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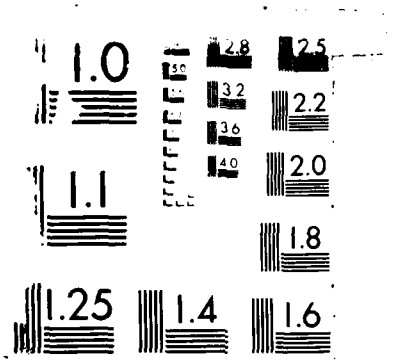

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Professor Srivastava had three papers published, and three accepted for publication. Important advancement was made in the foundations of design theory. Difficult work (using ideal theory) was done on information matrices. The (very significant) paper on Parallel Flats Designs was revised, and so was another important paper on search decision rules. Work was also done in reliability and other fields.

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Annual Report on the Air Force Grant #AFOSR 830080
for the year April 15, 1985 to April 14, 1986

Principal Investigator: Jaya Srivastava, Colorado State University

Briefly speaking, a very great deal was acheived under this grant in terms of basic research of high quality. If a hard look is given to the actual work done, it will be found to be very rich and significant. This attests to the wisdom of the technical monitors who have supported this research.

This report will be divided into three main parts, concerning respectively the most recent papers, the published papers, and other research activities.

I. New papers:

(1) 'On a General Theory of Sampling Using Experimental Design Concepts, I: Estimation'.

(2) 'Characteristic Polynomial of the Information Matrix of a Balanced Resolution V Design of the 4^n Type Approached through the 2^n Factorial' (with T. Shirakura).

(3) 'More Efficient and Less Time Consuming Censoring Designs for Life Testing'.

(4) 'Advances in the General Theory of Factorial Designs Based on Partial Pencils in Euclidean n-space'.

(5) 'A New Linear Principal Component Analysis for Symmetric Populations'.

Paper (1) was finished during the above period, and presentations containing parts of this paper were made in UCLA, in July 1985, at the conference on 'Efficient Data Collection', and also in Amsterdam in August 1985, where this was an invited paper at the 100th anniversary meetings of the International Statistical Institute. As is customary, the paper was preprinted before the conference, and circulated among the members of ISI. There were also two invited discussants, namely,

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Professors C.R. Rao and (Sir) D. R. Cox. The paper was called a 'fundamental contribution'. The author strongly believes that the paper is going to be very basic for future Sampling Theory, and will have repercussions in all kinds of directions.

The paper contains a generalization of the classical Hurwitz-Thompson estimator in three directions. One direction is the class of parametric functions to be estimated; this class is now extremely large. The other direction is that the estimator utilizes many units at a time from the sample. The third and the most fundamental aspect of the estimator is that it introduces a sample weight function. This was not done in Sampling Theory before. Almost all known estimators have turned out to be simple special cases; but whereas most of the earlier estimators were developed ad hoc, this development offers a unified theory. Furthermore, we can generate new estimators at will. We have hit at a large gold mine in sampling theory.

The basic idea behind paper (2) is to try to show how all discrete experiments could be approached using the 2^n factorial experiment theory. The contents of the paper constitute a mathematically very involved piece of computation using ideal theory.

Paper #3 presents some very important strides in the field of Experimentation for the Assessment of Reliability of Systems. In the wake of four major rocket explosions that have occured in 1986 (such as Challenger), the importance of good estimates of the Reliability of machines can not be over emphasized. In this paper, basic research has been done in this field. New censoring designs have been put forward which are more efficient from the point of view of variance of estimates and at the same time require much less 'total expected time under experiment'. The work is done under Weibull distribution, and certain generalizations of the same.

Paper #4 contains some fundamental advances in a difficult field in which very major achievements were made by the Principal Investigator five years ago. (These achievements have been greatly appreciated by

the AFOSR.) In 1981, the subject of certain classes of factorial designs was connected with the theory of cyclotomic fields and complex variables, and the information matrix was presented as a function of certain matrices over cyclotomic fields. However, the computation of these matrices was indirect.

Now, these, matrices are replaced by some newer ones, which are shown to be simple functions of the defining equations of the design. Special cases not included in the previous work, are also dealt with.

Paper #5 is a path breaking paper, a part of which was presented in Calcutta in December 1985. (An abstract of this paper has appeared on page 187 of the Bulletin of I.M.S.) The paper is not concerned with obtaining Hotelling's principal components in a new way. On the contrary, it introduces a new class of components. At the time of this writing the paper is not yet written, because a computer program is being written to study the methods of this paper versus all the previous methods. The paper will be prepared as soon as the computer work is finished. Since Hotelling's principal component analysis is one of the most important tools in all of Statistics, it will be appreciated that in case this method succeeds, it will be a very tremendous advancement.

Papers 2, 3, and 4 have been submitted for publication. Paper 1 will eventually appear in the Bulletin of the International Statistical Institute; it should already be considered as published.

II. Papers published:

1. (with F. Saleh) 'Need of t-Designs in Sampling Theory' Utilitas Mathematicas, November, 1985.

2. 'On a General Theory of Sampling using Experimental Design Concepts, I. Estimation' (Preprinted and circulated as an Invited Paper for the Proceedings of the Centinary meetings of the International Statistical Institute, Amsterdam 1985.)

3. (with R. J. Beaver) 'On the Superiority of the Nested Multidimensional Block Designs, Relative to the the Classical Incomplete Block Designs' (Jour. Stat. Plan. Inf., February 1986).

4. (with D. W. Mallenby) 'On a Decision Rule Using Dichotomies for Identifying the Nonnegligible Parameter in Certain Linear Models' (Jour. Mult. Anal., June 1985).

All the above papers contain fundamental advances. Paper #1 shows why ordinary simple random sampling could and should be replaced by the use of 4-designs. Paper (2) is discussed in section I. Paper (3) shows that the research effort in Block Designs should now be directed to Nested Multidimensional Designs rather than the Classical Block Designs in which many people are working at present. Paper (4) presents the first published technique for identifying nonnegligible parameters in Search Linear Models.

III. The following is a list of Institutions which I visited and where I gave invited lectures, during the above period.

1. Conference on Reliability Theory, sponsored by the Air Force, Virginia, May 1985.

2. International Conference on Efficient Data Collection, UCLA, July 1985.

3. Centinary Celebrations of the International Statistical Institute, Amsterdam, August 1985.

4. International Symposium on Applied Probability and Information Theory, McMaster University, Hamilton, Ontario, Canada, August 1985.

5. Mehta Research Institute, Allahabad, India (November 1985 - January 1986).

6. International Symposium on Advances in Multivariate Analysis, Indian Statistical Institute, Calcutta, December 1985.

7. Indian Society of Agricultural Statistics, Annual meeting Akola, India, December 1985.

8. University of Bombay, January 6-8, 1986.

9. Allahabad University, January 1986.

10. Indian Institute of Technology, Kanpur, India, January 20, 1986.

The lectures in Virginia, Allahabad, and Kanpur, were in the field of Reliability. The lectures in UCLA, Amsterdam, and Akola, were in the field of Sampling. The lecture in Hamilton was in the field of Information Theory as applied to Multivariate Analysis, and the talk in Calcutta was on Multivariate Analysis. The visit to Mehta Research Institute and the lectures at the University of Bombay were related to research in Combinatorial Mathematics.

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