wave functions and varying the nuclear radius as a parameter. This leads to the values $R = 2.29$ fm for ^{9}Be, $R = 2.52$ fm for ^{12}C and $R = 2.27$ fm for ^{16}O. (S84) Phy/1/69.

85. *Recoil deuteron vector polarization in elastic electron scattering* :

The vector polarization of the recoil deuterons in the elastic scattering of electrons on deuterons is shown to be non zero, if the deuteron S and D states differ in phase and an expression for the polarization is given in terms of the isoscalar electro-magnetic form factors of the nucleon and the deuteron radial integrals. (S85), Phy/2/69.

86. *Weak interaction of photons and neutrino bremsstrahlung* :

Assuming that photons can interact weakly with neutrinos, the cross section for the neutrino bremsstrahlung $\delta + z \rightarrow z + \nu + \bar{\nu}$ has been calculated. From this, the rate of stellar energy loss due to neutrino pair emission has been derived and is compared with the result obtained on the basis of the current-current coupling theory. (S86).

87. *Weak interaction of photons and the process* $\gamma + \gamma \rightarrow \gamma + \nu + \bar{\nu}$:

From the point of view that photons can interact weakly with neutrinos, the cross-section for the process $\gamma + \gamma \rightarrow \gamma + \nu + \bar{\nu}$ has been calculated. From this, the rate of stellar energy loss due to neutrino pair emission and neutrino luminosity of the star in this process has been calculated. (S87).

88. *Weak interaction of photons and photo-coulomb neutrinos* :

Taking into view that photons can interact weakly with neutrinos, the cross-section for the photo-coulomb neutrinos $\gamma + \gamma \rightarrow z + \nu + \bar{\nu}$ has been calculated. From this, the rate of stellar energy loss due to neutrino pair emission has been calculated and is compared with the result obtained on the basis of the current-current coupling theory. (S88).

89. *ω and B exchange and π^0 photoproduction on nuclei* :

ω and B exchange contribution to neutral pion photo-production on ^{7}Li, ^{9}Be, ^{12}C and ^{16}O are calculated at 160 MeV. While only ω exchange contributes to the spin zero nuclei like ^{12}C and ^{16}O both ω and B exchange mechanisms contribute to the nuclei like ^{9}Be and ^{7}Li with definite spin. The B contribution is however small even if we consider a pure spin flip transition like that to the 2.43 MeV excited state in ^{9}Be with spin parity 5/2. this is so even at higher energy like 500 MeV. (S89), Phy/3/69.

C. Anthropometry

90. *A revision of Risley's anthropometric data relating to the Darjeeling hill tribes* :

The anthropometric data relating to Bengal castes and tribes and Chittagong hill tribes collected by H. H. Risley in 1866-68 and published by him in 1891 were scrutinised by Professor Mahalanobis (1933-34) and his opinion was that the only fundamental objection to Risley's data was that the individual figures and averages given by Risley are seriously inconsistent. He concluded that the mistakes had crept in during calculation of averages and indices and in printing and the rectified data are singularly free from mistakes and can be used with safety. The author has scrutinised Risley's data relating to the Darjeeling Hill Tribes and reached similar conclusion. The rectified data which can be used with safety for the Darjeeling Hill Tribes are given in this paper. (S90).

91. *Social control and youth unrest* :

Problems of youth unrest in present India have been discussed with particular reference to the basic issue of social control that ensures 'human balance between stability and flexibility in organised group life'. The role of social institutions, especially that of the family, in enacting appropriate *means* for orderly and continuous adoptation and change has been stressed. The question of conforming or non-conforming behaviour being an aspect of the general phenomenon of group-interactions has been dwelt upon at a length to focus on the *co-ordinate* of the said problems within the overall societal condition in changing India. To examine differential behaviour—conforming or non-conforming—in the context of desirable

group standards the very existence of mutually conflicting values or *norms* within the highly differentiated social structures of our country is thought to be most crucial for those *agencies* which have been empowered by society to control any deviations in behaviour. The effective cataloging and early elimination of dys functional norms which fail to demarcate the bound of behaviour for our growing adolescents and youth appear to be the immediate (social) task for tackling indisciplined unrest. (S91) Nat/19/68.

92. *Village size and activity constellation in West Bengal* :

With respect to the problem pertinent to the question of the relation between size of population and organization, as observed by Hawley (1950), the paper attempts to study the nature of this relation. Smaller village aggregates (with a population of not more than 249) of the districts of Bankura, Malda, Nadia and Hooghly of West Bengal (1951) have been treated as primary units of investigation. In each district in question activity constellations (occupation groups) being sifted under four broad categories, namely, (i) fully and wholly agricultural (ii) fully and wholly non-agricultural, (iii) dominantly agricultural, and (iv) dominantly non-agricultural, have been examined with respect to the given village aggregates. Aggregates have further been divided under five categories, namely, (1) Population size : 1—50, (2) 51-100, (3) 101-150, (4) 151-200, and (5) 201-249. Altogether, 3,215 smaller village aggregates (9% of the total inhabitated villages of the State) have been employed in the study. One of the important findings is that occupation-oriented organisations start to differentiate distinctly in the given village aggregates at the size-limit of 100-150 persons. (S92), Nat/20/68.

93. *Momentus thoughts on population problem* :

Since Malthus (1798), storms of controverey have been raised repeatedly to discuss if ' the power of population is indefinitely greater than the power in the earth to produce subsistence for man'. Scholars of the early nineteenth century experienced the continuous rise in population in that time when such rise ought to have been restrained. Consequently, William Lloyd (1832) declared that the fault might rest, not with the people of overpopulous countries as individuals, but 'with the constitution of the society, of which they form part'. Unequal concentration of property was thought to be the prime factor to generate such 'fault'. After more than a century, Colin Clark observes that natural human fertility has nothing to do with 'undernourishment' when the probability of conception, if not impeded, in fertile human couples appears to average 0.1 per menstrual cycle. We are also given to understand that the world is still capable of supporting 28 billion people. Population and social researchers like Lorimer, Corea Du Bois, Stycos have stressed lately on socio-cultural factors in stemming rapid population growth. The significance of numerous beliefs, attitudes, values and above all the *mores* of each social group, irrespective of their economic status, has been emphasised while appraising the biological aspects of maximum fertility or otherwise. That the problem of overpopulation *relative to available resources* needs proper examination of the most basic customs and values governing human procreative behaviours has particularly been highlighted in the paper. (S93), Nat/2/69.

D. Biometry

94. *Electrophoretic determination of amylase in the postembryonic of carp Labeo Rohita (Ham.)*

An experiment was conducted to quantitatively compare amylase in the postembryonic carp *Labeo rohita(Ham.)* in the presence and absence of exogenous yeast

Saccharomyces cerevisiae. The carp were studied from the 3rd to 16th day of postembryonic life, and the yeast dosages employed were 0.0.5 gm. and 2.0 gm. yeast daily per experimental unit containing 9 liters of water. Amylase was evaluated by agar electrophoresis of the supernatant fluid obtained after centrifugation of a homogenate of whole carp. Only one electrophoretic band was observed for the tissue amylase so measured, in both treated and untreated carp. Exogenous yeast significantly enhanced amylae synthesis. (S94), Nat/8/68.

95. *Age-related variability of blood chemistry, mehalology and proteins* :

According to R. J. William's hypothesis of biochemical individuality, a person perfectly 'normal' in all of his numerous blood constituents would be most unusual, and variability among these blood constituents would increase with age, because a person seemingly 'normal' in youth might have metabolic peculiarities which would reveal themselves only in postmaturational diseases. To examine the suitability of this hypothesis, variability of blood constituents was examined for employed adult males ranging in age from 20 to 74 years. Twenty-one blood chemistry and haematology determinations obtained for 478 subjects, and fifteen protein determinations made on 284 subjects, were analysed separately. The mean frequency of determinations, classified according to normal deviates, for individuals grouped according to age, supports the hypothesis that variability characterises the blood constituents. The classification of individuals in terms of age and the variability of their blood constituents, shows that variability so measured is independent of age. This conclusion holds for blood chemistry and haematology determinations considered together or in terms of function tested (regulatory, excretory, metabolic, defence). It also holds for protein determinations considered together or separately for the serum proteins, ligproteins and glycoproteins, and amylase. (S95), Nat/9/68.

96. *Some implications of age-specific mortality, hospitalization and morbidity for the planning of hospital services* :

Assessment of need for hospital care is a basic problem in the planning of health services. N. T. J. Bailey (1967), P. Bierman *et al* (1968) are among the authorities in the field of health services research who have pointed out that, all too frequently, estimates of the volume of hospital services and hospital accommodation required are guesses made without a rational and quantitative basis. The proposal advanced in this essay is that a statistical model, which has as its basis a quantitative expression of the biologically different health needs of individuals varying in age and sex, can yield rational and quantitative estimates of need for health care. The model which is presented makes explicit the logic and assumptions of this approach. Attention is also directed toward demonstrating the influence of age on utilization of health services using illustrative data from different nations. Finally, some estimates of future need for services using this model are presented. (S96), Nat/17/68.

97. *Amylase synthesis in the postembryonic carp Labeo rohita* (Ham.) :

An experiment was conducted to quantitatively compare amylase in the postembryonic carp *Labeo rohita* (Ham.) in the presence and absence of exogenous yeast *Saccharomyces cerevisiae*. The carp were studied from the third to sixteenth day of postembryonic life, and the yeast dosages employed were 0, 0.5 gm and 2.0 gm yeast daily per experimental unit containing 9 liters of water. Amylase was evaluated by agar electrophoresis of the supernatant fluid obtained after centrifugation of a homogenate of whole carp. Only one electrophoretic band was observed for the tissue amylase so measured, in both treated and untreated carp. Exogenous yeast significantly enhanced amylase synthesis. (S97).

E. Chemistry

98. *Sorption of streptomycin by clays from an aqueous solution of streptomycin sulphate :*

The sorption of strongly basic antibiotic streptomycin by H-clay from aqueous streptomycin sulphate solution has been studied and the result reproduced as isotherms. The sorption has been found to be of the Langmuir type. With H-clay obtained from Giridih soil and Akli bentonite from Rajasthan an almost complete filling up of the available exchange sites is observed. The reaction is found to be predominantly a base exchange phenomenon involving the replacement of the H^+ by the organic base streptomycin. (S98), Nat/21/68.

99. *Sorption of crystal violet and malachite green by H-clay obtained from Giridih soil :*

Reaction, of the two triphenyl methane dyes with H-clay obtained from Giridih soil has been studied and the results reproduced as isotherms. The data also fit in with Langmuir equation up to 10^{-3}M-dye concentration studied. From the Langmuir plot, the maximum absorption for each of the two organic bases is found out by extra-polation. Maximum absorption of crystal violet corresponds with the cation exchange capacity of the clay with respect to Ba^{++} ion. The sorption of Malachite green, on the other hand, is found to be almost 50% higher. Better accessibility of the clay surface by the somewhat smaller molecules of Malachite green is partly responsible for the higher absorption value. However, the possibility of the dimerisation of the dye at higher concentration is to be taken into consideration in accounting for this higher value. (S99), Nat/26/68.

F. Computer Science

100. *A study on the disparities of food prices :*

A method to study the disparities of the prices of different food items is presented in the paper. First by L. P. technique, a number of food items are selected which satisfy some optimality criteria. The 'economic price' which is defined to be z_j's at the optimal solution stage are obtained for all the remaining items by the process. The percentage differences reflecting the disparities are evaluated next.

The method is illustrated with the help of National Sample Survey data. (S100), CSU/1/69.

101. *A modification of IBM 1401 FORTRAN II Compiler :*

The IBM version of the system has been modified mainly to increase the available core-store at the object time. This increment in storage, which is of the order of 1.5K characters, has been realised by breaking up the original object time package into overlays, using the random access disk memory as the backing store.

Three additional statements are added to FORTRAN II, two of them for movement of data from and to disk pack and one to test the end of file status by reading tape. (S101).

102. *A software package for analysis of dispersion :*

The paper describes a software package for ICL 1900 series of computers for analysing the statistical data under a linear model. Given the model and linear hypothesis to be tested, it computes the relevant statistics. The mode of specification is general enough

to comprehend a wide class of statistical analysis. The report is divided into two parts, the first part describing the statistical test and algorithms suitable for computers. The second part deals with systems and programming aspects of the software package.

For testing the hypothesis (i) $Z = MW+N$ or (ii) $CZV = 0$ under the model $E(X) = AZP$, where x is the observation matrix, A, P, C, V, M and N are known constant matrices and Z is the parameter matrix, the following three statistics are computed viz., (i) $t_1 = |Sel/Ne,|$ * (ii) t_2 = trace of $(S_h S_e^{-1})$ and (iii) t_3 = max. eigen value of $(S_h S_e^{-1})$ where s matrices are the error sum of squares and products matrices. (S102), Math-Stat/7/69.

G. Crop Science

103. *Difficulties in the genetic improvement of the coconut : A promising alternative method :*

Cocos nucifera L., the tree most useful to man, has not lent itself to those interested in its genetic improvement. Coconut has several unique characteristics; being a palm it is devoid of off-shoots. The enormous height coupled with the slippery smooth surface of the stem makes shinning it most hazardous which deters many a geneticist from carrying out the pollination work. Coconut is highly cross-pollinated in nature. Evolving pure parents covers very long periods since the judgement of the productive capacity of a seedling takes a minimum 15 years. The cumbrous size of the crop makes attempts of its study within laboratories or limited field spaces almost impossible. So far the crop is propagated solely through the seed.

Attempts to effect clonal propagation in the coconut have met with initial success. The most promising method seems to be the conversion of the spadices or individual flowers of desirable palms into bulbil-shoots and the bulbils layered and propagated as adults. Some instances of the formation of bulbils are reported. (S103), Nat/6/68.

104. *Bilateral symmetry in the leaves of Cocos nucifera L. :*

The arrangement of the leaves of palms is always alternate. From the positions of any two consecutive leaves of a palm, it is possible to determine whether the palm is left-spiralled or right-spiralled. Due to the spiral arrangement of the leaves, the lamina portion (of the leaf) is also asymmetric, the number of leaflets on one half of the leaf differing with that of the other. The asymmetry was studied by counting the leaflets (50, 768) of 361 leaves from 41 left-spiralled palms and those (58, 232) of 377 leaves from an equal number of right-spiralled palms. The pinnate type palms showed the highest degree of asymmetry, and the palmate type showed the least degree. Palms of the bipinnate type were found to be intermediary between the pinnate and palmate palms. A positive association exists between the number of green leaves a crown possesses and the percentage difference between the numbers of leaflets on both the halves of the laminae. (S104), Nat/14/68.

105. *Morphology and physiology of coconut pneumatophores :*

The coconut palm is able to withstand water-logging largely due to the presence of the small, whitish protuberances on the main roots and root-lets known as the respiratory organs or pneumatophores. These unbranched outgrowths are neither geotropic nor phototropic. The pneumatophores originate as root-lets, and so their size varies according to the size of the root from which they grow. However, anatomically the pneumathode differs from that of a root-let in many respects. According to changed environmental conditions,

a root-let can transform into a pneumatophore, and vice versa. Partial waterlogging of a palm has a great effect in producing respiratory roots as has been experimentally shown with *Cocos nucifera*, *Phoenix sylvestris* and *Livestona australica*. (S105), Nat/15/68.

106. *Vegetative apozimis in coconut and other palms*:

Apomixis occurs in palms very rarely. A few instances of obligate and facultative apomicts in the form of vegetative shoots developing from the flowers, young fruits and flowering shoots are briefly reported. The species which show such vegetative apomix are *Cocos nucifera*, *Borassus flabellifer*, *Areca catechu*, *Phoenix sylvestris*, *Elaeis guineensis* and *Chrysolidocarpus lutescens*. (S106), Nat/16/68.

107. *Aestivation of coconut flowers*:

The flowers of the coconut, male as well as female, have sixperianth lobes each. The outer three perianth lobes correspond to the sepals, and the inner three, the petals. In the female flowers, the sepals always imbricate and the petals are valvate. Imbrication may be clockwise or counter-clockwise. In any large population, the left imbricating and right imbricating flowers occur equally.

The sepals of females only imbricate like those of the male flowers. But the petals in about 10 percent of the flowers contort regularly and those in the rest imbricate. Among the contorting as well as imbricating flowers, left- and right-handed flowers occur, and are distributed almost equally. The calyx-corolla relationship regarding their arrangement was studied on 734 flowers of coconut and 629 flowers of *Ptychosperma macarthurii*. (S107), Nat/24/68.

108. *Structure of seed coat in Cassia sp. and its phylogenetic significance*:

The seed coat structure of four species of *Cassia* (*C. tora*, *C. auriculata*, *C. fistula and C. siamea*) were studied critically with a view to establishing the phylogenetic positions of these species. As these four species of *Cassia* differ from each other in stature vividly, the structure of their seed coat also reveals great variation. *Casia tora*, the smallest among the four species shows great adaptation in the seed structure which ensures survival than the other three species. *C. siamea*, the largest species shows least resistant adaptation in the seed-structure. (S108), Nat/25/68.

109. *Phyllotaxis of Elaeis guineensis jacq., and its effect on leaf form and position of spadix*:

The leaves of African oil palm (*Elaeis guineensis* Jacq.) are alternate, and any two successive leaves subtend between them approximately on angle of 138 degrees. The younger of any two successive leaves lies nearer to the older one by the left side or by the right. The former palm is thus termed left-foliar spiralled (left-handed), and the latter, right-handed. In a population examined in Malaysia, the two types of palms were found to occur almost in equal proportions.

The number of leaflets on one linear half of a leaf usually differs from that of the other. Although this difference between halves is not statistically significant in *Elaeis guineensis*, there are many other species of palms where one half has significantly larger number of leaflets than the other.

As the leaves are formed one after another, they appear to be arranged in distinct spirals. On any *Elaeis guineensis* trunk, 8 foliar spirals are seen moving on one direction,

and along the opposite direction five spirals veer. In a left-handed palm, the 8 spirals move clockwisely (left-handed), and the five spirals counter-clockwisely.

In a bearing palm, practically every leaf subtends a male, female or at least a sterile spadix in its axil. The bunch in course of development gets tilted slightly to the left or right of the subtending leaf, but always towards the direction of the next younger leaf. Therefore, in a left-handed palm having the eight foliar spirals moving towards the left, the bunch will be inclined to the left of the subtending leaf. The inclination will thus be to the right in a right-spiralled palm. It is inevitable, therefore, that the position of bunches appears to be reversed when the direction of the five spirals is considered. (S109), Nat/1/69.

110. *Variation in the staminal bundles of the wild silk cotton tree (Bombax ceiba* Linn.) :

The silk-cotton tree (*Bombax ceiba* L.) growing wild throughout the Indian forests produces the commercially important soft wood for match industry, and the silky fluff of its fruits is used for filling mattresses and cushions. The mean stamen-number per flower of this species varies significantly with individual trees, ranging from 90-105. The stamens are arranged in five peripheral bundles which enclose a central verticil invariable having 15 stamens. The number of stamens of the peripheral bundles usually varies within a flower, and more significantly so, between flowers. In this paper, data relating to over half a million stamens from 21 trees on how the five peripheral bundles of a flower compare numerically with each other are presented. In 31.04 per cent of the 4,774 flowers examined critically, all the five peripheral bundles had a similar number of stamens, and only in 0.53 per cent of the flowers, all bundles were dissimilar. There are five more possible categories falling between these two extremes. Towards the end of the flowering season, more flowers tend to be regular. Not only the mean stamen-number per flower per tree decreased during this period, but also their variances became smaller. (S110).

111. *Bilateral symmetry in the structure of flowering plants :*

Different organs of several plant species manifest bilateral symmetry. The corolla in many species of Malvaceae, Bombacaceae, Sterculiaceae, Oxalidaceae, Linaceae, Euphorbiaceae, Cochlospermaceae, Caricaceae, Plumbaginaceae and Palmae may be right- or left-twisting (contorting), the two types occurring nearly equally in any individual plant. Moreover, the alternate leaf arrangement in these families produces both right-and left-handed shoots. In some Malvaceous species, fruit-production is associated with foliar arrangement although the latter character is non-genetical. The number of the obviously perceivable foliar spirals in palm species ranges from 1 to 21, but it is always a Fibonacci Number. This situation arises from the optimal angular divergence between any two consecutive leaves. Due to the spiral arrangement of the foliage, the individual leaves of palms have become asymmetric. The degree of asymmetry is correlated with the number of green leaves a palm bears at any time. Stem-twiners may coil clockwisely or conversely, but a great majority of them in the northern hemisphere move against the Sun. When the normal direction of stem-twine (counter-clock wise) of *Vigna sinensis* was changed, the plant showed a significant difference in fruit-yield. (S111), Nat/4/69.

H. Demography

112. *Fertility and sex-sequence of children of Indian couples :*

This paper examines the data on fertility history of Indian couples collected in NSS 17th Round for studying the influence of the sex of the first two children born to a couple on

the incidence of a third child-birth within three years of the second child-birth. It appeared that for both rural and urban sectors of India, a larger proportion of couples with two female children (FF) had a third child within three years of the second child-birth than of couples with other sex-combinations of the first two children-male-male (MM), male-female (MF), and female-male (FM). This, if time, might be indicative of the common desire of having a male child and of the prevalence of some form of family limitation practices among couples with one or more male child. The statistical significance of these differences is examined by non-parametric tests.

In course of this investigation, a large excess of the number of 'MF couples' over the number of 'FM' couples became evident. This point has been examined in detail. Presumably, the dead first child was not reported more often if it was a female child. Other factors might have aggravated the situation, such as the tendency of reporting the first son as older than the first daughter, although this is not true of the possibly higher masculinity of first births. (S112), Dem./1/60.

113. *Net reproductivity of West Bengal (India) by districts and its association with some socio-economic variables :*

The differentials in the net reproductivity of West Bengal districts, and its association with some socio-economic factors, have been studied with the help of the Replacement Index, J, which as a measure of net reproductivity is derived by dividing the number of female children in the age-group 0-5 in the actual population by the number of women in the corresponding higher age group 20-45 in the actual population who would have been in the reproductive period when these children were born, and then dividing this quotient by the corresponding quotient in the life table population of females, derived from current mortality rates. For evaluating J for the district populations (as also for those of the rural and urban areas and of the State as a whole), as at the 1961 Census, the female age-structures, virtually unaffected by migration, have been corrected for Census enumerations by graduation, except for West Bengal for which corrected Age-Tables are available, and appropriate Life-Tables selected from U.N. Model Life Tables on the basis of the respective registered (female) infant mortality rates, 1957-60 inflated by a suitable factor. A geographical distribution of J, being higher in the northern districts and lower in the southern is apparent. Further, it appears to be inversely associated with literacy, age at marriage, degree of urbanization and of industrialisation. Also these associations can explain the large rural-urban differential in J, when compared to the corresponding large differentials in the above socio-economic factors. (S113), Dem/3/69.

114. *Construction of life table of Assam females* (1951-60) *:*

In this paper, an attempt has been made to construct the life table of Assam Females for the period 1951-60 by an alternative and simple method. Most of the computations were done by programming in IBM 1401 EDPM using FORTRAN II. This paper consists of four chapters. Chapter I gives the introduction. General procedures for construction of detailed life table have been discussed in Chapter 2. Chapter 3 describes the source of data and their adjustments due to migration. In the last Chapter, the method employed and the rationale of the method have been discussed. The complete life table for Assam Females (1951-60) is given at the end of Chapter 4. Ungraduated and graduated rates of mortality in the age range 40-60 are given in the Appendix. (S114), Nat/22/68.

115. *A note on the functional classification of towns in West Bengal :*

Studies based on a functional classification of towns help in gaining an insight into the processes of urbanization and industrialization. In this discussion three procedures have been adopted for functionally classifying the towns with population over 50,000 in West Bengal The results of these methods have been discussed. Method C (using B-coefficient), while laborious, is considered to be more objective. The results of Method B (as adopted by T. O. Wilkinson) are, however, fairly close to those of Method C. Further examination of these two methods is suggested which may lead to clues to strengthen Method B. If this could be achieved, then the functional allocation of towns could be made without so much of the computational effort that is associated with Method C. Some demographic features of the functional groups of towns have been briefly discussed. (S115), Nat/23/68.

116. *Status of census and vital registration data in the ECAFE countries :*

The paper briefly discussed the present status of census and vital registration data in the ECAFE countries. An attempt has been made to examine the improvement that had taken place in vital registration in these countries during 1957-66. The improvement was only marginal. (S116), Dem/1/69.

117. *A method to group the census industrial categories of workers :*

The census of India 1961 classifies the workers into nine industrial categories. It might facilitate further statistical analysis if these categories could be suitably grouped. An attempt has been made in this paper to form such groups by computing B-coefficients. The nine categories could thus be allocated to six groups. This study is based on data relating to West Bengal towns. A similar procedure may be tried for group formation of industrial categories in the other states also. (S117), Dem/2/69.

I. Documentation and Library Science

118. *DRTC and Education for Medical Library service :*

The training course offered by the Documentation Research and Training Centre, Bangalore, gives a sound foundation of the theory and practice of specialist library service and for research in library science. There is adequate provision in the training programme to orient the studies to suit the specific requirements of medical library service. Gives illustrative examples of such orientation to medical library service. (S118).

119-122. Give a revised step-by-step procedure for the design of depth classification schedules, with illustrations. Further articles in the series are expected to be published. *Selection of Isolate ideas*, S119; *Preparation of list of isolates and qualifiers*, S120; *Grouping of isolates*, S121; *Choice of a methodology for design of a scheme for classification*, S122.

123. *Preparation of schedule-on-tape for synthesis of class number by computer :*

Describes the procedure and gives flow-charts of the computer operations for the transfer on to magnetic tape, a schedule of Basic Subject, schedules of Special Isolates for subjects going with different Basic Subjects, and schedules of Common Isolates of different kinds. Mentions the technique used in identifying a specific schedule and the symbols to indicate the use of a particular Colon Classification Device in forming Isolate Number. (S123), DRTC/1/69.

124. *Formation of isolate number by computer using the devices of colon classification*:

Describes a step-by-step procedure for the formation of Isolate Number, using a general purpose computer, (1) according to the rules of Colon Classification for Alphabetical Device, Numerical Device, Environment Device, Geographical Device, and Chronological Device, and (2) for an isolate deemed to be a manifestation of the Fundamental Category either of Space or of Time. Also describes the assembly of the Basic Class Number and the Isolate Numbers to form Class Numbers retaining the helpful sequence of the isolate ideas arrived at in the idea plane. Gives flow-charts of the computer operations. (S124), DRTC/4/69.

125. *Conflict of authorship: Person vs. Corporate body*:

Refers to the importance of stating the Normative Principles of Cataloguing in a Catalogue Code and shows how ALA 1967 has made its first attempt in this direction. Enumerates the essential elements that a Catalogue Code should deal with. Refers to the Principle of Unity of Idea in a catalogue code and shows how ALA 1967 has followed the lead of CCC in the matter of respecting the principle by separating out the rules for the choice of heading from those for rendering it; but it still continues to mix up in one and the same rule the resolution of the conflict of authorship, and the choice of Heading for the Main Entry and for the Added Entries. Makes a comparative study of how the different editions of CCC and ALA Code resolve the conflict of authorship centring round person *vs.* corporate body. And in this, considers the following cases; (1) Documents to be deemed to be of corporate authorship; (2) Documents to be deemed to be of personal authorship; (3) Non-governmental edition of an act; and (4) Conference documents. Indicates the impact, if any, received by any code from the earlier codes. (S125), DRTC/7/69.

126. *Library-science-based library service*:

The first four introductory sections describe the beginnings of modern library service in India fifty years ago, and the circumstances leading to the establishment of the Sarada Ranganathan Professorship in Library Science in Madras. They also illustrate how the influence of the Library School of the University of Madras had spread. These sections end with a reference to the temporary set back being now experienced by the young librarians in the enjoyment of their library work and training. The one possible cause for this is, faults in the present-day teaching in some of the library schools. Then follows an account of the foundations of Library Science and of modern library techniques, modern forms of library service, and modern library organisation. The Five Laws of Library Science, formulated forty years ago, are described as the foundation and their potency and revolutionary qualities are traced. Then follows a detailed description of the generation and the continued improvement of each library technique—the streamlining of library administration; the invention of the Three-Card System, the genesis of colon classification and a dynamic theory of classification which has led CC to its present status of Freely Faceted Classification with capability for designing depth schedules; the design of the Classified Catalogue Code and of a theory of library catalogue providing guiding principles for its continued improvement. The structure of the State and National Library Systems, and of Public Library Acts, is then derived from the Five Laws. After a section on the education and the emoluments of the library profession, the last section gives the emphasis of the Five Laws on giving Long-Range Reference Service—the ultimate social and human purpose of library work. (S126), DRTC/8/69.

J. Embryology

127. *A chapter in progress in Biophysics and Molecular Biology :*

This is a comprehensive review of protein synthesis after fertilization and changing mRNA population (S127).

128. *Further investigations on transcription and translation in Limnaea :*

It has been found that there is a small peak of 10S RNA in the cleavage stage. The synthesis of protein increases rapidly during trochophore stage and attains a peak at the veliger stage. (S128).

K. Family Planning

129. *Motivational aspects of fertility control in an industrial town in West Bengal :*

Following a one-year field trial of the different communication media in family planning, a pre-project attitudinal study of 482 married women, aged 15-50, was carried out in Baranagar in early 1962. The main objectives of the study were to pre-test the programme methodology to be applied in future action programmes undertaken and to examine the current intensive programme got under way. The major findings are as follows : The average number of children per couple was found to lie between 2 and 3 and about 83% of women opted for no more issue, mainly because of economic and health grounds. The major disadvantage of a large family was reported to be its harmful effect on the health of the mother and children. The desired inter-birth space varied from 3 (illiterates) to 5 (undergraduates), with an overall average of 3.6 years. Out of 39% of the women having knowledge in family planning, 84% had ever-practised it. The age at marriage for a girl considered proper was to lie between 17 and 18 years on the average. The aspect of marriage feared by women was domineering husbands and in-laws, the expectation from marriage being economic security (33%), children (20%), and companionship (24%). (S129).

130. *Oral contraception : An application in family planning programme in Calcutta City :*

This diagnostic study involving 30 initial acceptors of the oral pill in the experimental centre of the Calcutta City Project was undertaken to examine its acceptability, effectiveness, tolerance and side effects. The pill programme was introduced on 1 August 1967 in the project area, through a doctor-operated clinic. The case cards provided the data for the study pertaining to the period 1.8.67-28.11.67. Out of the 30 women included in the programme, 15 had knowledge of fertility control measures and 12 had actually used a method prior to the acceptance of oral contraception. More than 53% of the acceptors experienced 4 and more pregnancies before acceptance. The side effects on the use of the pill were of a minor nature, except bleeding which was reported by 10% in the first week of use and by only 6% in the third week. No pregnancies and abortions were reported during pill consumation. (S130).

131. *Application of an experimental scale for measuring attitude towards family planning :*

For obtaining quantitative measures of attitudes relevant to family planning, an experimental Thurstone Scale was constructed in 1965 for application among a sample of 418 currently mated couples in the two centres of the Calcutta City Project area. The respondent were asked to read a list of 17+22 statements selected from an original list of 100 about family planning and family size and to endorse those that expressed their own sentiments. The informants belonging to age-group 20-34, the more educated groups, the

white collar workers were on the whole slightly more favourable to family planning than the rest. As regards attitude towards family size, each socio-economic group tended to give expression to what was supposed to be normative behaviour and not individual attitude. (S131).

132. *Viewing IUCD from personal and impersonal angles :*

A study on Intrauterine Contraceptive Device (IUCD) was instituted among 139 ever-used women and 855 non-users in the Calcutta City Project in 1968. The objective was to assess the achievement of the programme since its initiation in 1965. It appears from the study that the loop droppers constituting 53% of the initial adopters offered multiple complaints in support of their defection behaviour. More than 85% among the current users were retaining the device for at least a year. Most of the women not using the loop expressed the fear that it could cause cancer and other ailments. (S132).

L. Geology

133. *Rhynchosaurs in time and space :*

Rhynchosaurs were a widely distributed group of land vertebrates during the Triassic period, recorded from all continents except Australia and Antarctica. The family Rhynchosauridae includes seven well established genera. These genera may be grouped on their cranial characters into three well defined subfamilies. The least specialised subfamily Mesosuchinae includes *Mesosuchus* and *Howesia*. The intermediate subfamily Rhynchosaurinae includes *Rhynchosaurus* and *Stenaulorhynchus*. The most highly specialised forms *Hyperodapedon*, *Paradapedon* and *Scaphonyx* are grouped into a new subfamily Hyperodapedontinae. These three subfamilies 'primitive', 'intermediate' and 'advanced' represent successive stages in rhynchosur evolution and occur in Lower, Middle and Upper Triassic beds respectively. Thus rhynchosaurs seem to be extremely useful in continental Triassic correlation. Rhynchosaurs do not show 'explosive evolution' as Romer (1960) has suggested, but are more evenly distributed throughout the Trias. (S133), Geol/1/69.

134. *Some contributions to the stratigraphy of the upper Gondwana formations of the Pranhita-Godavari valley, Central India :*

The Gangapur beds, believed to be the basal beds of the Upper Gondwana Kota formation, are here shown to overlie the latter unconformably. This discovery, based on detailed mapping, clears up a long standing confusion; i.e., of a flora from the Gangapur beds judged to be later in age than the Kota fauna but successionally preceding it. The Gangapur beds are hence removed from the Kota formation and are called here the Gangapur formation.

The base of the Kota formation is redefined on the basis of faunal and lithological evidence. A new, late Upper Triassic, fauna has been discovered below the Kota beds, which is quite different from the typical, early Upper Triassic, Maleri fauna and also from the Lower Jurassic Kota fauna. On this faunal basis as well as on stratigraphic grounds, the erection of a new formation (here called the Dharmaram formation) is suggested. (S134), Nat/13/68.

135. *Geology of Southwestern Bengal :*

Geophysical surveys and deep drillings in the alluvium covered plains of southwestern West Bengal have revealed a thick section of Cretaceous and Tertiary sediments lying on a basement of basalt lava flows. The area covered can be divided into four major

structural units : a shield area, a marginal zone, a stable shelf zone and a deeper basin area. A brief account of these units, their lithological sequence and their inferred depositional environment is given in this paper, together with a summary of the depositional history of the whole region from the eastern margin of the Indian shield to the folded belt in Assam. (S135), Nat/11/68.

136. *Gondwana sedimentation around Bheemaram (Bhimaram), Pranhita-Godavari Valley, India :*

The Gondwana deposits around Bheemaram belong to six mappable rock units—the Barakar, Middle-Upper Kamthi, and Bhimaram formations consisting of coarse, argillaceous sandstones; and Ironstone Shale, Yerrapalli, Maleri formations consisting of thin sheets of clay and silty sandstones. The sandy and clayey formations juxtapose, often with interfingering contacts.

Lithology, sand body geometry, primary structures and patterns of grain-size distribution of the Gondwana rocks are comparable to those of fluvial sediments. The coarser deposits, transported by bottom traction currents, constituted point-bars and channel-bars of the Gondwana river. The finer sediments were deposited from suspension in interchannel flood plain areas.

Cross-bedding dip directions, pebble axis orientations and ripple marks indicate a northerly paleocurrent. During deposition of the Kamthi sediments the paleocurrent direction shifted gradually, but statistically significantly, to the west with time. Measurements of the scalar properties like pebble size and roundness suggest a local swing in the current direction.

The study reveals an uninterrupted fluvial sedimentation during the Upper Paleozoic and Mesozoic. It is suggested that an appropriate system of classification should be developed to depict the complex relationship between the different lithological, chronological and biological units which have developed as a result of this long and continuous process of fluvial sedimentation. (S136), Geol/2/69.

M. Planning, Economic Statistics and Econometrics

137. *Correlation between word-length and word-frequency in written English :*

This paper examines the negative correlation between lengths in letters and frequencies of occurrence in several word counts on written English prose. Although both regressions are curved, the correlation coefficient r is more meaningful than the correlation ratio, for r indicates the economic effect of the negative correlation upon text-length. But for the observed marginal distributions of word-length and word-frequency, r cannot attain the limits ± 1.

Attempts are made to estimate r etc., in infinitely large counts, but perhaps these limiting values cannot be defined in a satisfactory way. For all root words or all particular words in English, the best available estimate of r is -0.14, while the minimum and the maximum attainable values, for the most economic and the most uneconomic matchings of words (letter combinations) and concepts, are -0.20 and $+0.24$ respectively. The actual text-length is 62% of the 'expected' for random matching of words and concepts; and here

the minimum and the maximum attainable values are 46% and 176% respectively. Such results are also given for content words, function words and nouns. Thus, r is nearly -0.20 for content words and -0.30 for function words.

Some examination is made of the distribution of frequencies of words of a specified length and on the algebraic form of the regression of word-frequency on word-length. (S137), Econ/Cal/6/68.

138. *Rural-urban differentials in consumer prices in India :*

This paper is in continuation of paper no. 16 and gives price differentials at an all-India level for different groups of consumer items like cereals and cereal substitutes, other food and non-food, using Laspeyres', Paasche's and Fisher's formulae. On the whole, the urban price level was found to be 15 per cent above the rural price level; this differential was 11.5 per cent for cereals and cereal substitutes, 14 per cent for other food items, 12.5 per cent for all food items and 26 per cent for the non-food items to the extent included in the construction of the index. The above price indices were utilized for deflating the urban per capita total consumer expenditure to compare the level of per capita household consumption in rural and urban sectors. It was noticed that the urban-rural differential narrows for other food items, all food items and non-food items but widens for cereal substitutes. (S138).

139. *Growth of mining industry in the Indian Union by States, 1951-60 :*

The paper primarily deals with the growth of mining activities during 1951-60 in the Indian Union as a whole as well as in the individual States with the help of several indicators such as physical output, value of output, employment of labour, earning of labour etc. It has been found that the developing trend of the industry as a whole which was accelerated with the introduction of railways and steel factories in the earlier period and during the two world wars, has somehow been maintained during the two plan periods. The growth trends of the States are not without interruptions except in a few cases. (S139).

140. *On some aspects of knowledge industry :*

In this paper problems of evaluation of product of the education industry have been discussed. It also contains discussion regarding 'drop-outs' in the calculation of product and bye-products. A controversial item of cost viz. 'income foregone' i.e., the income a student could have earned if he could devote his time in doing something instead of continuing his studies has also been considered (S140).

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

In Engel curve analysis, the problem is to choose appropriate classificatory character and variable. In India and in other developing countries Engel curves are often estimated by regressing per capita (or per household) consumption (value or quantity) of specific commodity on per capita (or per household) total expenditure (or income). It is admitted that these are not the refined estimates of Engel elasticities but it is felt that in India the elasticities would continue to be estimated by such methods.

In the present paper we examine the Engel elasticities estimated 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 being classified by household total expenditure, the figures being obtained from those in (ii) by using average household size in different household total expenditure classes. 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. Secondly, the ordering of the commodities by the values of elasticity is not very different between the different models. (S141), NSS/3/68.

142. *Analysis of growth pattern of Indian manufacturing industries during* 1951-1961 *:*

In the course of the investigation, we find that wages per unit of labour are 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 produots and productivity per labour is determined by capital invested per labour and also the rate of growth of wages and output have practically remained the same during the period 1951 to 1961 and thus the share of net output going to labour has remained the same. We find that between 1951 and 1961, the population in India has increased from 359 million to 439 million or by nearly 22 per cent and during the same period employment index in manufacturing has also increased by 22 points. That is, the ratio of labour force employed in manufacturing to total population has remained fixed after the first two five year plans and this fact is amazing.

We observe that the index of fixed capital has increased by 140 points and the intensity of capital per labour year has increased by 97 points durig 1951 to 1961. We also observe that during the same period the indices of gross product and net product at constant prices have increased by 191 and 173 points. Also, net productivity per labour year have increased by 53 and 52 points at current and constant prices respectively and during the same period, the real wages and salaries per labour year have increased by 56 points, so that wages and salaries are more or less a fixed proportion of gross and net product (S142).

143. *Estimation of elasticity by least squares method :*

The estimates of elasticity for a large number of consumer items have many practical uses such as assessment of taxation yield, projection of future demand, etc. It is, therefore, important to know how best we can estimate elasticity from grouped family budget data, as available in India. In this paper, parameters of constant elasticity model and variable elasticity models were estimated by weighted least squares methods for a large number of consumer items. As a measure of goodness of fit we have used R = residual variation/total variation. We have found that some forms of variable elasticity model (from differing with item) give better fit than constant elasticity model. (S143).

144. *Estimation for a domain of study :*

When sampling is done independently within each domain, unbiased estimates of totals of various characters for each domain can easily be obtained. However, if a universe

is divided in a number of domains of study after sampling and the estimates are required for each of them separately, the problem does not remain straightforward. To deal with this situation, some estimators for the domain totals are suggested in this paper. To study the suitability of different estimators, an empirical study was undertaken with data of an actual sample survey where stratified multistage sampling scheme was adopted. Estimates of totals and their variance estimates for a number of characters, namely expenditure on items of cereals, milk and products, total food, total non-food and total consumer expenditure and population were obtained. (S144).

145. *Reference period in family budget enquiries:*

In family budget enquiries, the survey personnel or investigators contact the representatives of selected sample households and collect information on consumption of different items for a specified time period prior to the date of enquiry. The time period, to which information refers, is called the reference period for the enquiry. For items which are consumed frequently, a shorter reference period may be suitable but for items which are consumed infrequently a longer reference period may be suitable. The reference period should be decided upon objectively after conducting suitable pilot studies with different reference periods and examining their effect on sampling and non-sampling errors.

The NSS fourth and fifth rounds (April 1952 to March 1953) were designed to study the appropriateness of one week for one month as reference period in family budget enquiries. A stratified three-stage sampling design was used in both rural and urban India with provision of independent and interpenetrating networks of sub-sample (IPNS). The selected sample households in a second stage unit were divided into two groups and two types of schedules were used for the two groups. From the first group of households, data on domestic consumption for a period of 7 days preceding the date of enquiry were collected using the week reference schedule (W-schedule) and from the second group of households similar data for a period of 30 days preceding the data of enquiry were collected using the month reference schedule (M-schedule). Actually, week and month reference periods were tried for items coming under food and fuel and light, and also for certain non-food items grouped under 'miscellaneous'.

The present paper examines the differential bias and the precision of the estimates obtained from W-schedule and M-schedule by making use of some of the sub-sample estimates. It is found that for most items, per capita monthly consumption estimates from W-schedules are consistently greater than the corresponding estimates from M-schedule. Tests of significance based on value of Student's t with 1 degree of freedom indicate that the differential bias is significant for a number of consumption items. The analysis of variance was performed (with some assumptions) and the results indicate that mean square due to reference period is significant for most food items and fuel and light. The rough estimates of standard error obtained from the half-sample estimates indicate that very broadly month estimates are somewhat less than week estimates in order of magnitude of sampling errors. Standard error, calculated in a detailed way, indicates that both standard error and coefficient of variation of month estimates are appreciably smaller than those of week estimates. External checks indicate that month estimates are unbiased on the whole, at least to a first approximation. Month estimates thus seem to be superior to week estimates both in respect of bias, and also, to an extent, in respect of sampling error. (S145).

146. *An exercise in the estimation of the growth of tangible wealth of India since* 1900.

There are a number of studies on the growth of real national income in India over historical periods. Surprisingly, there was no study on the growth of the wealth of the country and this paper bridges the gap, furnishing estimates of tangible wealth (TW) and reproducible tangible wealth (RTW) at selected points of time during the first half of the present century. The estimates have been obtained by using perpetual inventory and income capitalization methods, the two methods throwing up dimensionally comparable estimates. The estimates obtained have been studied against the available estimates of the value of precious metals. Finally, capital output ratios have been computed showing a rising trend of the RTW-output ratio and a declining trend of the TW-output ratio. Some uncertainty, however, attaches to the findings because we do not have any estimates of capital stock in the past based on detailed analysis. (S146).

147. *Size and areal distribution of the level of living in India :*

In this paper, an attempt has been made to explain the shifts in the national size distribution of personal income in terms of changes in size distributions of Indian States, as well as the areal distributions of income, between urban and rural areas and between States. The role of urban-rural variation appears to be important in 1963-64, the latest year studied. Following up the study of areal distribution, an attempt has been made to locate the poor and the rich defined in the all-India context, in States and in NSS regions, yielding interesting maps. The densities of the poor and the rich, thus obtained, have been compared with areal estimates of per capita consumption expenditure. (S147).

148. *The small farmer and his credit problems :*

The problem of indebtedness of small farmers, tenants and share-croppers and their disabilities in securing credit on account of the existing criterion of creditworthiness were discussed in a paper. It suggested the declaration of a moratorium on outstanding debts and granting of loans to such households to be recovered in kind from the produce. (S148)

149. *Economic ideas of Mahatma Gandhi—the concept of trusteeship :*

A study on the economic thoughts of Mahatma Gandhi demonstrated how Gandhiji, who had begun with an aversion to the intervention of the State in dealing with economic problems, particularly the social conflicts between various sections of the population, ended up as an advocate of direct control of economic affairs by the State, including nationalisation of the means of production. (S149).

150. *The viability of small farms :*

The study discussed the prime significance of institutional changes in the tenurial system to increase the viability of small farms in India. (S150)

151. *Growth of capital formation in India in recent times :*

This study is concerned with the growth of capital formation in India during the post-independence period in relation to national income and in real terms. Steadily rising rates of growth of capital formation and saving during the First Plan, manifested a clearly fluctuating trend during the later part of the Second Plan. During the first-half of the Third Plan, the rates attained a declining trend. (S151).

152. *A note on the differences between the revised and the conventional series of national income estimates in India :*

An assessment of the nature of differences in the estimates of national income as revealed by the revised and the conventional series for the agricultural sector in 1960-61 was undertaken. The work involved a comparison on the following points : coverage of area and crops; coverage of data; methods of estimation; physical output; price series used for evaluating the physical output. (S152).

153. *Depreciation—a problem of national accounting in India :*

The paucity of appropriate data is the main problem faced by the Indian scholars in evolving a unified method of estimation of depreciation within the framework of national accounting procedure. In this connection, a brief discussion was made about the studies on depreciation initiated in India and in other developed countries both at theoretical and estimational level. In the last section, a series of depreciation was presented with sectoral breakdowns for the period 1948-49 to 1959-60 by way of filling up the gaps in the conventional series of national income in India. This series was used to assess the other two series of depreciations available in the country in relation to the capital stock. (S153).

154. *The effects of wage incentives in sugar and jute industries in India :*

In a developing economy, the need for increasing output with reduced cost of production is a basic prerequisite for rapid industrial development. Among the factors responsible for high standard of output, high rate of productivity per worker is doubtlessly the principal one. The system of wage-incentive is one of the methods applied for increasing productivity of workers in industries. A consideration of the interdependence of wage and output is obviously relevant in the present context. The study of the interdependence was based on least square method of estimating correlation-coefficients. Results obtained :

i) fair amount of correlation exists between wage per man-hour and output per man-hour in both sugar and jute industries;

ii) correlation-coefficient of wage and output is also quite high in both sugar and jute industries.

So, it is concluded that the application of wage incentive schemes is likely to be effective in sugar and jute industries in India. (S154).

155. *Relative contributions of language and reasoning to test performance :*

Using two tests (one measuring language ability and the other reasoning ability) as predictor variables, multiple correlation is computed for each of the several tests (criterion variables) in a selection test battery. The coefficients (R) range from .43 to .72. Consistency in the relative contributions of language and reasoning to test performance is found among two groups of subjects. Verbal reasoning test calls for proficiency in both language and reasoning. Non-verbal tests are seen to depend on language to some extent. Quantitative tests emphasize reasoning more than language. (S155), Psych/6/89.

N. Psychometry

156. *A comparative study of the interest patterns of the inmates of the house of detention, normal school-going children and children living in the slum area at Calcutta :*

The prevention of delinquency and proper adjustment of delinquents in society are common problems faced by almost every society nowadays. The study aims at finding out