STATISTICAL LABORATORY

established 1933

annual report

July 1, 1980 to June 30, 1981

IOWA STATE UNIVERSITY, AMES

Contents

THE STATISTICAL LABORATORY
Iowa State University
1980-81 Annual Report

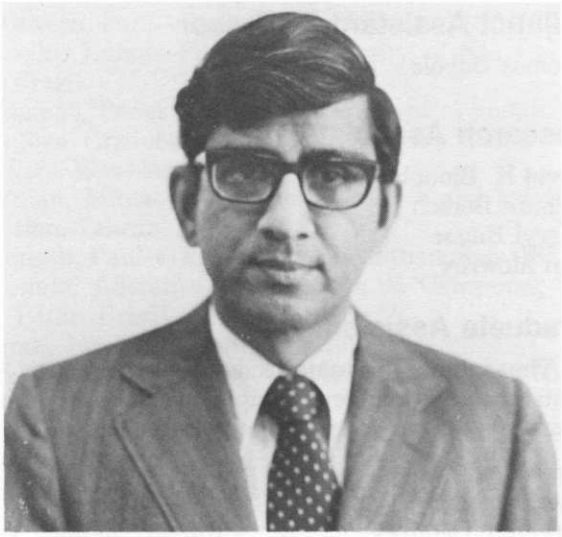
Personnel

Iowa State University's Statistical Center is directed by H. A. David. The Center consists of the Statistical Laboratory, an Institute under President Parks' office, the Department of Statistics in the College of Sciences and Humanities, the Statistics Department in the Agriculture and Home Economics Experiment Station, and the statistics participants in the Sciences and Humanities and Engineering Research Institutes. Many of the faculty members have duties in more than one of the Center's components.

The year 1980-81 brought a good many new faces to the department. Four new staff members joined the statistics faculty and there were four visiting appointments for periods of 9 to 12 months, as well as three short term visitors. One faculty member and a USDA Collaborator resigned. Two positions for 1981-82 were filled.

During July, 1980, Robert Johnson and Mervyn Marasinghe joined the staff as assistant professors. Bob is a joint appointee in Statistics and in Sociology and Anthropology. Mervyn filled the position vacated by James E. Gentle. Visiting Associate Professors George Battese, the University of New England, Armidale, Australia, and Talluri J. Rao, the Indian Statistical Institute, Calcutta, also arrived in July. Both spent the year in the Survey Section and each was engaged in teaching and research.

On August 1, 1980, Professor Krishna Athreya joined the Department in a joint appointment with Mathematics. During August, he gave a series of five lectures on "Renewal theory and its applications to population growth," and lectures on "Ergodic theory" once a week during fall and winter quarters.



Krishna Athreya, Professor of Mathematics and Statistics

Visiting Associate Professor Thomas O'Donovan, a statutory lecturer in Statistics, University College, Cork, Ireland, taught two courses and he interacted with Bill Meeker and professors from the ISU Department of Engineering.

Leone Low, a visiting associate professor from the Department of Mathematics and Statistics, Wright State University, Dayton, Ohio, arrived in October. She worked with Malay Ghosh and Krishna Athreya on bootstrap asymptotics and with David Harville on estimation of variance components.

During October and November, Professor Masao Tasaka, Kobe University of Commerce, Japan, visited the Statistical Laboratory. He studied graphical techniques in statistical data analysis and optimal design for regression analysis. In December and January, Carl Z. Roux returned as a visiting postdoctoral research associate in the Department. He received his Ph.D. in statistics from ISU in 1974 and did postdoctoral research here in 1976. He conducted research in mathematical genetics.

On December 1, Fred Lorenz became an assistant professor with a joint appointment in Statistics and in Sociology and Anthropology.

Fred Lorenz (center) and Robert Johnson (on his left), new Assistant Professors joint with Sociology, pictured with (from left to right) Robert Strahan, joint with Psychology, Mack Shelley, joint with Political Science, and Leroy Wolins, joint with Psychology

During spring quarter, Professor Klaus Hinkelmann, Virginia Polytechnic Institute, returned to the Department to collaborate with Oscar Kempthorne on a two volume revision of the *Design and Analysis of Experiments*.

At the end of winter quarter, Craig Van Nostrand resigned. He is now a statistical consultant and quality control officer for the Eastman Kodak Company at Rochester, New York. Gordon Booth left the Department on April 15. He has transferred to Ogden, Utah where he is the principal statistician at the Inter-Mountain Forest and Range Experiment Station.

Ronaldo Iachan, currently a lecturer at the University of Wisconsin, Madison, has been selected to fill the vacancy resulting from the death of B. V. Sukhatme two years ago. Ronaldo received a B.S. in mathematics and systems engineering from the Pontificia Universidade Catolica, Rio de Janeiro, in 1976; an M.S. in applied statistics and mathematics from the Instituto de Matematica Pura e Aplicada, Rio de Janeiro, in 1976; and a Ph.D. in statistics from the University of California, Berkeley, in 1980.

Stephen Vardeman will fill the vacancy created by the resignation of Craig Van Nostrand. He received a B.S. and M.S. in mathematics in 1971 and 1973 respectively from Iowa State University, and a Ph.D. in statistics from Michigan State University in 1975. From 1975 to 1981 he has been an assistant professor of statistics at Purdue. Compound and empirical Bayes decision theory and pattern recognition problems are his specialties.

We feel doubly fortunate in these times of austerity to have been allowed to proceed with our recruiting and to have found such fine candidates. The support of the University administration is much appreciated.

David Harville was elected a Fellow of the Institute of Mathematical Statistics.

Richard A. Groeneveld was honored by the College of Sciences and Humanities as the Outstanding Advisor in Statistics.

Statistical Laboratory Staff—Fiscal Year 1980-81 under the administrative direction of:

W. Robert Parks, Ph.D.—President of the University
Daniel J. Zaffarano, Ph.D.—Vice President for Research; Dean of the Graduate College
Wallace A. Russell, Ph.D.—Dean, College of Sciences and Humanities
Lee R. Kolmer, Ph.D.—Dean, College of Agriculture; Director, Iowa Agriculture and Home Economics Experiment Station
Herbert A. David, Ph.D.—Director, Statistical Laboratory; Head, Department of Statistics; Head, Statistics Department, Iowa Agriculture and Home Economics Experiment Station

Professors

Krishna B. Athreya, joint appointment with Department of Mathematics
T. A. Bancroft, Professor Emeritus
C. Philip Cox
David F. Cox
Herbert A. David, Distinguished Professor, College of Sciences and Humanities
Herbert T. David, joint appointment with Department of Industrial Engineering
Wayne A. Fuller, faculty status also in Economics
Malay Ghosh
Richard Groeneveld
Chien-Pai Han
David A. Harville
Roy D. Hickman
Paul Hinz, faculty status also in Forestry
Donald K. Hotchkiss
David V. Huntsberger, Professor Emeritus
Dean Isaacson, joint appointment with Department of Mathematics
Oscar Kempthorne, Distinguished Professor, College of Sciences and Humanities
William J. Kennedy
Glen Meeden
Edward Pollak, joint appointment with Department of Genetics
Vincent A. Sposito, joint appointment with Computation Center
Robert F. Strahan, joint appointment with Department of Psychology
Norman Strand, Professor Emeritus
Leroy Wolins, joint appointment with Department of Psychology

Associate Professors

Theodore B. Bailey, Jr.
George Battese, visiting
Leone Low, visiting
William Q. Meeker, Jr.
Thomas O'Donovan, visiting
Talluri J. Rao, visiting
Gordon D. Booth, USDA collaborator

Assistant Professors

Harold D. Baker
J. Jeffery Goebel
Robert Johnson, joint appointment with Department of Sociology and Anthropology
Kenneth Koehler
Fred Lorenz, joint appointment with Department of Sociology and Anthropology
Mervyn Marasinghe
Mack C. Shelley II, joint with the Department of Political Science
W. Robert Stephenson
Shashikala Sukhatme
R. Craig Van Nostrand

Adjunct Assistant Professor

Thomas Bubolz

Research Associates

David K. Blough
Richard Dorsch
Cheryl Enger
Dan Mowrey

Graduate Assistants

The status of graduate students often changes. Students who have held regular appointments as graduate assistants during the year are listed here.

Amemiya, Yasuo
Auer, Richard
Bergeron, Geoffrey
Bloor, George
Blough, David K.
Brandon, Dennis L.
Calcano-Collazo, José
Callanan, Terrance P.
Cassell, David L.
Chandhok, Promod K.
Chang, Stephen Fu-Chung
Christenson, Peter D.
Chua, Tin-Chiu
Crowder, Stephen V.
Dehghan-Nayeri, Majid
Devin, Jeanne A.
Drew, James
Escobar, Luis
Fahrenholtz, Steven
Guerrero, Margarita
Hale, Michael
Harter, Rachel

Hines, Merlon
Hung, Hsien-Ming
Ihnen, Leigh
Jeske, Daniel
Jobe, John Marcus
Josvanger, Lee
Keller, Sallie
Keune, Cynthia
Kinyon, Lawrence
Kruger, Gregory A.
Lee, Edward Henry
Lee, Moun-Shen Carl
Lewis, Jerry
Lin, Char-Lung
Lin, Cherng-Tarng
Lin, Josephine
Londhe, Anil
Marengo, James E.
Martin, Cindy
Mee, Robert
Midha, Chand
Nagaraja, H. N.
Niknian, Minoo
Noorbaloochi, Siamak
Oñate, Julia U.
Ostrouchov, George
Pantula, G. Sastry
Pareja, Gilda
Peixoto, Julio
Rangachari, Lakshmi
Razmpour, Ahmad
Rees, Mark
Rogers, Michael
Rossi, Richard
Roy, Joanne
Shih, Tai-Tao
Skarpness, Bradley
Stangl, Pamela
Tveite, Michael
van Schaik, Jan
Wang, John Lih-Gow
Wilson, Robert
Yeo, Woon Bang

Supported Graduate Students

Ahmad, Noorani—Malaysian Government
DaSilva, Antonio—CAPES (an agency of the Brazilian Ministry of Education and Culture)
Filos, Victor—Fullbright Scholarship, Tanzania
Herrera-Hoyos, Carlos—Mexican Government
Ho, Chung-Man—Industrial Engineering, ISU
Ihnen, Leigh—Entomology, ISU
Kumlung, Arunee—Chulalonghorn University, Thailand
Lamyordmakpol, Anuchit—Government of Thailand
Mazlom, Reda—Egyptian Government
McGovern, Paul—Department of Psychology, ISU
Miazaki, Edina—Federal University of São Carlos, Brazil
Mohamad, Bader Eldeen—Government of Sudan
Montoya, Cristobal—University of Costa Rica
Mowers, Ron—Agronomy, ISU
Niknian, Minoo—College of Statistics and Information, Tehran
Nkansah, Paul—Department of Mathematics, ISU
Petenate, Ademir—Universidade de Campinas, São Paulo, Brazil
Ramos, Juan—Mexican Government
Saad Eldin, Mohamed—University of Gezira, Khartoum, Sudan
Sastrosoewignjo, Soetarto—Government of Indonesia, AID
Slamet—Surabaya Institute of Technology Project, Indonesia
Tegene, Abebayehu—USAID, Ethiopia
Wilson, Jeffrey R.—Government of Trinidad
Zamudio, Francisco J.—National Council of Science and Technology, Mexico

Self-Supporting Graduate Students

Ahmad, Adnan Bin
Fakiya, James O.
Gan, Fah-Fatt
Hsu, Sheue-Wen
Kim, Byung C.
Kim, Byung H.
Lee, Youngjo
Morel, Jorge
Ray, Di-ou
Richards, Winston
Tang, Jee-Juin

Survey Section

Glenda Ashley, Key Entry Operator
Mary Lou Borts, Survey Supervisor beginning in October
Hazel Cook, Survey Supervisor through December
Julie Ann Cummings, Statistical Clerk
Dorothy Edwards, Statistical Clerk
Margaret Fowler, Statistical Data Processor
Evelyn Green, Survey Supervisor
Vimlesh Gupta, Key Entry Operator
Lynn Harrison, Statistical Data Processor August through February
John Highland, Research Assistant
Howard Hughes, Research Assistant
Marguerite Jeffrey, Statistical Clerk September through April
Marion Martin, Statistical Data Processor through September
Sylvia McNulty, Account Clerk
Helen Nelson, Secretary
Donna Omundson, Statistical Clerk
Florence Osam, Statistical Clerk
Linda Price, Secretary through August
Kathie Reinertson, Statistical Clerk
Susan Ridnour, Statistical Clerk beginning in April
Jasmine Seagrave, Statistical Clerk
Jeanne Sorenson-Wright, Statistical Data Processor
Jane Stowe, Clerk Typist beginning in September
Harvey Terpstra, Junior Systems Analyst
Sue Trexel, Statistical Clerk beginning in August
Elaine J. Widmann, Key Entry Operator
Frances Woolsey, Statistical Clerk

Statistical Data Processing Service

Bud J. Meador, Supervisor
Kathleen Shelley, Junior Data Analyst

General Office Staff

Avonelle C. (Jacobson) Hefflefinger, Administrative Assistant
Betty Ibrahim, Account Specialist
Nancy J. Barry, Information Specialist
Frances Bradley, Secretary beginning in December
Phyllis Carr, Secretary—Experimental Design Genetics Statistics Section
Norma Elwick, Secretary
Marylou Nelson, Secretary
Janice Peters, Secretary
Laura Robinson, Secretary through March
Sharon Shepard, Secretary
Linda Wheeler, Secretary through November
Darlene Wicks, Secretary—Statistical Numerical Analysis and Data Processing Section

Consulting and Cooperative Research

Statistical consulting and cooperative research bring faculty members and graduate students from many parts of the University in touch with Snedecor Hall. While almost every Statistics faculty member is occasionally tapped for consulting advice, a good many have specific budgetary support for such activities and are often aided by graduate student assistants. Grants held by research workers on campus augment regular funds.

Local, state, and federal agencies also seek the help of the Statistical Laboratory. This is made possible by grants, contracts, or cooperative agreements. Some of the results obtained are reported in the early parts of the Current Research section.

Presented here are examples of consulting activities reflecting the complex support arrangements devised to cope with the varied needs of a wide array of disciplines.

Agriculture and Home Economics Experiment Station

The consulting activities in the biological sciences involve many people. With a volume of work beyond the capability of the permanent staff to handle on an individual basis, the graduate assistants in consulting are indispensable to the present program. For the last year these have been David Blough, Dan Jeske, Cynthia Keune, Greg Kruger, Carl Lee, and Titus Shih. Often these students start with very limited backgrounds in experimental sciences and the initial consulting experience can be a jolt. Communication is a problem between students who have spent most of their academic careers in the mathematical sciences and biologists who have often purposely avoided mathematics but are well versed in the biological implications of their experimental work. We know of few ways to improve the communication other than to do the work. By the time students leave the unit they are operating well as successful, independent consultants handling all phases of the work from initial contact to final interpretation.

Only examples of the kinds of problems these students have been exposed to during the last year can be given in the space here. Plant breeders brought in work concerned with predicting soybean yield from number and width of pods and plant density. Plant scientists use multivariate techniques to handle problems in numerical taxonomy related to tribes of legumes. Horticultural studies on the crushing strengths of strawberries as they related to mechanical harvesting were processed. Characteristics of the wing dams present in the Mississippi were related to fish populations found around these sites. The behavioral traits of the wild turkey populations in southern Iowa were investigated using radio telemetry. The effect of exercise and diet on the composition and physiology of rats were reviewed. The pattern of rainfall and its measurement in Iowa was modeled by workers in meteorology. Work with nutritional physiologists, reproductive physiologists, and other scientists in Animal Science and Veterinary Medicine goes on almost daily.

All of this effort has a major requirement of good support in statistical computing and computer science; it could not exist without. The Department's Numerical Analysis section and the University's Computation Center are vital to the business labeled as statistical consulting.

A few more detailed examples of consulting projects follow. Recently the consulting statisticians have been involved in the analysis of a bacteriology taste panel study of dried fish stored for varying lengths of time at two holding temperatures using two packaging materials. The analysis was complicated due to numerous missing cells in the data set. This project involved the consultants with researchers in Costa Rica who are utilizing ISU expertise through a cooperative agreement with the College of Agriculture.

An interesting regression analysis was used for three years of black cutworm data related to the plant damage level of insect infestation and to the maturity of the plant at time of infestation. Results of the analysis will be helpful in the establishment of an economic injury level indicator that will guide farmers in decisions regarding treatment or replanting the damaged fields.

The effects of soybean mosaic virus on varietal performance and seed characteristics were investigated. In a study involving 15 soybean cultivars representing 4 maturity groups, artificial infection of plants with the virus resulted in reductions in yield and seed quality. Solid-phase radioimmunoassay was used to determine virus antigen content of seeds from the inoculated plants. This study is part of a larger one designed to investigate the radioimmunoassay technique as a means of determining the amount of soybean seed infection by the virus.

Assistance was also provided in the design, analysis and interpretation of a study of two experiments on multiple cropping systems. Several factors were investigated regarding their effect on yield of corn when strip intercropped with soybeans.

Some of the consulting and cooperative research of Ted Bailey, D. F. Cox, Paul Hinz, and Don Hotchkiss resulted in published articles which can be found in the Publications Section of this annual report.

During the past year, V. A. Sposito developed a computer package to solve linear programming problems using a new algorithm by Khachian. The algorithm, which has received much publicity, is based on the methods of ellipsoids. This optimization procedure was extensively tested and compared to IBM's MPSX linear programming code.

Modifications of Khachian's procedure were derived and incorporated into the computer code which reduced considerably the number of iterations needed to obtain an optimal solution. Experimental testing gained confirms recent computational studies conducted by IBM, and other universities, that Khachian's unmodified

procedure is not computationally suitable for large scale linear programming problems.

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C. P. Cox advised on the analysis of an unequally replicated factorial experiment with multivariate observations. The investigation concerned the role of uterine lymphatics in the transport of embryonic steriods.

C. P. Cox and Ahmad Razmpour planned a switchback design experiment for investigations by a graduate student in Biomedical Engineering into the effects of magnetic fields on the electrical conductivity of frog skin.

Discussing sampling strategy: from left to right, T. J. Rao (visiting), Roy Hickman, George Battese (visiting), Wayne Fuller, Jeff Goebel, Harold Baker

Survey Section

The Survey Section continues to work with the University of Iowa and the National Cancer Institute (NCI) on studies of cancer incidence. Data continue to be collected in a case-control epidemiologic study designed to identify familial and environmental factors that are associated with the occurrence of brain tumors in children. The cases are children under 16 years of age at the time of diagnosis of certain types of brain tumors. Controls are randomly selected and matched with cases on age, sex, and geographic area. Data were collected on 18 cases and 54 controls. It is expected that this five-year project will obtain data from approximately 100 cases and 300 controls in Iowa. Cases will be identified by the University of Iowa Cancer Registry. The Survey Section is in charge of control selection, field interviewing of parents of cases and controls, and initial data edit. Data analysis will be completed by researchers at the Children's Hospital Medical Center in Boston.

NCI is also studying long-time survivors of childhood cancer. The cases, identified by the Iowa Cancer Registry at the University of Iowa, were diagnosed as having cancer between birth and age 19, have survived at least five years, and had attained age 21 by December 31, 1979. Sibling controls are also being studied to compare psychosocial morbidity of the survivors and these closely matched controls. The Survey Section carried out a pilot study for NCI on 23 cases and 39 controls. Eventually 285 cases and 485 controls are expected to be studied. The Section is responsible for the field interviewing, editing, and validation of completed questionnaires. Analyses will be conducted by the National Cancer Institute researchers.

A third NCI study, under the direction of the Atlanta Center for Disease Control, is designed to assess association of oral contraceptive use and subsequent development of breast, endometrial, and ovarian cancer in women. Personal interviews are being conducted with 600 cases and with 400 controls selected by a random digit dial telephone technique. The Survey Section will interview cases and controls, edit, and validate the data.

Roy Hickman, George Battese, and Dick Dorsch contributed in the analysis of the 1978 survey of the Iowa State University Alumni Association. Summaries of the responses were obtained for the variables in the survey. Particular attention was given to the analysis of the financial contributions of the sample respondents. Some classifications were identified for which there were significant diferences among the proportions of alumni making financial contributions to the Association.

For the second year, the Survey Section worked with the Iowa Conservation Commission on a study of duck and goose hunting on public hunting lands in Iowa. Three strata were defined—opening weekend, other weekends, and week days. Within each stratum, a sample of observation periods was selected at each hunting site. The data were collected by personnel of the Conservation Commission. Survey Section staff processed the data using the SUPER CARP computer program.

Field work was carried out on a study of the effects of foreign ownership of farm land. Survey Section personnel had previously selected the sample and assisted in constructing the questionnaire and other field forms. The study was conducted by researchers from the Department of Economics under an agreement with the U.S. Department of Agriculture. Data were collected in California, Iowa, and Mississippi.

Data collected last year in a study of drainage districts in the upper Des Moines River Basin were processed this year. This study was sponsored by the Soil Conservation Service through the Department of Economics. Data collected last year in a statewide telephone survey of attitudes toward education in Iowa were processed this year also.

A sample of households within approximately 50 miles of Rochester, Minnesota, was selected from telephone directories for the Mayo Clinic. The households were to be contacted by telephone and individuals within sample households selected to complete the Minnesota Multiphasic Personality Inventory. In addition to drawing the sample, members of the Survey Section designed the necessary control forms and field procedures needed to enable the field workers to apply different sampling rates to 14 subgroups defined by age and

sex categories. They also trained the clinic personnel who carried out the field work.

A sample of households was selected from the Des Moines telephone directory for a researcher in Family Environment. Another researcher in that department was given assistance in selecting a statewide sample of households from telephone directories. This sample was to be used for a mail survey concerned with home energy audits. A random-digit sample of telephone numbers was selected from the seven Standard Metropolitan Statistical Areas of Iowa and Iowa City to be used in a survey of attitudes toward land use planning.

Assistance was given to the Legislative Fiscal Bureau in selecting a sample of state income tax returns. The sample will be used as the database for compiling statistical tables requested by various state agencies. Its use in lieu of using all the tax returns will be a cost-saving measure.

A sample of voting precincts was selected in Des Moines and Ames for the WOI News Department. During the November general election, an exit poll was conducted in these precincts by students in Political Science. The precincts were ordered on the basis of percent Republican vote cast in the last presidential election and a sample selected systematically with probabilities proportional to the total number of votes cast in the previous presidential election. Assistance was also provided in writing the questionnaire. Survey Section personnel processed the data for broadcasting on election night also.

A student in the Department of Community and Regional Planning was assisted in writing a questionnaire and setting up a sampling procedure to be used in studying school integration in a southern city.

A student in Entomology was given assistance in devising a sampling plan for studying pupal weights and egg counts in assessing the effects of different diets on cutworms being raised in an artificial environment. A student in Agricultural Economics was aided in writing a questionnaire to be used in investigating the effects of changes from a nomadic system of agriculture to a more stationary system in a certain area of his home country. A student in Education was given assistance in writing a questionnaire investigating factors related to the use or nonuse of the Student Affairs Research Office. A sample of about 600 women who had received Ph.D. degrees from American universities during the 1973-74 academic year was selected for a student in Education. A subsample of Iowa high school students, all of whom had participated in a previous study, was selected for a student in Home Economics Education for the purpose of making a follow-up study. A member of the News Department of WOI was given assistance in writing a questionnaire to be used in surveying drug use by Des Moines high school students. The Survey Section also processed the data.

A sample of sections (mile square land areas) was chosen from selected soil districts in 11 counties in western Iowa to supplement a sample that had originally been selected in 1949 and revisited on three subsequent occasions. The supplemental sections were selected in order to bring the sample size in terms of number of farms back up to the number originally identified in 1949.

Sallie Keller (left) and Cheryl Auer. Sallie is a Research Assistant in Statistical Computing and Cheryl a full-time Research Associate in the Survey Section.

A critique was made of a method proposed by a state agency for selecting a sample of properties in Iowa. These properties were to be re-appraised as part of the procedure for achieving statewide property tax equalization.

The Survey Section assisted Home Economics Education in a study of the perception and utilization of senior citizens centers by the black elderly. Interviews were conducted with 114 people in two Iowa cities.

A telephone interview carried out with 102 grain elevator operators within the WOI radio listening area was designed to assess the sources of market information used.

Engineering Research Institute

H. T. David and R.Craig Van Nostrand consulted on research problems in engineering, assisted by Steven Fahrenholtz. Fahrenholtz's consulting assistantship was supported by the Engineering Research Institute.

Agricultural Engineering staff were assisted in the design of a small-scale alcohol production system. Four selective bacterial media were compared for the Ames Lab, for possible use in an air quality monitoring device. Civil Engineering staff were assisted in the design of an experiment to test the effectiveness of a novel water conditioning system. Civil Engineering staff also consulted on the development of surface graduating procedures alternative to kriging and regression. Other Civil Engineering staff sought help in the estimation of variance components in the measurements of water pollutant levels. A project for Chemical Engineering called for comparing alternative coal sulfur reduction treatments. Another project in Chemical Engineering involved the stochastic modeling of crystal growth, an industrial engineer required assistance in designing a simulation comparison of alternative shop scheduling strategies, and Nuclear Engineering staff sought

advice in the quantification of the human error component of reactor system failure rates.

Social Sciences

Mack Shelley assisted Iowa Department of Transportation personnel with time series models for revenue forecasting. He consulted with students and faculty in the Departments of Political Science, Art, Family Environment, Community and Regional Planning, and Industrial Relations. Topics included surveys of: Iowa DOT managers and personnel officers about personnel operations; office workers' satisfaction with their work environment; participants' attitudes regarding the federal home improvement program in Des Moines; mass transit needs for ISU; the analysis of an experiment regarding the effect of sex and race on perceptions of black female interviewees; and ministers' wives.

Leroy Wolins consults primarily with students and faculty in Child Development and Home Economics. Of special interest is a designated study of student evaluations of instructors in which nearly 25 multisectional courses taught by approximately 100 instructors are involved. The study design allows for separate assessments of student variability within sections, instructor differences within courses, and course differences as well as the traditional control variables such as student ability and the sex of the student and the instructor.

Off-Campus Consulting

T. A. Bancroft consulted with faculty and graduate students at San Diego State University relative to a problem, involving conditionally specified inference procedures, initiated during his distinguished visiting professorship at San Diego State in 1980.

During last August, Jeff Goebel consulted with officials of Compuroute, Incorporated, in Dallas, Texas, on graphical display techniques. In March, he addressed the Soil Conservation Service's National Meeting of ADP Managers and Operations concerning the use, manipulation, and accuracy of resource inventory databases, and worked with regional ADP managers in designing data transmittal tests.

Statistical Numerical Analysis and Data Processing Section

One activity of the section is to maintain major statistical analysis packages such as SAS, SPSS, MINITAB, and BMDP. Major new releases of SAS and MINITAB were installed during the past year. The section also provides a scheduled consulting/debug service for users of statistical packages. Persons who are first time users or who need assistance with programming problems can obtain assistance from section personnel four hours per day, five days a week without an appointment. Examples of specific projects with which the section was involved during the year are given below.

Thomas Bubolz worked closely with the systems programming group in the ISU Computation Center to implement a fully interactive version of WATFIV running under the OS Simulator (OSSIM) system.

Bradley Skarpness implemented a data analysis package called CAPTURE for Dr. William Clark of the Department of Animal Ecology. The package analyzes information about wild animals captured in the field and yields maximum likelihood estimates of population totals for selected geographic areas. Bradley also assisted a Statistics student in programming a Monte Carlo study on small-sample, two-way classification data.

Bradley Skarpness and Thomas Bubolz continued with design improvements and maintenance on an interactive order entry system for the Iowa State Forest Nursery. This system, in its third year of operation, contains extensive facilities for interactive editing and updating of master data files. New computer based methods for managing tree shipments and inventory control have been designed and implemented. Database capability is being added to the system this year. This will permit comparative analysis and reporting of sales-related data over time. Stephen Chang provided much of the programming support for this phase of development.

A cost accounting and seed bed management system is in its second year of development. Its database contains complete records on materials and labor applied to each of over 1200 seed beds. All invoices received by the nursery are coded so that cost and items purchased can be related to specific nursery activities. A next phase in the project will be to develop a set of standards for evaluating the quality of trees produced. It will then be possible to relate the quantity and quality of trees produced to factors such as chemical balance of the soil, seeding density, and applications of specific amounts and types of herbicides and fertilizers at specific times in the growth cycles of over 40 species of trees. Jan van Schaik and Thomas Bubolz are responsible for designing the system.

Jan van Schaik completed programming for data management on a joint study between the Departments of Sociology and Food and Nutrition to investigate linkages between persons' eating habits and social-psychological characteristics. The program transformed data collected from over 900 individuals and produced output datasets that will be analyzed using statistical package programs.

Programming to support the analysis of historical data on European kinship systems has been provided by Sallie Keller, Stephen Chang, and Thomas Bubolz. Sallie, working on a project for Andrejs Plakans, Professor of History, has been developing programs to link genealogical records of German families from the years 1300 to 1900. Some objectives of the project are to identify the origins and length of family trees and to evaluate the role of marriage as a vehicle for social mobility. Stephen has begun work on a project for a client to investigate kinship and social structure in seventeenth-century Bordeaux. The initial phase of the project has been to identify networks of kin and friendship relations among witnesses to marriage con-

tracts formed in seventeenth-century Bordeaux, France. Stephen is currently revising earlier network analysis programs and will provide all the programming support for an analysis of occupational data of participants in the ceremonies.

Stephen Chang provided programming support for the Iowa Conservation Commission's annual Deer Harvest Survey. Samples of hunters to be contacted were drawn simultaneously from 20 populations representing about 65,000 individuals who purchased hunting licenses. Two mailings were used and achieved a response rate in excess of 80 percent. Final analysis and tabulation yielded estimates of game harvest totals for combinations of license type, zone, and season. These estimates are used to help commission personnel formulate harvest policies for the following year.

Other new projects undertaken by the section involve on-going data processing systems for CIRAS and Engineering Extension and for two commercial beef producing firms. These projects were transferred to the section from other support sources in March 1981. Kathy Shelley and Char-Lung Lin are working with these new systems.

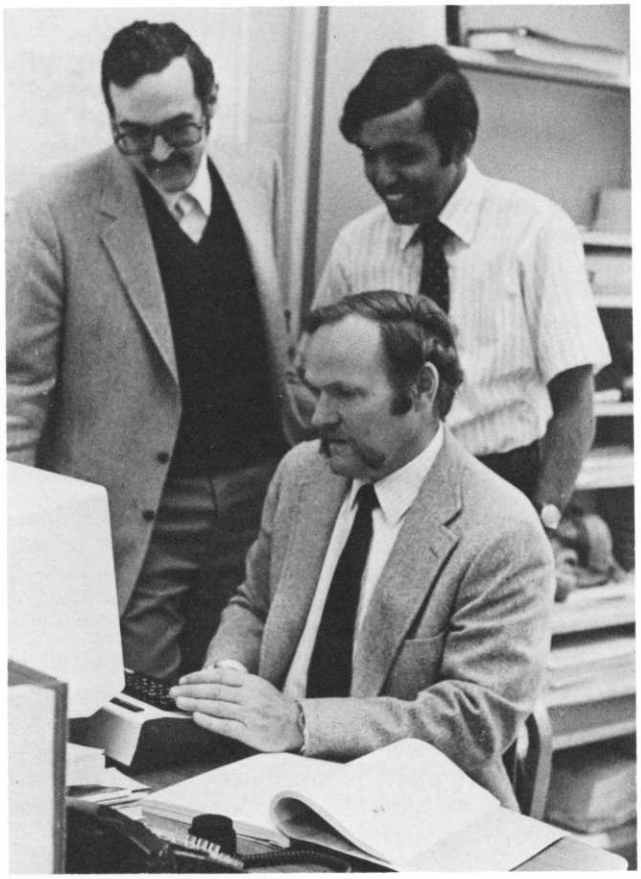
The analysis of data for corn and soybean experiments continues to occupy each member of the section at one time or another. Luis Escobar, Sallie Keller, and Josephine Lin each developed similar but unique data analysis and reporting systems for three commercial seed companies. Char-Lung Lin and Gordana Miletic handled continuing work for a fourth company. Kathy Shelley handled similar work for the University. The work for the crop related projects varies from generating planting randomizations for Randomized Complete Block, Rectangular Lattice, and Square Lattice designs, to printing field books, planting and harvesting specimen pressure-sensitive labels and subsequent reports. The support for the 1980 Iowa Corn Yield Test Report was handled by Char-Lung Lin and Kathy Shelley.

Gordana Miletic provided the data processing work for an analysis of a Human Sexuality Study conducted by the Home Economics Education Department. This study required considerable effort in writing unique programs as well as in making use of established programs and procedures. Incidentally, Gordana is the second graduate student from Child Development to work in the section. She is supported by a research assistantship from the Graduate College through a program intended to strengthen the quantitative analysis techniques of students in disciplines that provide minimal exposure to data processing and computer applications in research work.

The section also handled some of the computer processing to accumulate records and prepare reports for the College of Veterinary Medicine. Most notable is the work for the Diagnostic Laboratory and for Clinical Sciences. The data files have been maintained for several years and information retrieval or search for records satisfying specified criteria is a valuable product. Char-Lung Lin is responsible for most of the Veterinary College projects.

Luis Escobar and Josephine Lin worked on separate projects for the analysis of U.S. grain production and edible oil production—the data were furnished to research workers in Economics by the U.S.D.A. Luis also helped in translating the information contained in a questionnaire administered to families in Costa Rica. The purpose of the survey and analysis was to determine the nutrients in the diets of family members.

Professor Mervyn Marasinghe joined the section during the summer to replace Dr. James Gentle who now is employed by IMSL Corporation. Dr. Marasinghe provides consulting support for the section operations. The other consultants on the section's staff are Professors Kennedy and Sposito.



Mervyn Marasinghe, Assistant Professor (rear right), has joined the Statistical Computing group, Bill Kennedy (at terminal) and Vince Sposito

IBM's 370 MPSX linear programming package was tested extensively for overall effectiveness in solving large scale economic problems. Summaries of this study were made available to Professor Earl Heady, Economics, and Professor Clair Maple, Computation Center.

During the year, V. A. Sposito assisted various members of the department of Economics and CARD in interfacing software packages with MPSX. He also assisted Professor Mike Boehlje in setting up a Quadratic Programming software package which is able to compute various sensitivity computations.

Computers and Their Impact on Statistics at ISU

A veritable revolution has taken place since 1933 when Mary A. Clem became the Statistical Laboratory's first computer. Back then "computer" referred to one who computes. Today one associates the word with various automatic electronic machines for performing calculations. The Statistical Laboratory possesses a wide range of these machines—from desktop calculators to the recently installed computer terminals providing interactive computing capabilities. Computers are now used in (1) teaching and doing homework, (2) carrying on sponsored research and consulting, and (3) conducting unsponsored research.

Classroom use

Two major and separate computer systems are used for teaching. The National Advanced Systems AS/6 is a large central processing unit which supports teaching and research. Two smaller computers, Digital Equipment Corporation VAX 11/780 machines, are used only for teaching. Both of these systems, which are installed in the ISU Computation Center, have computer terminals in Snedecor Hall, and some homework is done on each of them. There are eleven VAX terminals and one printer in 307 Snedecor. Four terminals connected to the AS/6 are located in 120 Snedecor.

The VAX machines support total interactive computer use in the sense that one keys in a command and the terminal requests another command. The AS/6 computer is used less in the interactive mode but it does provide some support for interactive use. The AS/6 machine is primarily used in the batch processing mode in which one punches cards and then submits them to the card reader in the Computation Center.

There is some difference in the statistical software support provided by the two systems. The AS/6, being a larger computer system, has the following statistical software packages not available on the VAX; (1) SAS (Statistical Analysis System), (2) SPSS (Statistical Package for the Social Sciences), and (3) BMDP (Biomedical Computer Programs). If any one of these packages is most appropriate for homework problems, the students will write their program in the appropriate package language and then process it either by using a remote terminal and the WYLBUR RJE/RJO software support system or having cards punched and submitted to the card reader in the Computation Center or elsewhere on campus.

The VAX machines support the basic programming languages: (1) BASIC, (2) FORTRAN, and (3) PASCAL. MINITAB is available on both the AS/6 and VAX computers, and provides the primary statistical computing capability on the VAX system.

The amount of use of computers in a class varies with the nature of the course and the instructor. In the statistical methods courses such as Statistics 401-402-411, computers are used by students and the instructors. Some of the more advanced classes (Statistics 380, 481, 482, 579, 580, 581, and 680) are specifically devoted to statistical computing, and feature more extensive use of computers.

The students in the 100-level courses may use the Department's desktop calculators during the laboratory periods designated for these courses. Frequently students wish to have their own pocket calculators for homework in statistics and in other courses. As the cost is now so low, almost all students have such calculators of their own.

In Statistics 327, students become familiar with MINITAB. Both Drs. Groeneveld and Meeker make extensive use of that package in 327. MINITAB is used primarily to accomplish the computation required in multiple regression and other statistical problems which is too detailed and laborious to do by hand. According to Dr. Meeker, MINITAB is easy to use and easy to teach his students. "After one hour in a lab session, my students can learn to solve their problems." He gives them an option of using the AS/6 or VAX computers. Dr. Meeden is also using MINITAB in Statistics 322, Statistical Inference for Engineering, to illustrate statistical concepts.

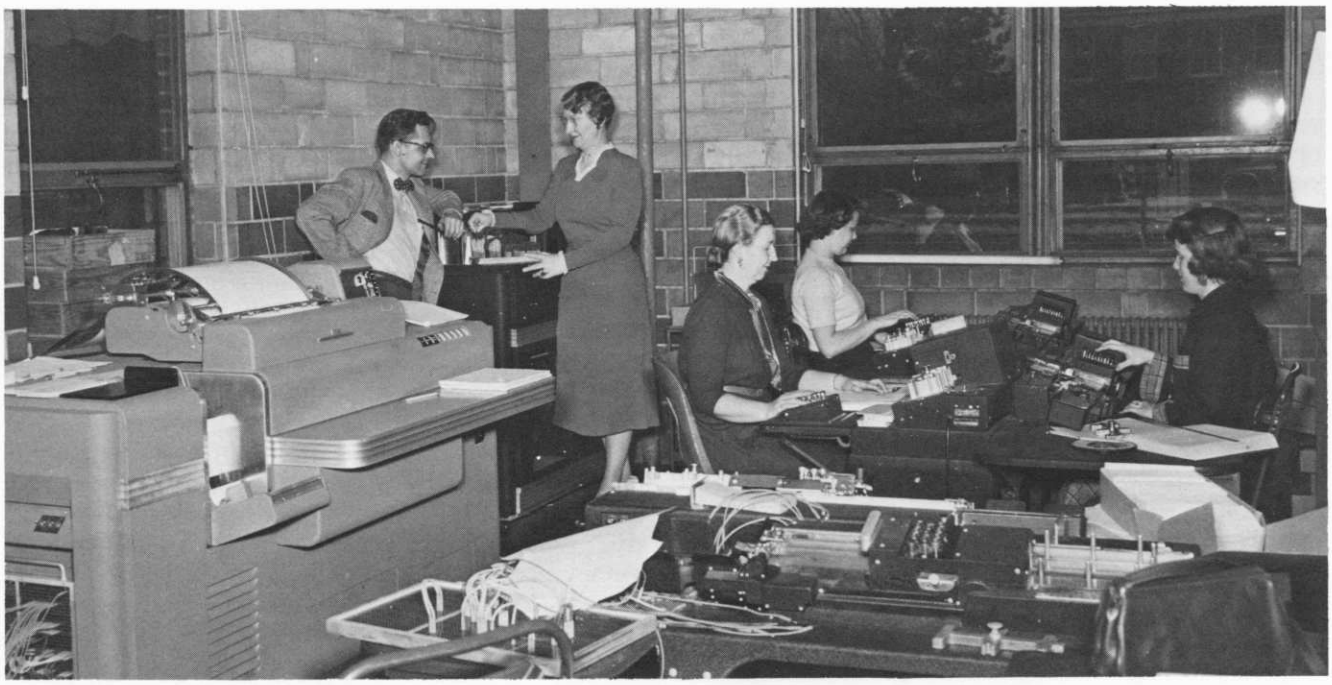
Both Groeneveld and Meeker foresee using the VAX more and more in the future. Jerry Niebaum, Computation Center, says "Although the VAX system costs approximately $300,000 and each terminal costs about $750, the VAX system was purchased by the University for economic reasons. In comparison with the AS/6, the VAX is less expensive for instructional interactive computing." Compared to batch processing, using the VAX takes less personnel time. With VAX Dr. Groeneveld says that one can run a program and immediately get the output from the terminal. "It is possible to examine the output which may indicate ways in which the statistical model can be improved. The VAX can then be employed to alter the model used in order to improve the description of the data set." Performing these functions on the AS/6 would result in more delay between operations.

Dr. Groeneveld regards it probable that VAX will be used in upper division (300-400 level courses) or special sections of lower division courses since large enrollment in lower division courses makes the use of VAX infeasible. "The Department as a whole is very appreciative of the fact that the University has provided the VAX terminals. They will be put to increasing use with the passage of time," he adds.

Beginning in Statistics 380 emphasis is placed on development of skills necessary for programming of complex algorithms. In 481 one learns computing for a wider variety of statistical applications such as regression. In 482 students become adept at using the computer for the analysis of statistical data. They become familiar with the hardware and software aspects involved in storage and manipulation of data.

Beginning in some classes at the 400-level, students are introduced to SAS, a powerful statistical analysis package which is capable of handling large data sets. BMDP and SPSS are also introduced in the appropriate courses at this level.

Kenneth Koehler wrote an interactive program for the analysis of frequency data in which students in



Computing around 1950. C. C. Mosier talking to Mary Clem

Statistics 507X could perform analyses of data sets that could not be processed with the standard statistical computing packages. The immediate response provided by this VAX program enables students to attempt complicated analyses which would be too time consuming to assign as class projects on the AS/6 system. Dr. Koehler continues to develop this program.

In Statistics 579, graduate students learn how to use WYLBUR and the major statistical packages, primarily SAS on the AS/6. WYLBUR is a software system for interactive text editing and remote job output. It is used in conjunction with SAS, SPSS, BMDP, and other software packages. Beginning in the fall of 1980, orientation for using the VAX terminals was included. After having taken Statistics 579, graduate students could then be expected to do homework by using SAS, SPSS, BMDP, or MINITAB.

Sponsored research

The AS/6 computer is also used for carrying on sponsored research and consulting. At ISU, statistical consulting is a highly developed activity, backed by funding from the Statistical Laboratory, the Agriculture and Home Economics Experiment Station (AES), and the Survey Section. The primary aim is to assist ISU faculty and graduate students with statistical facets of their research projects.

SAS remains the main computing tool for the AES supported consulting statisticians but its usefulness extends to any kind of data. SAS is useful with data from experiments in the physical sciences; social sciences data; business data; agricultural data; marketing data—in short, any kind of data.

The researchers in the Experiment Station collect data and put it into a form that the computer can read. The consulting staff help in both the planning and analyzing of experiments. They assist in interpreting the results. SAS is used to analyze data, to check for errors, to sketch plots, to summarize, and to print results. Some of the research is carried out using interaction with the AS/6 through WYLBUR, and the other work utilizes batch processing with cards.

The AS/6 computer is an increasingly important tool in the research and consulting activities conducted by the Survey Section. The system's interactive capabilities, computational speed, and large storage capacity permit many stages of a survey or research project to be handled in an efficient manner. Activities include: evaluation of possible survey designs; sample unit selection; preparation of instructions and materials for interviewers and field data collectors; data entry; data editing and quality control; data file manipulation; estimation; and report preparation.

Graduate students, staff members, and clerical workers in the Survey Section use available packages, such as SAS, IMSL (International Mathematical and Statistical Libraries, Incorporated) and SPSS in their research and data analysis, whenever possible. However, because of data set size and other special requirements, many speciality programs are prepared by the Survey Section staff and students. The Survey Section has developed several packages of their own, including the well known SUPER CARP. Analyses of clustered and stratified survey data as well as of regression models containing measurement errors are uses of SUPER CARP.

Recent advances in computer hardware and in its availability indicate that changes in computer usage will continue at a fast pace. Changes in computer graphics and transmittal of information via telephone lines will definitely affect Survey Section data collection and analysis. More offices and individuals will

have access to computers and will expect the most recent data and results to be available.

Programming and data processing support for sponsored research projects is available in the Statistical Numerical Analysis and Data Processing Section of the Statistical Laboratory. This section employs approximately fifteen persons who perform needed analyses, using the AS/6, by employing existing software whenever possible and developing custom programs as required. Sometimes the projects presented to the section are initiated by a consulting statistician from another section of the Statistical Laboratory. The section also provides consulting support in statistical computing to the ISU faculty and students. Since the section is responsible for installing and updating statistical software systems, continuous close coordination with the ISU Computation Center is maintained.

Unsponsored research

Computers also support unsponsored research within the University. This research covers the special interests of faculty and graduate students. Money is needed for this work and is allocated from the office of the Vice-President of Research. Some of Dr. Meeker's unsponsored research involved writing a computer program for analyzing time series data. Although computer programming is a hobby of Dr. Meeker's, in this case, his efforts were needed so that students in Statistics 451 could analyze their own data. He is presently involved in developing computer software for life and survival data analysis to support his research in this area.

Looking to the future

In 1957 the Statistical Laboratory acquired an IBM 650 and since then the University has provided computer hardware to meet the changing needs of the ISU's Statistical Center. What can be expected in the future? Dr. Kennedy sees ". . .a continued trend toward more and better computer programs to support the computing that statisticians want to do. Software development will however continue to lag well behind hardware enhancements because production of high quality software requires expenditure of large amounts of time by highly skilled people, and such people are in short supply."

Kennedy says that the machines themselves are becoming far less expensive and far more capable; a trend that has continued over the past twenty years. "In other words, you get a lot more for your dollar in terms of the amount of arithmetic you have the machine do for a dollar. There is miniaturizing to the point where the electronic circuits are on chips with circuitry that is interruptable by a speck of dust." Kennedy also predicts that there will be ". . .ever more capable computer hardware for less money and more and better software available to statisticians. There will be a very wide array of equipment and a diverse family of computers linked in networks—all of these designed to help people with all kinds of data processing applications."

Current Research

Statistical Laboratory staff members are actively engaged in statistical theory and methodology research. Research funds are made available through the budgets of the Statistical Laboratory, the Agriculture and Home Economics Experiment Station, the Engineering and Sciences and Humanities Research Institutes, and government contracts and grants.

A brief summary of research sponsored by contracts as well as some staff members' individual research is reported in this section.

AES Project 890

Oscar Kempthorne continued to work on foundations of statistical thinking. A critical ingredient is the nature of statistical tests which can be regarded as evidential or decisional tools. The principal use of tests seems, in fact, to be evidential and justification of them as decisional is quite obscure. One is led to the perhaps unpleasing view that decision making must be based, at least to some extent, on Bayesian ideas, which, however, lead to the age-old problem of obtaining an appropriate proof. This must be based, it seems, on analogy with other data and analysis of those other data. The making of analogies, however, seems to be an entirely intuitive nonobjective process. The interesting ideas of P. D. Finch on the role of analogy and description in statistics are being studied. Running through the whole area is the question of similarities and dissimilarities of inference and decision. Then also there is the question of the relation of evidentiality to inference.

In recent years there has been extensive discussion and publication on a supposed new direction in statistics called "Data Analysis." This seems, at present, to be little more than a collection of ad hoc techniques with an absence of basic philosophical outlook. Attempts are being made to "make sense" of the area.

Controversy on randomization has been continued with the curious outcome that some statisticians accord it increasing significance while others deny it any significance at all. The potential role of randomization in weather modification has been discussed. Another aspect is raised by the criticism, voiced by some statisticians in connection with a particular experiment, that a particular randomization is not fair. The nature and role of covariance in randomized experiments has been studied.

An entirely different area of study has been the validity and use of mental tests, this being prompted by the book "Bias in Mental Testing" by Arthur Jensen. A brief general conclusion without various caveats, is that the use of mental tests, such as the IQ test, is not racially biased.

Small Area Estimation

Research on the prediction of crop areas by county using survey and satellite data has been conducted by George Battese, Wayne Fuller, Cheryl Enger, and Rachel Harter. Survey observations are assumed avail-

able on the crop area in a sample of segments within a sample of counties. In addition, it is assumed that satellite classifications of crop cover are available for all pixels (picture elements of the satellite scanner) within the sample counties. Given that the nested-error regression model defines the relationship between the survey observations and the satellite data in the sample segments, a class of predictors for the mean area per segment in the counties has been considered. The mean squared error and mean squared bias of these predictors have been derived. Software for the computation of the predictors and associated statistics have been developed. Empirical analyses for corn and soybeans in Iowa indicate that the mean squared error of the best predictor is less than that of the simple survey estimator. The Economics and Statistics Service of the U.S. Department of Agriculture plans to implement the computer software for crop area prediction for the 1981 crop year.

AES Project 2155

The Survey Section under the leadership of Roy D. Hickman continued its research in agriculture-related sample survey methodology. The U.S. Department of Agriculture supports this work through Project 2155 with the Agriculture Experiment Station. Project 2155, one of the largest research agreements administered by the Iowa State University AES, focuses primarily on cooperative research with the Soil Conservation Service (SCS). This research work deals with inventorying the nation's natural resources, with special emphasis on soils-related items. Jeff Goebel serves as co-investigator for this project. Also involved are Wayne Fuller and Survey Section staff members Richard Dorsch, Howard Hughes, John Highland, and Cheryl Enger, as well as research assistants Jeanne Devin, Tin-Chiu Chua, and Rachel Harter. Data manipulation and editing, coding, sample selection, and mapping also require the efforts of a number of Survey Section clerical personnel.

This cooperative research with the SCS involves sample design, large data set methodology, evaluation of data quality, investigations of ratio and regression estimators, and variance estimation techniques. Also included are analyses of past studies, supervision of ongoing surveys, planning of future investigations, and discussions with SCS personnel of the principles and potentials of sampling.

A major portion of this project during the past year was the design, sample selection, and questionnaire construction for the 1982 National Resources Inventory, which includes about 800,000 specific sample sites. Data are desired on land use and cover, wind and water erosion, conservation needs, characteristics of soils, prime farmland, wetlands, and numerous other agricultural and wildlife resources. Presently being investigated are ways to transmit these data from the 50 SCS state offices utilizing the Harris 1600 Distributed Data Processing System, which is linked via telephone lines to the Iowa State Unviersity AS/6 computer. This system should also be useful in transmitting information and estimates from the Survey Section to the various states, as well as to the national office in Washington, D.C. Results of this natural resource inventory are desired by the U.S. Congress at the national and regional levels. State governments and various local planning groups are interested in estimates at the county level or by certain types of physiographic subregions within a state or region. The Survey Section is cooperating with the SCS in the development of sampling and data analysis methodology that will help answer questions concerning these agricultural resources for the many geographical universes of interest.

Also included in the SCS cooperative work is the storage, retrieval, and analysis of the interpretation data of soil series in the United States. This data file continues to expand, with more than 15,000 soil series now in storage. Updating of these records has increased as the SCS field staff attempts to keep the data as current as possible. A primary use of these data is to generate tables for inclusion in published soil surveys. Various subfiles of the data set have been provided to a number of land-use planning, environmental, and research organizations. Preliminary work was completed to associate soil interpretive data with records in the National Resource Inventory data sets. Soil interpretation information is now being accessed remotely by the SCS state and national offices via the Harris Processing System. Harvey Terpstra continues to work with regional and national SCS personnel in the development and use of this data system.

AES Project 2383

The U.S. Bureau of the Census and the Iowa Agriculture and Home Economics Experiment Station supported joint research in measurement error models, time series, and survey design. Support from the U.S. Bureau of the Census was through Joint Statistical Agreements J.S.A. 80-6 and J.S.A. 81-14. Personnel working on the project include Wayne Fuller, principal investigator, Yasuo Amemiya, Henry Lee, Hsien-Ming Hung, and Sastry Pantula.

A report was prepared on the design and estimation for stratified samples. The situation considered is one in which there is sufficient information to stratify the population to the point where the sample would be composed of one unit per stratum.

Expressions for the bias and mean squared error of alternative estimators of the parameter of the seasonal autoregressive model were developed. An important source of bias arises from estimating the seasonal means. This study demonstrated that estimators adjusted for the bias can have considerably smaller mean squared errors than the ordinary least squares estimator. For monthly data the adjusted estimators were superior for about three-fourths of the parameter space. The adjusted estimators were much superior for positive values of the autoregressive parameter.

Research was conducted on the estimation of regression coefficients from a stratified cluster sample with independent variables subject to measurement error.

Estimation procedures for certain nonlinear models and models with heterogeneous error variances were investigated.

A model for the probability that a sampled person will respond was studied. Estimators were developed for the situation in which persons are given more than one opportunity to respond.

Order Statistics and Nonparametric Statistics

H. A. David, principal investigator of the above grant collaborated with R. A. Groeneveld on a paper treating the dependence of the expected spacing and of the variance of the r-th order statistics on r, with n fixed, for various classes of distributions; the two quantities studied provide measures of local variation in a distribution. Resulting from his Ph.D. dissertation (see abstract elsewhere in this issue), written under Dr. David's supervision, H. N. Nagaraja has prepared papers on record values and extreme value distributions, on finite sample and asymptotic theory of the selection differential, and on the induced selection differential.

Malay Ghosh, co-investigator, has research in progress on obtaining rates of convergence to normality for different order statistics and nonparametric statistics. A paper on rates of convergence to normality for U-statistics based on independent but nonidentically distributed observations, both when the sample size is fixed and random, will appear in the Proceedings of the International Conference on Nonparametric Statistical Inference organized by the Janos Bolyai Mathematical Society at Budapest, Hungary. Currently, he is looking at rates of convergence to normality for linear functions of order statistics and linear functions of concomitants of order statistics.

Dr. Ghosh is also working in sequential nonparametric point and interval estimation and has written two papers on sequential point estimation of means of U-statistics when sampling is from either a finite or an infinite population. An asymptotic expansion for the average sample size in all these problems is currently being explored.

Mathematical and Statistical Genetics

Research in mathematical and statistical genetics is supported by Project 1669, Iowa Agriculture and Home Economics Experiment Station and the National Institutes of Health. Edward Pollak is the principal investigator. Oscar Kempthorne and Krishna B. Athreya have also worked on the project during the period of this report and Jerry W. Lewis and Terrance P. Callanan have been the research assistants.

Professor Pollak did research on the project while he was on Faculty Improvement Leave at the Department of Human Genetics at the University of Michigan. He studied the assumptions underlying three methods for estimating mutation rates in humans, due to Kimura and Ohta, Nei, and Rothman and Adams. These all make use of observed genetic variability and are based on the assumption that an isolated finite population has had time to reach an equilibrium with respect to random loss of alleles and mutation. It was found that all three methods are best applied to rare variants and that they are all based on probabilities conditional on ultimate extinction.

Oscar Kempthorne has studied the role of quantitative genetic theory in analyzing human populations, particularly with respect to mental testing. He has also made efforts to develop expressions for long term, in contrast to immediate, gains from truncation selection.

Krishna B. Athreya has established the convergence to steady state of age, type and state of general population growth models such as those of Crump, Mode and Jagers, using renewal theoretic techniques. This theory is very general, in the sense that, for example, the past history of reproduction of an individual can be incorporated as well as the age at which it has a particular child. This has a bearing on the study of the progress of mutant genes in populations with realistically complex structures.

Jerry Lewis obtained further results on models involving selection and interaction of a host and pathogen. The solution for polymorphic equilibria with complete dominance and multiple allele was simplified. Techniques were developed to deal with mutation and the effects of genetic recombination in a pathogen that is haploid for most of its life cycle. He has also done research on the stochastic theory for finite subdivided populations with neutral alleles. A program was developed by him to compute the moments of the limiting frequency for various levels of mutation and migration between the subpopulations. In the process of accomplishing this, explicit formulas were developed for the inverse of an arbitrary tridiagonal matrix.

Terry Callanan has studied the theory of random mating in an infinite age-structured population with respect to long run frequencies of alleles and genetic combinations when two loci are involved. Results have also been obtained for rates of convergence to these equilibrium frequencies.

Linear Statistical Inference

Research continued on various topics related to linear models. This work was supported in part by Air Force Office of Scientific Research Grant No. 76-3037, entitled "New Techniques for Linear Statistical Inference." David Harville was the principal investigator. Robert Mee served as the research assistant.

Work was conducted by Mee and Harville on the modification of linear model techniques to make them applicable to ordered categorical data. The adopted approach is based on the introduction of an underlying continuous (generally conceptual) random variable, whose values can be fitted to a fixed, mixed, or random linear model.

Two-stage procedures for estimating the fixed and random effects of a mixed linear model (which consist of first estimating the variance components and then using the estimators of the effects that would be best

linear biased if the variance component estimates were treated as true values) were investigated. This work was conducted jointly by Raghu N. Kackar of Bell Laboratories and by Harville. They studied the accuracy of those variance approximations for the two-stage estimators that they had proposed earlier.

Optimization Problems

H. T. David and V. A. Sposito continued their work under this contract. Areas investigated included (1) topics in dynamic programming: source expendability in multi-source Bayes sequential decision problems, asymptotic value independence for correlated stochastic perfect-information games, and certain asymptotic firing distributions associated with ϵ-good strategies for noisy duels; (2) generalized-convex duality and optimality; (3) homogeneous programming; (4) tight bounds for convolutions via generalized linear programming, with applications in reliability and utility theory; and (5) topics in optimum estimation: alternative algorithms for Chebyshev estimation in regression, the sample mean as optimum median—unbiased under Alamo's measure of dispersion, and construction and characterization of optimum unbiased estimates for finite not necessarily complete parameter spaces and measures of dispersion other than variance.

Michael Hand, Willamette University; J. Colby Kegley, Iowa State; and Gabriela Stangenhaus, Federal University of Sao Carlos; contributed to the project during the year. Participating graduate assistants included Steven Fahrenholtz, Michael Hale, Anuchit Lamyordmakpol, Soetarto Sastrosoewignjo, and Bradley Skarpness.

Sciences and Humanities Research Institute (SHRI)

Krishna B. Athreya, Chien-Pai Han, Dean Isaacson, Mervyn Marasinghe, and Glen Meeden receive some support from SHRI funds. Areas of research covered by these five faculty members include probability theory (Athreya and Isaacson), statistical methodology (Han), linear model theory and statistical computing (Marasinghe), and statistical inference (Meeden).

Jointly with Peter Ney (University of Wisconsin), Krishna B. Athreya worked on a research monograph entitled "Markov Chains—A Renewal Approach." He has also been using a fresh point of view in studying some classical problems in probability theory.

Chien-Pai Han, T. A. Bancroft, and several students continue to work in areas of multivariate analysis, inference based on conditional specification, sample survey theory, and computation of noncentral distributions.

Dean Isaacson has completed papers on Markov chains with E. Seneta (Sydney University) and P. Colwell.

Mervyn Marasinghe has written up research on linear model theory done for his M.S. and Ph.D. degrees at Kansas State. He has continued some work with Dallas Johnson (Kansas State) and begun computational research with Bill Kennedy.

Glen Meeden and Malay Ghosh have continued to investigate inferential problems in finite population sampling. He and Richard A. Groeneveld have studied certain unimodal, asymmetric distributions and identified the set of sensible measures of location.

Simultaneous Estimation of Parameters in Exponential Families

Malay Ghosh is conducting research to improve on the classical (maximum likelihood, minimum variance unbiased or best invariant) estimators when samples are drawn from p independent distributions, each belonging to the one parameter exponential family being either discrete or absolutely continuous. Many important special cases including the Poisson, negative binomial, and gamma distributions are considered. Also various new estimators (some improving on the classical ones) are constructed from a Bayes or an empirical Bayes viewpoint.

Conservative Coalition in the U.S. Congress

Mack Shelley received a university research grant for 1980-81 to expand on his previous research on decision-making processes in the United States Congress. The research focuses on the Southern Democrat-Republican "conservative coalition" from 1933-1980. He examined the relationship of that policy coalition to the Presidency, the party system, the principle of representative democracy, congressional committees, the general function and operation of political coalitions, and the policy impact of the conservative coalition on a number of specific issue areas (the economy, defense and foreign affairs, civil rights and liberties, social welfare). The statistical methods used included time series analysis, both univariate and intervention models, and correlational analysis. This work has resulted in a book manuscript submitted for publication and in several other derivative pieces of research.

Professional Activities

For the American Statistical Association, Wayne Fuller has been elected chairman of the Business and Economics Section for 1982. Bill Kennedy is serving on the Board of Directors for 1981 representing the Statistical Computing Section. David Harville is the Biometrics Section representative on the Council of the ASA for 1981. H. A. David is a member of the Ad Hoc Committee on the filming of distinguished statisticians. During the year, Jeff Goebel served as secretary of the Iowa Chapter of the ASA.

H. A. David has been elected vice-president of the Biometric Society; he will serve as president in 1982 and 1983.

Bill Kennedy and H. T. David participated in the Conference on the Teaching of Statistics and Statistical Consulting held at Ohio State University November 24-25. Bob Johnson and Bob Stephenson attended the conference.

The Committee of Presidents of Statistical Societies appointed Oscar Kempthorne chairman of the R. A. Fisher Award Committee.

From May 31-June 5, Glen Meeden attended and chaired a session of the Third Purdue Symposium on Statistical Decision Theory.

During the year, four professors participated in international conferences. In July H. T. David presented a paper at the Fourth Symposium on Probability and Statistics held in Rio de Janeiro, Brazil. Oscar Kempthorne gave three papers at the 15th Mathematics Annual Conference in Statistics, Computer Science, and Operations Research held in Cairo, Egypt, during December. Wayne Fuller and Oscar Kempthorne presented papers at the 1981 Canadian Conference in Applied Statistics held in Montreal during late April. Professor Kempthorne participated in a panel discussion entitled "Teaching and training in statistics at Canadian universities," at that conference. During late June, Krishna Athreya presented a paper at the International Conference on Stochastics and Analysis held at the University of Tübingen, West Germany.

At the joint annual meeting of the American Statistical Association and the Biometric Society, Houston, Texas:

DAVID, H. A.: "Gini's mean difference";

Drew, James H. and **Wayne A. FULLER:** "Modeling nonresponse in sample surveys with callbacks";

FULLER, Wayne A.: "Regression analysis for time series data";

Hahn, G. and **William Q. MEEKER, Jr.:** "Common pitfalls in product life analysis";

HAN, Chien-Pai and **John L. G. Wang:** "On the computation of central and noncentral F. distributions";

Kackar, Raghu N. and **David A. HARVILLE:** "Variance approximations for two-stage estimation and prediction procedures for mixed linear models";

KOEHLER, Kenneth and Harold Ridpath: "Assessing the home field advantage in professional sports: a paired comparison approach";

MARASINGHE, Mervyn G. and Dallas E. Johnson: "Testing subhypotheses in the multiplicative interaction model";

MEEKER, William Q. Jr.: "Some practical problems in accelerated testing";

MEEKER, William Q. Jr. and Steven D. Duke: "CENSOR—a user-oriented computer program for life data analysis";

Sallas, William M. and **David A. HARVILLE:** "Best linear recursive estimation for mixed linear models";

SHELLEY, Mack C. II: "Forecasting the federal budget: univariate strategies";

SPOSITO, V. A. and M. L. Hand: "Optimal L_p estimators for symmetric distributions";

STEPHENSON, W. Robert: "Adaptive tests based on certain linear rank statistics."

At the 15th Mathematics Annual Conference in Statistics, Computer Science, and Operations Research, Cairo, Egypt:

KEMPTHORNE, Oscar: "Basic theory of least squares and analysis of variance."

"The role of the Moore-Penrose inverse."

"Classificatory data structures, associated linear models, and analyses of variances."

At the Conference of the American Educational Research Association, Los Angeles, California:

FULLER, Wayne A.: "Estimation of nonlinear measurement error models."

STRAHAN, Robert F.: "On combining the significance levels of independent studies."

At the 1981 Canadian Conference in Applied Statistics, Montreal:

FULLER, Wayne A.: "Measurement error models with heterogeneous error variances."

KEMPTHORNE, Oscar: "Foundations of statistics: pure and applied," and "Adventures of a Cornish farm boy in search of statistics (with apologies to George Bernard Shaw)."

At other locations:

ATHREYA, Krishna B.: "Renewal approach to Perron Frobenius theory," at the International Conference on Stochastics and Analysis held at the University of Tübingen, West Germany, June 26.

BATTESE, George E.: "Prediction of county crop areas using survey and satellite data," to the Remote Sensing Branch of the Economics and Statistics Service, U.S. Department of Agriculture in Washington, D.C., April 20.

DAVID, Herbert A.: "Concomitants of order statistics: theory and applications," at Bell Laboratories, West Long Branch, July 9; at Bell Laboratories, Murray Hill, July 10; at Harvard University, October 24; and at Ohio State University, April 15.

"Theory and applications of order statistics," and "Tournaments, paired comparisons, and cyclic designs," at Oakland University, Rochester, Michigan, April 16. These seminars were presented under the Visiting Lecturer Program in Statistics.

DAVID, Herbert T.: "Mathematical optimization and statistics" at the Fourth Symposium on Probability and Statistics, Rio de Janeiro, Brazil, July 24.

"A relevant statistical education," at the Federal University of Sao Carlos, Brazil, August 7.

"Some examples of functional iteration in statistics," at the State University of Sao Paulo Institute of Mathematical Science, Campus of Sao Carlos, Brazil, August 8.

"Discussion on the teaching of statistical consulting," at Ohio State University, November 24.

FULLER, Wayne A.: "Estimation for autoregressive processes with a unit root," at the University of Chicago, November 19.

"Regression analyses for time series," at North Carolina State University, February 11.

"A nonresponse model and estimators for surveys with callbacks" at the Ottawa Chapter of the ASA, May 4.

GHOSH, Malay: "Consistency and asymptotic efficiency of two stage and sequential estimation procedures," and "Sequential point and interval estimation of means of U-statistics," at Albert Ludwig's University, Freiburg, West Germany, July 1-2.

"Sequential point and interval estimation of means of U-statistics," at Oklahoma State University, July 10.

"Finite admissibility and finite population sampling," at Indiana University, November 14.

"Multiparameter Estimation: The Stein phenomenon," at the Indian Statistical Institute, Calcutta, June 10, 12, 16, and 18.

"Finite admissibility and finite population sampling, at Calcutta University, June 19.

GOEBEL, Jeff: "Planning the SCS National Resources Inventory," at the Arid Land Resource Inventories Meeting in LaPaz, Mexico, December 2.

"Inventorying natural resources—sampling, estimation, and data processing problems," at the 1982 Conference on National Resources Inventory in Lincoln, Nebraska, March 4, 1981.

GROENEVELD, Richard A.: "Probabilistic and statistical properties of the best of 2m-1 game series," under the Visiting Lecturer Program in Statistics (Committee of Presidents of Statistical Societies), at Wichita State Unviersity, Wichita, Kansas, December 1.

HAN, Chien-Pai: "Statistical inference based on conditional specification," and "On some classification procedures in multivariate analysis," at the University of Texas, Arlington, January 26 and 27.

HARVILLE, David A.: "Assigning probabilities to the outcomes of horse races and other multi-entry competitions," at Cornell University, Ithaca, New York, February 25.

HINZ, Paul N.: "What is a good statistical education?" a seminar for the ISU Department of Plant Pathology and Weed Science, December 9.

"A critique of multiple range tests," for the ISU Seed Science Center, January 13.

ISAACSON, Dean: "Markov chains and their applications," at Mankato State, November 24 and at St. John's University, Collegeville, Minnesota, November 25.

JOHNSON, Robert A.: "Analysis of age, period, and cohort effects in time series of age-specific marital fertility schedules," at the Population Association of America, Washington, D.C., March 26.

KEMPTHORNE, Oscar: "The teaching of statistics," at Bowling Green State University, Ohio, October 14.

"The foundations of statistics" at Harvard University, October 15.

"The 2 × 2 table," at the Massachusetts Institute of Technology, October 16.

"What are we to make of R. A. Fisher?" at the Montreal Chapter of the American Statistical Association, April 29.

"Nature and roles of data analysis," at Carleton University's "Statistics Days," Ottawa, Canada, April 11.

KENNEDY, William J.: "Tutorial on statistical computing," at the 36th annual conference on Applied Statistics, Newark, New Jersey, December 4.

"The statistical computing portion of a curriculum in statistics," at the Conference on the Teaching of Statistics and Statistical Consulting at Ohio State University, November 24.

"Education and training in statistical computing at Iowa State University," presented to the Department of Statistics at the University of Missouri, Columbia, April 16.

MEEKER, William Q.: "Practical accelerated life tests," at the annual fall Technical Conference of the American Society for Quality Control and the Section of Physical and Engineering Sciences of the American Statistical Association, Cincinnati, Ohio, October 23.

"Common pitfalls in product life analysis," at the Central Iowa Chapter of the American Statistical Society for Quality Control, January 14, and at the Colorado/Wyoming Section of the ASA, April 29.

"Statistical quality control in the turkey industry," at the 19th Annual Turkey Processors Seminar, Mason City, April 8.

"Statistical aspects of planning accelerated life tests," at the Department of Statistics, Colorado State University, April 29.

RAO, Talluri J.: "Optimum utilization of auxiliary information in sample surveys," at Virginia Polytechnic Institute and Virginia State University, Blacksburg, Virginia, February 26.

SHELLEY, Mack C.: "Forecasts, foresight, and future-telling: applications of time series analysis in political science," at the 1980 Annual Meeting of the Southern Political Science Association, Atlanta, Georgia, November 7.

"Patterns of competition in congressional elections," at the Annual Meeting of the Midwest Political Science Association, Cincinnati, Ohio, April 16.

Maney, Ardith and **Mack C. SHELLEY:** "Polls, predictions, and the press," at the Political Science Club and Pi Sigma Alpha Seminar, October 27.

STEPHENSON, Robert W.: "Statistics by example: a training course for high school teachers," a series of lectures for the NSF Pre-College Teacher Development in Science Project delivered at the University of Connecticut, July 7-25.

STRAHAN, Robert F.: "More on averaging judges' ratings: determining the most reliable composite," at the meeting of the Midwestern Psychological Association, St. Louis, May, 1980.

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Publications and Dissertation Abstracts

Directed by David F. Cox, the AES consulting section finalized the page proofs for Snedecor and Cochran's seventh edition of *Statistical Methods*. In recognition of this work, the Iowa State University Press donated $500 to the Statistical Laboratory Reading Room.

A second edition of *Order Statistics* by H. A. David has been published by John Wiley and Sons. Nauka, Moscow, published a Russian translation of the first edition.

Robert Alan Johnson's Ph.D. dissertation, *Religious Assortative Marriage in the United States*, is now a volume in the Studies in Population Series published by Academic Press.

In 1981 William Q. Meeker Jr. coauthored *Volume 7* of *Selected Tables in Mathematical Statistics*. William J. Kennedy served as coeditor of the book.

Directions in Time Series, proceedings of the IMS Special Topics Meeting on Time Series Analysis, Iowa State University, Ames, May 1-3, 1978, edited by D. R. Brillinger and G. C. Tiao was published in 1980. *The Mathematics of Genetic Diversity* by J. F. C. Kingman was also published in 1980. The book is based on the lecture material presented at the NSF Regional Conference held at Iowa State June 4-8, 1979.

Departmental faculty members serve in the following editorial and administrative capacities for statistical journals:

H. T. David is book review editor of the *Journal of the American Statistical Association*.

Malay Ghosh is a member of the journal committee of *Sankhya A* and *B*; he has been appointed a member of the editorial board of the new journal *Communications in Statistics (Series C): Sequential Analysis;* and he has been named as associate editor of the Book Review Section of the *Journal of the American Statistical Association*. In addition, he serves on the advisory board of a new journal, *Statistics and Decisions*.

Wayne A. Fuller is an associate editor of *The American Statistician*.

Chien-Pai Han is a member of the editorial board of *Communications in Statistics A*.

Paul N. Hinz is an associate editor for the *Iowa State Journal of Research*.

William J. Kennedy is a member of the editorial board and co-editor of the Algorithms Section of *Communications in Statistics B;* associate editor and also editor of the section entitled "New Developments in Statistical Computing" of *The American Statistician*; and co-editor of *Selected Tables in Mathematical Statistics*.

William Q. Meeker is an associate editor of *Technometrics*.

Leroy Wolins is a member of the board of editors for *Educational and Psychological Measurement*. He is also on the management board for *Educational Statistics*.

Along with dissertation excerpts, abstracts of papers and books published by staff members and graduate students are included in this section. When research was conducted at Iowa State but the author has since accepted a new position, his current location is listed in parentheses after his name. Some of these publications are included in the Statistical Laboratory's Reprint Series (SLRS), and copies are available upon request. These are indicated by an asterisk (*).

Books

DAVID, H. A. *Order Statistics,* 2nd Edition. John Wiley & Sons (New York) 1981. 360 pages.

The subject of order statistics has grown rapidly since the publication of the first edition in 1970. This is reflected in the second edition by an increase in the number of references from 700 to 1000.

JOHNSON, Robert Alan. *Religious Assortative Marriage in the United States.* Academic Press (New York) 1980. 256 pages.

This book discusses, and applies to American religious data, parametric models of marital selection between groups—or assortative marriage—in pluralistic societies. The models assume that assortative marriage is influenced by such group factors as relative population size; geographic, socioeconomic, and cultural divisions; and conscious selection. The particular models applied to the religious data, collected from sample survey respondents in the United States, establish social structural uniformities in regional and residential patterns of religious marital selections and significant changes in assortative marriage, including unilateral declines in the occurrences of various types of religiously endogamous marriages.

A detailed review and critique are given of previous theories and models of assortative marriage and mating. This leads to a formal mathematical analysis of the properties of alternative marriage market models, which are tested using the American religious data.

Mathematical models are utilized in explaining differences in assortative marriage in terms of population composition, social structural differentiation, and preference patterns. This approach relies heavily on recent advances in log-linear analysis of contingency tables, which is here applied to the phenomenon of assortative marriage.

It is maintained that marital selection is a demographic process that both conditions and is conditioned by population composition. The proposed model of population development therefore provides for the joint dependence of population composition and assortative marriage.

MEEKER, W. Q., L. Cornwell, and L. A. Aroian. The product of two normally distributed random variables. *Volume 7* of *Selected Tables in Mathematical Statistics* edited by R. E. Odeh and **W. J. KENNEDY**, published by the American Institute of Mathematical Statistics and the Mathematical Society. 1981.

Tables for the fractiles of the distribution of the product of two normal random variables are presented. The numerical methods used to compute and check the tables are described and some of the applications of this distribution are reviewed. Interpolation in the tables is discussed and some examples are given.

Published Research

*BAILEY, T. B. Jr., C. O. Qualset, and **D. F. COX.** Predicting heterosis in wheat. *Crop Science* 20 (1980) 339-342. SLRS 498.

Quantitative gene action and heterosis effects were estimated using populations derived from matings of four wheat cultivars. The cultivars included in the study were 'Ramona 50,' 'Pitic 62,' 'INIA 66' and D6301. Diallel and triallel crosses among these cultivars, and F_2 populations were grown in replicated trials in 2 years at Davis, California. Additive and heterosis effects were the major genetic effects in this study, whereas epistasis was not an important component of genetic variability in either year. Significant mid and high-parent heterosis values were observed in certain single-crosses. One of 12 three-way crosses showed significant high-parent heterosis. Single-cross means were closely predicted by using estimates of genetic effects obtained from parent, F_2, and three-way F_1 means. Thus, heterosis in wheat can be predicted for specific hybrid combinations without field testing the F_1 hybrid. The expected sampling variances of mid and high-parent heterosis values were developed and used to illustrate the number of replicates needed in field experiments to detect heterosis.

Loesch, P. J. Jr. and **T. B. BAILEY Jr.** Field emergence comparisons of opaque-2 and sugary-2 opaque-2 segregates in two maize synthetics. *Crop Science* 20 (1980) 459-462.

The improved protein quality associated with opaque-2 (o2) maize (Zea mays L.) has not been widely used because grain yield, grain quality, and field stands generally are reduced relative to normal maize. This study was conducted to determine if the superior grain quality of sugary-2 opaque-2 (su2 o2) would be expressed also in seedling emergence percentage, rate of emergence, and seedling weight by comparing o2 and su2 o2 segregates of S_1 and S_2 ears from two maize synthetics.

Very similar emergence responses were obtained for the two endosperm classes when S_1 segregates were examined.

Under the cold field conditions encountered when S_2 segregates were examined, o2 kernels were significantly superior to su2 o2 in emergence percentage and rate of emergence.

Relationships among traits within endosperm classes were different than for the pooled endosperm classes.

Heritability estimates for the emergence traits were large and suggest that selection for improved emergence should be effective within either of the endosperm classes.

*BANCROFT, T. A. and **Chien-Pai HAN**. Inference based on conditionally specified ANOVA models incorporating preliminary testing. In *Handbook of Statistics, Volume I* edited by P. R. Krishnaiah. North-Holland Publishing Company (1980) 407-441. SLRS 510.

The use of conditionally specified models in ANOVA is given in this review paper. After some historical remarks on the development of the conditionally specified models incorporating preliminary testing, the random models and fixed models are discussed. In both cases, testing hypotheses after preliminary testing and estimation after preliminary testing are given. Finally, the conditionally specified regression models are discussed. A recommendation of the level of significance based on theoretical and computational studies is given for each case.

*BANCROFT, T. A. and **Chien-Pai HAN**. On the reduction of erroneous statistical inferences due to incorrect specification of the model under analysis.[1] *International Statistical Review* 48 (1980) 309-316. SLRS 511.

The problems of specification in statistical inference are discussed in this paper. These arise in the choice of a mathematical-statistical model. It is the objective of this study to call attention to procedures proposed to improve the usual methods of choosing an appropriate model in situations involving certain remaining uncertainties in a proposed "reasonable" model. Since the validity of statistical inferences with some exceptions for small deviations are conditional upon the appropriateness of the selected model, any improvement in the usual model selection procedure should result in a reduction of any erroneous statistical inferences due to incorrect specification of the model under analysis. Procedures involving the use of preliminary tests for reducing erroneous inferences due to uncertainties in a proposed model specification are given. Such procedures are called conditionally specified inference procedures.

[1]Presented, 28 Feb. 1980, at the Colloquium of the Mathematical Sciences Department of San Diego State University by T. A. Bancroft while serving as a Distinguished Visiting Professor for the Spring Semester of the 1979-80 academic year.

COX, C. Philip. The all-elements unity matrix: a letter to the editor. *The American Statistician* 34:2 (1980) 191-192.

It was noted that the matrix (J), of which every element is unity, is widely used in statistics so that a standard reference name for it would be convenient. The name "unitform" was suggested.

Lloyd, W. E., A. L. Jenny, **D. F. COX**, and G. E. Rottinghaus. Relationship of sulfamethazine in swine diets and resultant tissue concentrations, using Tishler and gas liquid chromatographic methods. *American Journal of Veterinary Research* 42:2 (1981) 339-343.

Sulfamethazine (110 mg/kg of feed) was fed to 4 groups of pigs for 10 days. Each group was then fed withdrawal rations containing 0, 1.1, 11.0, or 110.0 mg/kg of feed for 10 days before slaughter. A 5th group was fed a sulfamethazine-free diet only. Fat, kidney, liver, and muscle from each pig were analyzed by several laboratories, using the Tishler Bratton-Marshall (BM) and gas liquid chromatographic (GLC) methods.

*__Ebrahimi, Nader__ (University of Missouri, Columbia) and __Malay GHOSH.__ Multivariate negative dependence. *Communications in Statistics; Theory and Methods* A10:4 (1981) 307-337. SLRS 523.

Various notions of multivariate negative dependence are introduced and their interrelationship is studied. Examples are given to illustrate these concepts. Applications of the results in statistics and probability are given.

*__FULLER, Wayne A.__ Samples and surveys. *Proceedings of Symposia in Applied Mathematics* 23 (1980) 1-18. SLRS 496.

The steps in the execution of a large scale survey are discussed. Basic ideas of probability sampling are introduced and comparisons are made with purposive selection. Criteria used for the design of surveys and the construction of estimators are discussed.

__FULLER, Wayne A.__ Comment on R. M. Royall and W. G. Cumberland's "An Empirical Study of the Ratio Estimator and Estimators of Its Variance." *Journal of the American Statistical Association* 76:373 (1981) 78-80.

The sampling properties of alternative pivotals available for constructing confidence intervals using the ratio estimator are investigated. Efficiency of randomized designs in the presence of prior information is discussed.

*__FULLER, Wayne A.__ and David P Hasza. Predictors for the first-order autoregressive process. *Journal of Econometrics* 13 (1980) 139-157. SLRS 500.

The error made in predicting a first-order autoregressive process with unknown parameters is investigated. It is shown that the least squares predictor is unbiased for symmetric error distributions. Alternative predictors for stationary and non-stationary processes are studied using the Monte Carlo method. The ordinary least squares statistics perform reasonably well for one period predictions with samples as small as ten for both stationary and non-stationary processes. It is demonstrated that there is a considerable loss in efficiency when outdated estimators are used to construct predictors.

__FULLER, Wayne A.__ and David P. Hasza. Properties of predictors for autoregressive time series. *Journal of the American Statistical Association* 76:373 (1981) 155-161.

The prediction of the $(n+s)$th observation of the pth order autoregressive process is investigated. The mean square of the predictor error through terms of order n^{-1}, conditional on $Y_n, Y_{n-1}, \ldots, Y_{n-p+1}$, is obtained for the stationary normal process. The mean squared error expression is similar to the usual regression formula for the variance of the predictor error. The usual regression formula for the estimated variance of a predictor error and its generalization to s-period prediction is shown to provide a consistent estimator of the mean squared error of the least squares predictor for both stationary and non-stationary processes.

__FULLER, Wayne A.__, David P Hasza (Kansas State University), and __J. Jeffery GOEBEL.__ Estimation of the parameters of stochastic difference equations. *Annals of Statistics* 9:3 (1981) 531-543.

Let Y_t satistfy the stochastic difference equation

$$Y_t = \sum_{i=1}^{q} \psi_{ti}\alpha_i + \sum_{j=1}^{p} \gamma_j Y_{t-j} + e_t,$$

where the $\{\psi_{ti}\}$ are fixed sequences and (or) weakly stationary time series and the e_t are independent random variables, each with mean zero and variance σ^2. The form of the limiting distributions of the least squares estimators of α_i and γ_j depend upon the absolute value of the largest root of the characteristic equation,

$$m^p - \sum_{j=1}^{p} \gamma_j m^{p-j} = 0.$$

Limiting distributions of the least squares estimators are established for the situations where the largest root is less than one, equal to one, and greater than one in absolute value. In all three situations the regression t-type statistic is of order one in probability under mild assumptions. Conditions are given under which the limiting distribution of the t-type statistic is standard normal.

*Carter, R. L. and __Wayne A. FULLER__. Instrumental variable estimation of the simple errors-in-variables model. *Journal of the American Statistical Association* 75:371 (1980) 687-692. SLRS 502.,

Alternative instrumental variable estimators for the slope in the simple errors-in-variables model are discussed. The maximum likelihood estimator is derived for the model in which the error covariance is known to be zero and for the model in which the error covariance is unknown. Modified maximum likelihood estimators and randomly weighted average estimators similar to those studied by Huntsberger are discussed. The limiting distributions of the estimators are presented and the estimators are compared in a Monte Carlo study.

*__GHOSH, Malay__ and __Ahmad Parsian__ (College of Arts and Sciences, Shiraz, Iran). Admissible and minimax multiparameter estimation in exponential families. *Journal of Multivariate Analysis* 10:4 (1980) 551-564. SLRS. 513.

Consider p independent distributions each belonging to the one parameter exponential family with dis-

tribution functions absolutely continuous with respect to Lebesgue measure. For estimating the natural parameter vector with $p \geq p_o$ (p_o is typically 2 or 3), a general class of estimators dominating the minimum variance unbiased estimator (MVUE) or an estimator which is a known constant multiple of the MVUE is produced under different weighted squared error losses. Included as special cases are some results of Hudson and Berger. Also, for a subfamily of the general exponential family, a class of estimators dominating the MVUE of the mean vector or an estimator which is a known constant multiple of the MVUE is produced. The major tool is to obtain a general solution to a basic differential inequality.

GHOSH, Malay and **Ahmad Parsian** (College of Arts and Sciences, Shiraz, Iran). Bayes minimax estimation of multiple Poisson parameters. *Journal of Multivariate Analysis* 11 (1981) 280-288.

For the ρ-variate Poisson mean, under the sum of weighted squared error losses, weights being reciprocals of variances, a class of proper Bayes minimax estimates dominating the usual estimate, namely the sample mean is produced. An example is given to illustrate this. The interrelation of our results with those of Clevenson and Zidek is pointed out.

***GHOSH, Malay** and Bimal Kumar Sinha. On the robustness of least squares procedures in regression models. *Journal of Multivariate Analysis* 10:3 (1980) 332-342. SLRS 507.

The criterion robustness of the standard likelihood ratio test (LRT) under the multivariate normal regression model and also the inference robustness of the same test under the univariate setup are established for certain nonnormal distributions of errors. Restricting attention to the normal distribution of errors in the context of univariate regression models, conditions on the design matrix are established under which the usual LRT of a linear hypothesis (under homoscedasticity of errors) remains valid if the errors have an intraclass covariance structure. The conditions hold in the case of some standard designs. The relevance of C. R. Rao's (1967 in *Proceedings Fifth Berkeley Symposium on Math. Stat. and Prob.*, Vol. 1, pp. 355-372) and G. Zyskind's (1967, *Ann. Math. Statist.* 38 1092-1110) conditions in this context is discussed.

***GHOSH, Malay** and **Shashikala SUKHATME.** On Bahadur's representation of quantiles in nonregular cases. *Communications in Statistics; Theory and Methods* A10:3 (1981) 269-282. SLRS 515.

The paper considers Bahadur's representation of quantiles in cases where the usual assumptions regarding the existence and boundedness of the derivatives of the distribution function in a neighbourhood of the population quantile(s) of interest are not met. Following Kiefer we provide an exact order of the remainder term in Bahadur's representation. A weaker result regarding the order of the remainder term is also provided under weaker regularity assumptions.

*Sen, Pranab Kumar and **Malay GHOSH.** On the Pitman efficiency of sequential tests. *Calcutta Statistical Association Bulletin* 29:113-114 (1980) 65-72. SLRS 512.

The paper defines a new notion of Pitman efficiency of sequential tests and examines in the light of this notion the asymptotic relative efficiencies of some sequential rank order tests with respect to the sequential probability ratio tests and sequential likelihood ratio tests.

Arnold, Barry C and **Richard A. GROENEVELD.** Maximal deviation between sample and population means in finite populations. *Journal of the American Statistical Association* 76:374 (1981) 443-445.

Bounds are presented for the maximal deviation in finite populations between sample and population means in units of (i) the population mean deviation (ii) the population range and (iii) the population mean, extending previous results for the population standard deviation. The efficiency of sampling is illustrated by various sample size calculations. The effect of symmetry on these bounds is considered. An application is made, in the symmetric case, to the expression for the bias of the ratio estimator.

***HAN, Chien-Pai.** On estimating the variance of the sample mean in random models based on conditional specification. *Communications in Statistics; Theory and Methods* A9:14 (1980) 1417-1425. SLRS 501.

In a one-way random model, the variance of the sample mean is estimated by the between-group mean squares divided by the total number of observations. If there are no group differences, it is advantageous to pool the within-group mean squares with the between-group mean squares. When it is uncertain whether the groups are different, a preliminary test may be used. A preliminary test estimator of the variance is given and its bias and mean square error are derived. Recommendation of the level of the preliminary test is given.

***HAN, Chien-Pai** and **John L. G. Wang** (M & S Computing Inc., Huntsville, Alabama). On the computation of central and noncentral F distributions. *1980 Statistical Computing Section Proceedings of the American Statistical Association* (1980) 122-124. SLRS 519.

A computational formula for computing the cumulative distribution function of central and noncentral F distribution with (ν_1, ν_2) degrees of freedom, where ν_2 is an even integer, is given. The formula involves only finite sums of simple terms and gives exact probabilities. No complicated functions are used in the computation. When ν_2 is an odd integer, interpolation may be used to compute the cumulative distribution function.

***HARVILLE, David.** Predictions for National Football League games via linear-model methodology. *Journal of the American Statistical Association* 75:371 (1980) 516-524. SLRS 505.

Results on mixed linear models were used to develop a procedure for predicting the outcomes of National Football League games. The predictions are based on the differences in score from past games. The underlying model for each difference in score takes into account the home-field advantage and the difference in the yearly characteristic performance levels of the two teams. Each team's yearly characteristic performance levels are assumed to follow a first-order autoregressive process. The predictions for 1,320 games played between 1971 and 1977 had an average absolute error of 10.68, compared with 10.49 for bookmaker predictions.

HARVILLE, David A. Unbiased and minimum-variance unbiased estimation of estimable functions for fixed linear models with arbitrary covariance structure. *Annals of Statistics* 9:3 (1981) 633-637.

Consider a general linear model for a column vector y of data having $E(y) = X\alpha$ and $var(y) = \sigma^2 H$, where α is a vector of unknown parameters and X and H are given matrices that are possibly deficient in rank. Let $b = Ty$, where T is any matrix of maximum rank such that $TH = \phi$. The estimation of a linear function of α by functions of the form $c + a'y$, where c and a are permitted to depend on b, is investigated. Allowing c and a to depend on b expands the class of unbiased estimators in a nontrivial way; however, it does not add to the class of linear functions of α that are estimable. Any minimum-variance unbiased estimator is identically [for y in the column space of (X, H)] equal to the estimator that has minimum variance among strictly linear unbiased estimators.

Platt, K. B., C. J. Maré, and **P. N. HINZ**. Differentiation of vaccine strains and field isolates of pseudorabies (Aujeszky's Disease) virus: trypsin sensitivity and mouse virulence markers. *Archives of Virology* 63 (1980) 107-114.

Five cloned virulent North American field isolates and 2 European vaccine strains of pseudorabies (PR) viruses were compared by their sensitivity to trypsin and their virulence for mice. Marked differences in trypsin sensitivity were detected between and among virulent and vaccine PR viruses. Mouse virulence was evaluated by comparing the mean times-to-death of mice infected with individual viruses. Three distinct levels of virulence were observed.

***KEMPTHORNE, Oscar.** Some statistical aspects of weather modification studies. In: Wegman, Edward J. and Douglas J. DePriest (Eds.) *Statistical Analysis of Weather Modification Experiments*, Marcel Dekker (1980) 89-107. SLRS 508.

After introduction and initial discussion of the general problem, it is argued that there has been partial failure by the cloud physicists and by the statisticians to bring to bear essential ideas. General ideas for fertile comparative experiments are discussed, in particular, the concept of experimental unit and its use, delivery of the stimulus and measurement of yield. The role of randomization with respect to judging whether there are treatment effects is discussed. Comments are given on the role of multivariate data analysis, data searching and crossover designs. The essay closes with comments on the Florida State statistical effort, and on the presentations that were given at the conference.

***KEMPTHORNE, Oscar.** Foundations of statistical thinking and reasoning. *CSIRO Division of Mathematics and Statistics Newsletter* I. 68 (1980) 1-5. II. 69 (1980) 3-7. SLRS 509.

Journal Paper No. J-9433; Iowa Agriculture and Home Economics Experiment Station, Project 890.

The growth of the teaching and uses of statistics in the past three decades has been huge and has been in response to societal needs. What is the nature of statistical thinking and reasoning? What are the foundations? These questions are discussed. The view is taken that so-called foundations do not start at the beginning but from a knowledge of a probability structure that one never has. Model search and validation by some goodness of fit questioning are therefore at the foundations. The view is taken that significance tests are evidential and not in a tight sense inferential. Attempts by some to fix the deficiencies of Neyman-Pearson-Wald theory with regard to evidentiating are discussed and are declared to be failures. The problem of forming rational beliefs is declared to be critical and must be faced. The problem of decision making, ignored, for example, by Fisher, is said to be important, and it is suggested that the only possible approach is by some Bayesian process. But the Bayesians are indicted because a prior has to be obtained by data analysis. So, even with this view, data analysis is the foundation with, of course, data collection.

***KEMPTHORNE, Oscar.** The design matrix. *The American Statistician* 34:4 (1980) 249. SLRS 518.

The view is expressed and supported that the term "design matrix" should not be used for X in the linear model, $y = X\beta + \ell$.

KEMPTHORNE, Oscar. Comment on: Randomization analysis of experimental data: the Fisher randomization test, by D. Basu. *Journal of the American Statistical Association* 75:371 (1980) 584-587.

KOEHLER, Kenneth J. and Kinley Larntz. An empirical investigation of goodness-of-fit statistics for sparse multinomials. *Journal of the American Statistical Association* 75:370 (1980) 336-344.

This paper examines conditions for which goodness-of-fit tests for large, sparse contingency tables have null distributions which are approximately normal. Monte Carlo techniques are used to assess the applicability of the normal approximations for tables with small sample sizes and moderate numbers of cells.

***MEEDEN, Glen.** Betting against a Bayesian bookie. *Journal of the American Statistical Association* 76:373 (1981) 202-204. SLRS 517.

For a simple game, the optimal strategy for a Bayesian bettor playing against a Bayesian bookie is found. A necessary and sufficient condition for the bettor's expected winnings to be positive is given.

MEEKER, William Q. Jr. and **Steven D. Duke** (Weyerhaeuser Company, Hot Springs, Arkansas). CENSOR—a user-oriented computer program for life data analysis. *The American Statistician* 35:2 (1981) 112.

This note briefly describes a new computer program for the analysis of censored and group censored life data. The program uses the method of maximum likelihood to fit single distributions as well as linear regression models with assumed distributions such as Weibull, normal, and lognormal. Probability (hazard) plotting and cross plotting (y versus x) features are also available.

In order to make the program both versatile and easy to use, a simple command structure allows the user to selectively request analyses and program options. Additional features include data manipulation and transformation, case selection, random number generation, looping, and free field input of data.

MEEKER, William Q. Jr. and Gerald J. Hahn. Prediction intervals for the ratios of normal distribution sample variances and exponential distribution sample means. *Technometrics* 22:3 (1980) 357-366.

Methods are given for constructing, from past sample data, prediction intervals (i) to contain the ratio of the variances of future samples from two normal distributions and (ii) to contain the ratio of the means from future samples from two exponential distributions. Such intervals are required, for example, when a producer wishes to predict the results of a future test, to be conducted by a consumer or regulatory agency, to compare its product with a competitor's. A new tabulation of percentage points of the distribution of two independent F ratios to obtain such intervals is provided; this extends existing tabulations.

***POLLAK, Edward.** Effective population numbers and mean times to extinction in dioecious populations with overlapping generations. *Mathematical Biosciences* 52 (1980) 1-25. SLRS 503.

Journal Paper No. J-9685 of the Iowa Agriculture and Home Economics Experiment Station, Project 1669; partial support from National Institutes of Health Grant GM 13827.

We consider a finite dioecious random mating population that is observed at times 0,1.... Let there be age groups $0,1,...,K_1$ among males and age groups $0,1,...,K_2$ among females, so that the population consists of K_1+K_2+2 parts, called age-sex classes. It is assumed that the numbers of individuals in the various age-sex classes do not change with time and that there is no mutation, selection, or migration. One locus, with an allele A_1 that is initially rare, is studied. A general result obtained by Pollak (1979) is then used to obtain expressions for the effective population number, whether the locus under consideration is autosomal or sex-linked. Another result in the same paper is used to derive expressions for the mean time to extinction of a line of individuals with A_1, which are descended from a single ancestor in age-sex class (ai), where $i=1,2$ and $a=1,...,K_i$.

RAO, T. J. On a class of almost unbiased ratio estimators. *Annals of the Institute of Statistical Mathematics, Tokyo,* 1981 A, 29-35.

Murthy and Nanjamma studied the problem of construction of almost unbiased ratio estimators for any sampling design using the technique of interpenetrating subsamples. Subsequently, Rao has given a general method of constructing unbiased ratio estimators by considering linear combinations of the two simple estimators based on the ratio of means and the mean of ratios. However, it is difficult to choose an optimum weight which minimizes the variance of the combined estimator since the weights are random in certain cases. In this note, we consider a different method of combining these estimators and obtain a general class of almost unbiased ratio estimators of which Murthy and Nanjamma's is a particular case and derive an optimum in this class. The case of simple random sampling where a similar class of almost unbiased ratio estimators can be developed is briefly discussed. The results are illustrated by means of simple numerical examples.

***Skarpness, B.** and **V. A. SPOSITO.** Technical note: a modified Fritz John optimality criterion. *Journal of Optimization Theory and Applications* 31:1 (1980) 113-115. SLRS 514.

A modified Fritz John optimality criterion is presented for a certain class of nonlinear programming problems.

SPOSITO, V. A. Quadratic programming. In Volume 12, Pattern recognition to reliability of computer systems, of *Encyclopedia of Computer Science* edited by Jack Belzer, Albert G. Holzman, and Allen Kent. Marcel Dekker, Inc., (1979) 393-415.

Quadratic programming problems occur frequently in our scientific community.

This paper presents the classical underlining theory of quadratic programming as originally considered by Kuhn and Tucker. In this vein quadratic duality theory is explored via the Saddle-Valued problem.

Computational algorithms to solve this class of problems are presented.

***SPOSITO, V. A.** and M. L. Hand. Optimal L_p estimators for symmetric distributions. *1980 Statistical Computing Section Proceedings of the American Statistical Association* (1980) 311-313. SLRS 520.

This paper examines the efficiency of L_p estimates as an estimate of central tendency for symmetric distributions. Moreover, a rule is established for determining an optimal value of p based on the kurtosis of the error distribution.

*SPOSITO, V. A., W. J. KENNEDY, and J. E. Gentle. Useful generalized properties of L_1 estimators. *Communications in Statistics; Theory and Methods* A9:12 (1980) 1309-1315. SLRS 495.

Recent results by G. Appa and C. Smith, as well as I. Barrodale and F. D. K. Roberts, underscore several properties exhibited for fitting a linear model to a set of observation points under the criterion of least sum of absolute deviations (commonly denoted as the L_1 criterion). This paper will generalize these properties to the non-full rank case and relax in a natural way some assumptions given by Appa and Smith.

Klemm, R. J. and **V. A. SPOSITO.** Least squares solutions over interval restrictions. *Journal of Communications in Statistics; Simulation and Computation* B9:4 (1980) 423-425.

This note derives closed form solutions for least squares problems over interval restrictions. These forms are applicable to least squares problems with bounds imposed on the regression coefficients.

Saygideger, Orhan, Earl O. Heady, Gary F. Vocke and **Vincent A. SPOSITO.** An analysis of trade-offs in food production costs and soil conservation by an interregional programming and multigoal model. *Journal of Water, Air, and Soil Pollution* 14 (1980) 69-80.

This analysis measures trade-offs between soil loss and food production costs. It is made by means of multigoal interregional programming model. The trade-off curve is derived by means of the prior weighing technique. The results indicate that soil loss from agricultural land can be decreased considerably with very little increase in costs and decrease in efficiency in food production. However, the trade-off curve has a 'corner' in it, and further reductions in soil loss give rise to sharp increases in food production costs. As higher costs are assigned soil loss, important shifts take place in the interregional patterns of crop production and land use. Also, further decreases in soil loss and increases in food production costs raise food prices for consumers.

STRAHAN, Robert F. More on averaging judges' ratings: determining the most reliable composite. *Journal of Consulting and Clinical Psychology* 48:5 (1980) 587-589.

This note adds to comments by Horowitz, Inouye, and Siegelman in a previous issue of this journal that stressed the generally superior reliability and validity of pooled subjective ratings. It calls attention to different methods for selecting the most reliable subset of judgments and illustrates one particularly simple technique.

STRAHAN, Robert F. Self-exposure in the classroom: a case study in tutorial method. *Teaching of Psychology* (1981) 112-113.

A technique is described for enlivening discussion in advanced psychometrics courses.

STRAHAN, Robert F. Time urgency, Type A behavior, and effect strength. *Journal of Consulting and Clinical Psychology* 49:1 (1981) 134.

Expressions of effect strength should be reported in, or readily derivable from, descriptions of psychological research. This contention is presented in the context of Gastorf's recent demonstration of a relation between measures of time urgency and Type A (coronary-prone) behavior.

*STRAHAN, Robert F. and Paul G. McGovern. What's in a number? Verbal equivalents of numerical p-values. *1979 Statistical Education Section Proceedings of the American Statistical Association* 91-94. SLRS 485.

To our knowledge, there has been no systematic investigation of the relation between numerical p-values and verbal expressions of belief/disbelief generally held by workers in statistics. This survey is a modest empirical effort toward bridging these two cultures of precise, but dumb, numbers and meaningful, but vague, words.

Grimes, J. E. and **B. V. SUKHATME**. A regression-type estimator based on preliminary test of significance. *Journal of the American Statistical Association* 75:372 (1980) 957-962.

If data on an auxiliary variable X correlated with the variable Y under study are available, regression-type estimators are often used to estimate the population mean μ_y. An estimator based on a preliminary test of significance that chooses between the difference estimator and the regression estimator has been proposed. This article investigates the efficiency of the proposed regression-type estimator with respect to other regression-type estimators.

Singh, Umed and **B. V. SUKHATME**. Planning of fruit surveys—I. *Sankhyā C: The Indian Journal of Statistics* 41:1 (1979) 44-59.

In this paper some important problems connected with the planning of surveys are studied. Problems studied are (i) choice of sampling design, (ii) probability scheme of sampling, (iii) relative efficiencies of the two sub-sampling design and (iv) determination of optimum sample sizes. These problems are examined with reference to the data collected in a sample survey on lime crop.

SUKHATME, Shashikala. Bahadur efficiencies of Cramér Smirnov-Von Mises tests. *Journal of the Indian Statistical Association* 17 (1979) 161-171.

Let $X_1,..., X_n$ be n independent identically distributed random variables with a continuous distribution function G(x) and $F_n(x)$ be the empirical distribution function of the sample. A test based upon the statistic

$$\omega_n^2 = n\int_{-\infty}^{\infty}(F_n(x) - F(x))^2 dF(x),$$

proposed by Cramér et al. is well known, for testing the hypothesis H_0:G(x) = F(x). In case F(x) is not completely

known but $F(x) = F(x, \theta)$ θ unknown, it is natural to consider a statistic C_n^2, which is a modification of ω_n^2, obtained by replacing $F(x, \theta)$ by $F(x, \hat{\theta})$ in ω_n^2, $\hat{\theta}$ denoting the estimate of θ obtained from the sample. This note compares ω_n^2-test and C_n^2-test with other tests, using Bahadur's approximate measure of efficiency.

*__WEISSMAN, Ishay.__ Estimation of tail parameters under Type I censoring. *Communications in Statistics; Theory and Methods* A9:11 (1980) 1165-1175. SLRS 494

This paper is a continuation of previous work concerning the estimation of tail-parameters under Type II censoring (Weissman 1978). The same estimation problem is considered here, this time under Type I censoring. A sample of size n is censored below at a given level x_0. It is assumed that the underlying distribution function (df) F belongs to the domain of attraction of a known extreme-value distribution and that $K = K(x_0)$, the number of observed values, remains finite as $n \to \infty$. We offer here estimators, which are asymptotically maximum likelihood estimators (MLE's), for quantiles associated with the tail of F such as location and scale parameters, quantiles and F(x) itself (for x in the tail). The results are applied to two illustrative examples.

*__WEISSMAN, Ishay.__ Confidence intervals for the threshold parameter. *Communications in Statistics; Theory and Methods* A10:6 (1981) 549-557. SLRS 521.

Confidence intervals for the threshold parameter (guarantee-life) are considered. The first k failure-times from a sample of size n are observed. Under the assumption that as $n \to \infty$ the first failure-time is attracted to the Weibull distribution, confidence intervals based on the observed range are constructed. It is shown that as $k(k \geq 2)$ increases the expected length of the confidence interval is substantially reduced. However, when $k = 10$ (or 20 in some cases) the expected length is near its minimum value.

*__WOLINS, Leroy__. Our teaching mistakes lead to mistakes in research. *1980 Section on Survey Research Methods Proceedings of the American Statistical Association* 386-387. SLRS 522.

An attempt is made to relate mistakes in data analyses occurring in current psychological literature to inadequate discussion of statistical methods in textbooks. For example, Wilcoxson's least-signed rank test is usually inappropriate for social science data for the same reason that the t-test is inappropriate and Wilcoxson's rank sum test is admissable even for paired observations.

Motoyama, Tetsuro and **Leroy WOLINS**. On an indicator of good prediction. *Educational and Psychological Measurement* 40 (1980) 939-942.

A high correlation between predicted and criterion values in cross-validation may not always be a sufficient indicator of goodness of prediction. An alternative indicator of goodness of prediction is reviewed in terms of what kind of prediction is sought.

Winakor, Geitel, Bernetta Canton, and **Leroy WOLINS**. Perceived fashion risk and self-esteem of males and females. *Home Economics Research Journal* 9:1 (1980) 45-56.

An instrument was developed to examine a person's perception of fashion risk in clothing, relative to his or her self-esteem. Fashion risk is the uncertainty a consumer perceives when making a choice involving a fashion good, in addition to the uncertainty perceived when a good is not subject to fashion. Items were written or adapted to represent self-esteem, self-esteem related to clothing, perceived fashion risk, and economic, social, psychological, and performance risks related to clothing. Approximately 400 university students, half males and half females, responded to the instrument. Response patterns of males and females differed; therefore data were factor analyzed separately for each sex.

Book Reviews

BUBOLZ, Thomas A. A comparative review of statistical software: exhibition of statistical program packages, by Ivor Francis, editor. Reviewed in *Journal of the American Statistical Association* 75:372 (1980) 1041.

COX, C. Philip. Bioassay, by J. J. Hubert. Reviewed in *Journal of the American Statistical Association* 75:372 (1980) 1040.

FAHRENHOLTZ, Steven. An introduction to applied probability, by Ian F. Blake. Reviewed in *Journal of the American Statistical Association* 76:373 (1981) 209-210.

KEMPTHORNE, Oscar. Theory of population genetics and evolutionary ecology: an introduction, by J. Roughgarden. Reviewed in *Nature* 288 (1980) 628.

KEMPTHORNE, Oscar and **Leroy WOLINS**. Précis of bias in mental testing, by Arthur R. Jensen. Reviewed in *The Behavioral and Brain Sciences* 3 (1980) 348-349.

SHELLEY, Mack. Applied research for social policy: the United States and the Federal Republic of Germany compared, by Kenneth J. Arrow, Clark C. Abt, and Stephen J. Fitzsimmons in *Journal of the American Statistical Association* 75:371 (1980) 760.

SHELLEY, Mack. Demystifying social statistics, by John Irvine, Ian Miles, and Jeff Evans, editors. Reviewed in *Journal of the American Statistical Association* 75:371 (1980) 748-750.

WOLINS, Leroy. Statistical methods in education and psychology, by Albert K. Kurtz and Samuel T. Mayo. Reviewed in *Journal of the American Statistical Association* 75:371 (1980) 760.

Dissertation Abstracts

da Silva, Antonio Guilherme. Pooling means for normal populations. Ph.D. thesis, Iowa State University Library, November, 1980.

In estimating the mean vector of k independent populations, the experimenter may suspect that the k means are equal. The uncertainty may be resolved by using a preliminary test of the equality of means. Using an inference procedure based on conditional specification, we define an estimator of the mean vector which is made to depend on the outcome of an F-test based on analysis of variance table. The estimator is equal to the conventional estimator if the hypothesis is rejected; otherwise the sample means are pooled to estimate the common mean. The bias and the mean square error of the preliminary test estimator are obtained. The relative efficiency of the preliminary test estimator to the conventional estimator is derived and discussed. Recommendation of the significance level of the preliminary test is given. The estimator is extended to the case that the population is multivariate normal. Further a "two-stage sometimes-pool estimator" is given when it is suspected that m(<k) out of the k means are equal.

Dehghan-Nayeri, Majid. Johnson-type algorithms for m-machine flow shops. Ph.D. thesis, Iowa State University Library, February, 1981.

The concept of a flow shop scheduling algorithm is introduced, with particular attention paid to algorithms for obtaining permutation schedules that are based on the orderings of pairs of jobs. Such orderings are called "pairwise J-orderings," in recognition of the prototype of such orderings proposed by Johnson. Motivated by Johnson's work, the two abstract properties of "transitivity" and "job-adjunction-robustness" are identified as sufficient for a pairwise J-ordering to lead to an optimum permutation schedule. In recognition of the fact that transitivity often will not be realized in practice, a partial optimality result is discussed, to cover situations when pairwise J-orderings fail to be transitive.

A certain pairwise J-ordering for 3-machines is introduced. This ordering is optimal in a certain strict sense in the case of the ordering of two jobs. In addition, it coincides with the standard 3-machine adaptation of Johnson's ordering when the latter applies and provides optimal ordering in certain additional cases.

The work also extends the above 3-machine adaptation of Johnson's ordering to the general case of m-machines.

Drew, James Howard. Nonresponse in surveys with callbacks. Ph.D. thesis, Iowa State University Library, February, 1981.

A class of models is considered for the response-nonresponse of individuals who are given repeated opportunities to respond to a survey questionnaire. From an error-free list of sampling units, a probability sample of units is selected to estimate the univariate population mean $\bar{Y}$. Associated with each unit is a response probability q_k, where $0<q_k\leq 1$. The sampled units which do not initially respond to the survey are recontacted on a second call. On the r^{th} call, $r=1,2,\ldots,R$, those units are recontacted which have not furnished a response by the $(r-1)^{th}$ call.

Assuming the population is partitioned into K categories, models are developed from the described survey situation whose parameters include f_k and q_k $(k=1,2,\ldots,K)$, where f_k is the population proportion of units in the k^{th} category, and q_k is the response probability of a unit in the k^{th} category. It is assumed that the units in a part of the population will never respond to any call of the survey. Various allocations of units in this part of the population to the K categories are discussed and appropriate models are described. Explicit expressions for the maximum likelihood estimates of the parameters in these models are given.

For the estimation of $\bar{Y}$, we use the estimator

$$\hat{\bar{Y}}=\sum_{k=1}^{K}\hat{f}_k\bar{y}_k,$$

where $\hat{f}_k$ is the maximum likelihood estimate of f_k and $\bar{y}_k$ is the sample mean of Y for units in the k^{th} category over all calls. This estimator is consistent for fixed K, and also consistent for sequences of samples in which K is allowed to increase to infinity. The asymptotic variance of the estimator of $\bar{Y}$ and a consistent estimate of the asymptotic variance are given for fixed K.

The model is extended to the sample designs of stratified random sampling, and two stage sampling with simple random sampling at the second stage. Estimators of the number of units in the k^{th} category, $k=1,2,\ldots,K$, for the population are produced for these designs. Consistent estimators of the covariance matrix are given. Estimators of the population total of Y are constructed and variances and consistent estimators of the variances are given.

An example is given to illustrate the major features of the method.

Lamyordmakpol, Anuchit. Aspects of symmetric Bayesian sequential decision problems. Ph.D. thesis, Iowa State University Library, November, 1980.

This thesis concerns Bayesian sequential decision problems with a finite number of states of nature, a finite number of actions, and one or two sources of information. The results involve the concepts of problem symmetry, effective N-truncation, effective non-truncation and source expendability.

Several conditions are given for certain one-source problems to be effectively non-truncated. More specific conditions are given for certain one-source binomial problems to be effectively 1-truncated.

The main result for two-source problems is motivated by the concept of uniform inequality of risk functions for Bayesian decision problems. For the binomial case with equal sampling costs, it is shown that a standard fixed-sample-size uniform risk inequality also applies in the sequential case. It is shown as well, by example, that a source expendable in the short run need not be expendable in the long run.

Problem symmetry, of use in some of the above

analysis, is discussed in its own right in the last chapter.

Londhe, Anil Ramchandra. Nonparametric density estimation using kernels with variable size windows. Ph.D. thesis, Iowa State University Library, November, 1980.

Nonparametric kernel density estimators can be classified into two broad categories, the ones utilizing fixed windows as opposed to the ones using variable size windows. The optimal choice of the window in the fixed window estimators depends upon the unknown density. However, satisfactory methods of obtaining a suitable value for the window in the absence of such knowledge are not available.

Variable window estimators use the nearest neighbor technique by taking the window proportional to the distance to a certain nearest neighbor, which depends upon the sample size. Methods for determining the constant of proportionality and the number of neighbors considered are time consuming and do not yield satisfactory results.

Two estimators, which use all the neighbors up to a certain neighbor in determining the windows are presented and their theoretical properties established. The performance of the estimators, as compared to the fixed window kernel estimator using optimal window, is studied with respect to mean squared error and the integrated mean squared error in a Monte Carlo study using various distributions.

Macpherson, Brian Douglas. Properties of estimators for the parameter of the first order moving process. Ph.D. thesis, Iowa State University Library, February 1981.

The first order moving average time series Y_t is defined by

$$Y_t = e_t + \beta e_{t-1},\ t = 1,2,...,$$

where e_t are independent identically distributed random variables, and β is a constant. For normally distributed e_t, maximizing the likelihood function with respect to β is approximately equivalent to minimizing the sum of squares function. A technique that can be used to achieve this minimization is the modified Gauss-Newton nonlinear least squares procedure. Details for the Gauss-Newton procedure are presented and difference equations for the derivatives used in the computations are developed. Alternative initial estimators of β and of e_0 are discussed.

The approximate bias of the least squares estimator of β is obtained. For the model $Y_t = e_t + \beta e_{t-1}$ with $|\beta|<1$, the bias is $n^{-1}\ \beta + O(n^{-2})$, and for the model $Y_t = \mu + e_t + \beta e_{t-1}$ with $|\beta|<1$, the bias is $n^{-1}\ (2\beta - 1) + O(n^{-2})$.

Most estimation procedures for the parameter of the model restrict the parameter space to the open interval $-1<\beta<1$. The nonlinear least squares estimator can be defined for the parameter space $-1\leq\beta\leq1$ and it is shown to be consistent for $\beta = \pm 1$.

The results of a Monte Carlo study of estimators of β are reported. The empirical mean, variance and mean square error of the estimates are tabulated for 1,000 realizations at various parameter value and sample size combinations. Several t-statistics are considered and tests of goodness of fit performed. It is found that the nonlinear least squares estimator is substantially more efficient than the other estimators considered, particularly for large $|\beta|$. The empirical bias is in good agreement with the theoretical bias, particularly for large sample sizes and small values of $|\beta|$. The empirical variance is found to exceed the large sample variance for all sample size and parameter combinations. The t-statistics approximate Student's-t distribution only for large sample sizes. The distribution is closer to that of Student's-t for β close to zero.

Midha, Chand Krishan. Contributions to survey sampling and design of experiments. Ph.D. thesis, Iowa State University Library, November, 1980.

This dissertation consists of two parts: Part A deals with contributions to survey sampling and Part B with contributions to the design of experiments.

Part A deals mainly with the theory of sampling with unequal probabilities. Several estimators for the variance of the Horvitz-Thompson estimator of the population total are available in the literature. The stability of the several estimators is compared numerically, by means of analytic expressions for the variances of these estimators. Also, the stability is compared using as a criterion the mean square error of each estimator based on all possible samples of size n. An empirical study is made of the distribution of standardized (Studentized) estimates and average widths of confidence intervals obtained using different estimators of the variance of the Horvitz-Thompson estimator. The sampling procedure of Sampford has been used to draw the samples. The exact expressions for inclusion probabilities given by Sampford are very cumbersome. Therefore, reliable approximations for the inclusion probabilities for Sampford's procedure are obtained under the assumption of Hartley and Rao, viz. n is small relative to N and p_i is of $0(N^{-1})$. To have some idea about the accuracy of the approximate expressions for inclusion probabilities, the approximate and exact probabilities are compared using a natural population.

Part B deals mainly with the construction of Partially Balanced Incomplete Block (PBIB) designs. Some combinatorial matrices, viz. Generalized Balanced Matrices (GBM) and Strongly Balanced Matrices (SBM) are used to obtain two-associate and higher associate PBIB designs. Several methods of construction of GBM's are given. Among the two-associate PBIB designs, the most extensively studied in the literature are the group-divisible designs. A large number of group-divisible designs have cyclic solution. However, many other designs have solutions which are not in cyclic form. Some methods for obtaining cyclic solutions of certain of these group-divisible designs are explored. It is found that there are some regular group-divisible designs for which a cyclic solution is not possible.

Mowrey, Daniel Herbert. The effect of inequality of variance and autocorrelated errors on tests of non-

additivity. Ph.D. thesis, Iowa State University Library, August, 1980.

Tests for detecting non-additivity have been developed under the usual assumptions of homogeneous and uncorrelated errors. This thesis investigates how departures from these assumptions affects the level of significance of several tests. These include Tukey's test and the tests for concurrence, non-concurrence, and slopes proposed by Mandel. Departures from the usual assumptions can have a substantial affect on the level of significance. It is not possible to characterize these tests as conservative or liberal because the difference between the desired and achieved level of significance can be in either direction. In general, departures from the usual assumptions affects the tests for slopes and non-concurrence much more than the test for concurrence. Tukey's test performs well, but overall is affected more than the test of concurrence.

Nagaraja, Haikady Navada. Contributions to the theory of the selection differential and to order statistics. Ph.D. thesis, Iowa State University Library, November, 1980.

Let $X_{1:n} \leq X_{2:n} \leq \ldots \leq X_{n:n}$ be the order statistics of a random sample $X_1, X_2, \ldots, X_n$ from a distribution with mean μ and variance σ^2. The various distributional aspects of

$$D_{k,n} = \frac{1}{k} \sum_{i=n-k+1}^{n} \left(\frac{X_{i:n} - \mu}{\sigma} \right),$$

the selection differential, are studied here. Finite-sample theory for $D_{k,n}$ is developed and various bounds for $ED_{k,n}$ are obtained assuming that the distribution is continuous. Asymptotic results for $D_{k,n}$ are obtained in the extreme case (k fixed, $n \to \infty$) and in the quantile case ($k = [np]$, $0 < p < 1$). Nondegenerate limit laws for $D_{k,n}$ are established in both these cases. These results are extended to the case where μ and σ^2 are estimated from the sample and also to the case where the X_i's are not identically distributed. Some degenerate limit laws for $D_{k,n}$ are proved. The asymptotic theory is then applied to construct approximate percentage points for $D_{k,n}$ when the parent population is normal. These are useful in testing for outliers.

Now suppose (X_i, Y_i), $i = 1$ to n, is a random sample of size n from a continuous bivariate population. Let $Y_{[i:n]}$ be the concomitant of $X_{i:n}$ and define the induced selection differential $D_{[k,n]}$ to be

$\frac{1}{k} \sum_{i=n-k+1}^{n} (Y_{[i:n]} - \mu_Y)/\sigma_Y$, where μ_Y and σ_Y^2 are the mean and variance of the Y-population. Both finite-sample and asymptotic theory are developed for $D_{[k,n]}$. Non-degenerate limit distributions of $D_{[k,n]}$ are obtained in both the extreme and quantile cases. The asymptotic joint distribution of $D_{[k,n]}$ and $D_{k,n}$ is derived for the quantile case. Asymptotic properties of $D_{[k,n]}$ in the simple linear regression model are examined.

The asymptotic distribution of extreme order statistics is identified as the distribution of lower record values from the three extreme value distributions and is used to give new proofs of some known asymptotic results. The asymptotic joint distribution of two linear functions of order statistics is derived and its applications are discussed.

Richards, Winston A. The randomization analysis of covariance and change-over designs. Ph.D. thesis, Iowa State University Library, November, 1980.

The analyses of covariance and multiple covariance situations (ANOCOVA) in the completely randomized design (CRD), the balanced change-over design (COD) and the extra-period change-over design in the absence and presence of first order residual treatment effects, are examined under randomization theory with additivity of unit and treatment effects.

For ANOCOVA in the CRD, the "finite" model with $N = rt$ experimental units, arranged into t treatment groups of replicate units is considered. The means, variance and covariances, under randomization, of the "residual" sums of squares and sums of products are derived. Taylor-MacLaurin expansions to larger order of probability $O_p(N^{-2})$, and approximations to the means and variance to larger order of magnitude $O(N^{-2})$, are derived under randomization, for various Gauss-Markov normal (GMN) statistics, including the estimators of the linear regression parameters, the adjusted estimators of treatment differences and the adjusted treatment sum of squares.

Results under GMN theory and under randomization theory are compared. "Biasedness" in the analysis of variance under randomization theory is noted.

Department of Statistics

Coursework in the Department of Statistics can culminate in a B.S., M.S., or Ph.D. degree in statistics through the College of Sciences and Humanities. A specialized biometry program of study leads to a B.S. degree conferred by the College of Agriculture.

Undergraduate statistics majors are prepared through a combination of theory and application courses for employment in industry or government or to pursue graduate studies.

Graduate students may specialize in experimental design, general methods, general theory, probability, statistical computing, survey sampling, or one of several areas of application. Operations research is offered cooperatively with the Department of Industrial Engineering.

A student may receive a graduate or undergraduate degree jointly with another department. An M.S. candidate may choose a thesis or nonthesis option. The latter requires six additional credits including a "creative component" of at least three credits of individual work.

Graduate student enrollments in the fall stood at 88, a slight, probably temporary drop. Undergraduate enrollments continue steady, spring figures being 44 in Statistics and 7 in Biometry.

Iowa State University is moving to the Semester System beginning in the fall of 1981. Through four committees almost the entire Statistics faculty was involved in restructuring the department's course offerings. The results can be seen in the 1981-83 ISU General Catalog.

Dean Isaacson and Krishna Athreya taught a course on martingales (submartingales, super martingales) under the course number Stat 648. The first half of the course was restricted to *discrete time* martingales. Topics covered included: stopping times, the Optional Sampling Theorem, Doob's Decomposition Theorem, the Upcrossing Lemma, the Martingale Convergence Theorem and a martingale version of the Central Limit Theorem. The second half of the course considered *continuous time* martingales. Problems raised by this generalization such as separability, natural processes, and right continuous families of σ-fields were studied in detail. In this generalized setting the Option Sampling Theorem, the Upcrossing Lemma and the Doob-Meyer Decomposition were proved. The Optional Sampling Theorem was used to study properties of Markov processes.

1980-1981 Course Offerings in Statistics

Courses for Undergraduate Students Only

100	Orientation in Statistics	R	F	Stephenson
101	Principles in Statistics	5	F,W,S	Auer, Christenson, Josvanger, Martin, Rangachari, Stangl, Stephenson
104	Introduction to Statistics	5	W,S,SSI	Cassell, C. P. Cox, Hotchkiss, Jobe, Martin, Pareja, Peixoto, Stephenson, Sukhatme
105	Introduction to Statistics	3	F,S	Cassell, Pareja, Peixoto, Ramos, Sukhatme
127	Elementary Business Statistics	5	F,W,S	Jobe, Kinyon, Martin, Meeker, Pareja, Stangl, Sukhatme
301X	Statistical Methods with Applications	5	F	Hotchkiss
305	Engineering Statistics	3	S	O'Donovan
327	Elementary Business Statistics	4	F,W,S, SSI	Auer, Guerrero, Jobe, Keller, Kinyon, Meeker, O'Donovan, Rees, Tveite
331	Probability for Engineers	3	F	Meeden, Van Nostrand
332	Statistical Inference for Engineering Data	3	W	Meeden, Van Nostrand
341	Introduction to Theory of Probability and Statistics	3	F,W	Ghosh, Groeneveld, Stephenson, Sukhatme
342	Introduction to Theory of Probability and Statistics	3	W,S	Groeneveld, Sukhatme
343	Introduction to Theory of Probability and Statistics	3	S	Groeneveld
380	Statistical Applications of Digital Computers	3	F,S	Marasinghe

Courses for Graduate Minors and Undergraduates

401	Statistical Methods for Research Workers	4	F,W,SSI	Bailey, C. P. Cox, D. F. Cox, Groeneveld, Hickman, Hotchkiss, Johnson, Koehler, Lorenz, Shelley, Strahan
402	Statistical Methods for Research Workers	4	SSII,W,S	Bailey, Blough, C. P. Cox, D. F. Cox, Groeneveld, Hickman, Hotchkiss, Johnson, Koehler, Shelley, Strahan

Graduate Students

Ten Ph.D. degrees and seventeen M.S. degrees were earned by students in the Department this fiscal year. Abstracts of the Ph.D. dissertations appear in the publications section. All seventeen M.S. degrees were conferred on a nonthesis basis this time. If educational or employment plans are known, a brief account is given for each student.

M.S. Recipients

David Blough (Summer, 1980, under Glen Meeden) is working toward a Ph.D. in the Department. He is interested in general theory.

Peter Christenson (Fall, 1980, under David Harville) is working toward a Ph.D. in the Department. His areas of specialization are general theory and the design of experiments.

James O. Fakiya (Summer, 1980, under Glen Meeden) has returned to Nigeria where he has a position as an assistant lecturer in the Department of Statistics at the University of Nigeria, Nsukka.

Carlos Herrera-Hoyos (Spring, 1981, under Kenneth Koehler) is a statistical data analyst for Dr. Hideyo Niguchi's Research Institute in Yucatan, Mexico.

Sheue-Wen Hsu (Summer, 1980, under Glen Meeden) is working toward an M.S. in Computer Science at Southern Illinois University, Carbondale.

Greg Kruger (Spring, 1981, under Paul N. Hinz) is a statistical engineer in the Instrument Division of Hewlett Packard, Loveland, Colorado. He helps with the design of experiments in addition to interpreting data on hardware and software products.

Josephine Weng Lin (Winter, 1981, under William J. Kennedy) is an associate research engineer in the Research Lab of United States Steel in Monroeville, Pennsylvania. Her job duties include consulting and data analysis computing.

Bader Eldeen Mohmad (Spring, 1981, under Kenneth Koehler) is a research statistician in the Agricultural-Economics Division of the Government of Sudan.

Mark Rees (Spring, 1981, under William Q. Meeker) is a statistician for Rockwell International, Richland, Washington. He has been assigned to the Hanford Project and will interact with chemists and engineers on experiments.

Richard J. Rossi (Summer, 1980, under Glen Meeden) is an instructor in mathematics at the University of Wisconsin, Stout, Menomonie.

Joanne Roy (Spring, 1981, under Kenneth Koehler) is studying toward a Ph.D. in Biometry at the University of Minnesota.

Abebayehu Tegene (Fall, 1980, under Kenneth Koehler) is working toward a Ph.D. in Economics at ISU.

John Lih Gow Wang (Summer, 1980, under Chien-Pai Han) is a statistical data analyst for M&S Computing, Inc., Huntsville, Alabama.

Jeffrey R. Wilson (Fall, 1980, under Kenneth Koehler) is pursuing a Ph.D. in the Department. His interests include sampling and analysis of frequency tables from complex samples.

Robert Wilson (Fall, 1980, under David Harville).

Woon Bang Yeo (Summer, 1980, under Wayne A. Fuller) is working toward a Ph.D. in the Department.

Wei Yih (Spring, 1981, under Craig Van Nostrand) has returned to Taiwan.

Ph.D. Recipients

Antonio da Silva (Fall, 1980, under Chien-Pai Han) is assistant professor of statistics and mathematics in the Federal University of Ceara, Fortaleza, Brazil.

Majid Dehghan-Nayeri (Winter, 1981, under H. T. David) has returned to Iran.

James Howard Drew (Winter, 1981, under Wayne A. Fuller) is a member of the technical staff in research and consulting at GTE Labs, Incorporated, Waltham, Massachusetts. He designs survey samples.

Anuchit Lamyordmakpol (Fall, 1980, under H. T. David) is an assistant professor in the Faculty of Liberal Arts, Thammasat University, Bangkok, Thailand. He teaches undergraduate courses and conducts research.

Anil Ramchandra Londhe (Fall, 1980, under V. A. Sposito) is a research statistician in the Schering-Plough Company, Bloomfield, New Jersey. He analyzes clinical trials data and designs experiments for comparison of test drugs with various standard treatments.

Brian D. Macpherson (Winter, 1981, under Wayne A. Fuller) has returned to Winnipeg where he is an associate dean and associate professor of statistics at the University of Manitoba, Canada.

Chand Midha (Fall, 1980, under H. A. David and Oscar Kempthorne) is an assistant professor of statistics at the University of Florida, Gainesville.

Daniel Herbert Mowrey (Summer, 1980, under Paul Hinz) is a senior statistician in the Eli Lilly Company, Indianapolis. His duties include the design of experiments and analysis of data in the plant and animal science areas of the company.

H. N. Nagaraja (Fall, 1980, under H. A. David) is an assistant professor of statistics at Ohio State University.

Winston A. Richards (Fall, 1980, under Oscar Kempthorne) is a visiting assistant professor in the Department of Statistics, New Mexico State University.

M.S. Candidates

Ahmad, Adnan Bin
Ahmad, Noorani
Arnold, Robert
Bergeron, Geoffrey
Bloor, George
Blough, David K.
Brandon, Dennis
Calcano-Collazo, Jose
Callanan, Terrance
Chang, Stephen Fu-Chung
Christenson, Peter D.
Crowder, Stephen V.
Devin, Jeanne
Fakiya, James O.
Filos, Victor
Gan, Fah-Fatt
Harter, Rachel
Herrera-Hoyos, Carlos
Hines, Merlon
Hsu, Sheue Wen
Jeske, Daniel
Josvanger, Lee
Keune, Cynthia
Kim, Byung Hwee
Kruger, Gregory A.
Kumlung, Arunee
Lin, Josephine
Marengo, James
Martin, Cindy
Mazlom, Reda
Miazaki, Edina
Mohmad, Bader Eldeen
Montoya, Christobal
Morel, Jorge
Onate, Julia
Ostrouchov, George
Ray, Di-ou
Rees, Mark
Rogers, Michael
Rossi, Richard
Roy, Joanne
Silva, Fernando
Stangl, Pamela
Tang, Jee-Juin
Tegene, Abebayehu
Tveite, Michael
van Schaik, Jan
Wang, John Lih-Gow
Wilson, Jeffrey R.
Wilson, Robert
Yeo, Woon Bang
Yih, Wei

Ph.D. Candidates

Amemiya, Yasuo
Auer, Richard
Cassell, David L.
Chandhok, Promod
Chua, Tin-Chiu
daSilva, Antonio
Dehghan-Nayeri, Majid
(joint Industrial Engineering-Statistics)
Drew, James
Escobar, Luis
Fahrenholtz, Steven
Guerrero, Margarita
Hale, Michael
Ho, Chung-Man
(joint Industrial Engineering-Statistics)
Hung, Hsien-Ming
Ihnen, Leigh
Jobe, J. Marcus
Keller, Sallie
Kim, Byung Chun
Kinyon, Lawrence
(joint Economics-Statistics)
Lamyordmakpol, Anuchit
Lee, Edward Henry
Lee, Moun-Shen
Lee, Youngjo
Lewis, Jerry
Lin, Char-Lung
Lin, Cherng-Tarng
(joint Industrial Engineering-Statistics)
Londhe, Anil
Macpherson, Brian
McGovern, Paul
(joint Psychology-Statistics)
Mee, Robert
Midha, Chand
Mowers, Ron
(joint Agronomy-Statistics)
Mowrey, Daniel
Nagaraja, H. N.
Niknian, Minoo
Nkansah, Paul
(joint Industrial Engineering-Statistics)
Noorbaloochi, Siamak
Pantula, Sastry
Pareja, Gilda
Peixoto, Julio
Petenate, Ademir J.
Ramos, Juan
Rangachari, Lakshmi
Razmpour, Ahmad
Saad-Eldin, Mohamed
Sastrosoewignjo, Soetarto
Shih, Tai-Tao
Skarpness, Bradley
Slamet
(joint Industrial Engineering-Statistics)
Zamudio, Francisco J.

Snedecor Award

David Blough, Seal Beach, California, and Sastry Pantula, Calcutta, India, were chosen as the recipients of the 1981 George W. Snedecor Award. The awards consisted of a cash prize and a one-year membership in the Institute of Mathematical Statistics.

Established in 1954, this award is given each year to the most outstanding Ph.D. candidate(s) in the Department of Statistics to honor George W. Snedecor, founder and first director of the Statistical Laboratory.

David Blough received the B.S. degree from the University of California, Los Angeles, and the M.S. from the University of Arizona. He has been both a teaching assistant and a research associate in the Department of Statistics. Sastry Pantula received the B.S. and M.S. degrees from the Indian Statistical Institute, Calcutta, and has served as a research assistant in the Department of Statistics. David is specializing in general theory while Sastry is carrying on research in time series.

Bancroft Award

Mario Luiz Martinez, Brazil, was chosen as the recipient of the 1981 T. A. Bancroft Statistics Award. Presented at a departmental seminar on January 28, the award consisted of a cash prize and a year's membership in the Biometric Society.

Conferred annually on the most outstanding doctoral candidate minoring in statistics or doing a joint degree, the award honors T. A. Bancroft, professor emeritus of statistics and former head of the Department of Statistics and the second director of the Statistical Laboratory.

Martinez, majoring in Animal Science, is the author of eight papers in professional journals in animal breeding.

Mu Sigma Rho

A lecture entitled "Fallout from the 1980 Election" was presented by Warren J. Mitofsky, Director of the CBS News Election and Survey Unit, at the annual banquet and spring initiation of the local chapter of Mu Sigma Rho. Seven undergraduates, 13 graduate students, and one faculty member were initiated as new members of Mu Sigma Rho.

Officers for the 1981-82 academic year are:
President—Sallie Keller
Vice-President—George Ostrouchov
Secretary-Treasurer—Carolyn Conner

Richard Auer was the recipient of the Mu Sigma Rho Award for academic excellence and service to the organization and the department.

Mu Sigma Rho also sponsored two Wednesday afternoon seminars in the Statistics Department. One entitled "Statistical Methods for Election Estimates" was presented by Warren J. Mitofsky while here for the spring meeting of Mu Sigma Rho. The second was given by T. A. Bancroft and detailed some of the history of Mu Sigma Rho. At this seminar Dr. Bancroft was acknowledged for his role in the founding of Mu Sigma Rho at Iowa State University in 1968. There are now ten chapters nationally.

Founding Fathers of Mu Sigma Rho. From left to right: (front) Oscar Kempthorne, T. A. Bancroft, Dave Huntsberger; (back) H. T. David, Wayne Fuller, Don Hotchkiss. Absent: Holly Fuchs. Drs. Bancroft and Huntsberger are professors emeriti.

Iowa Stat-ers

The Iowa STAT-ers graduate student club was organized in 1979 to encourage professional growth in statistics, to promote statistics on campus, and to provide opportunities for fellowship among graduate students. This year the club compiled a notebook containing descriptions of recent master's degree projects designed to aid students in choosing major professors for

their master's programs. The student seminar series consisted of a few seminars by students and faculty, as well as a videotaped seminar given by William G. Cochran in 1978. The club also initiated a newsletter for keeping students informed of opportunities and events in the Department. To promote interest in statistics, the club organized an essay contest for undergraduates. Social functions included a get-acquainted pizza party, a bowling party, parties celebrating the completion of Ph.D. prelims and masters exams, and a skit for the annual Stat Lab Winter Party.

The officers of the Iowa STAT-ers were: Rachel Harter, president; James Marengo, vice president; Steve Fahrenholtz, secretary; David Cassell, treasurer; Jerry Lewis, faculty meeting representative; Yasuo Amemiya and Tin Chiu Chua, faculty committee representatives; Rick Auer, contest and notebook chairman; George Ostrouchov and Jeanne Devin, seminar committee; Mike Tveite, Cindy Martin, and Terry Callanan, social committee; Brad Skarpness, Jan vanSchaik, Leigh Ihnen, George Bloor, Cindy Keune, and Lee Ann Josvanger, graduate student senators.

Undergraduates

At the Scholarship Recognition Dinner held May 12 three undergraduates were honored. At this annual dinner the upper two percent of students by class in each of the colleges and the high scholarship graduating senior in each individual major are recognized. Beth A. Huegli, a Statistics junior in Sciences and Humanities, and Paula M. Lasack, a Biometry-Pest Management senior in Agriculture, were so recognized. John R. Cook, a Sociology-Statistics major was honored as the high scholarship graduate in Statistics and Paula Lasack was honored as the high scholarship graduate in both Biometry and Pest Management.

During the year Carolyn Connor was elected as a member of Lampos, the Sciences and Humanities Honorary. Debra J. Schroeder was initiated into the Phi Kappa Phi Honor Society during ceremonies on March 26, 1981 in the Memorial Union. J. Robert Bartos received a Laura Vernon Scholarship award during ceremonies at Veishea on May 9.

In a difficult year for summer employment six students were aided in obtaining summer employment in 1981 in positions related to statistics. J. Robert Bartos spent his second period of work with the U.S. Bureau of Census, Washington, D.C., under a cooperative education program. Amy Chen, a statistics junior, and Debra Schroeder, a graduating senior, worked at the Mayo Clinic in Rochester, Minnesota, in medical statistics. Carolyn Connor worked at the Johns-Manville Corporation in Denver, Colorado, for the third summer. Kevin Kramer worked for the Upjohn Company in Kalamazoo, Michigan, in biostatistics. Linda Nollen was an intern at the Iowa Commerce Commission in Des Moines, working as a data analyst.

Richard A. Groeneveld, Donald K. Hotchkiss, William Q. Meeker, W. Robert Stephenson, and Shashikala B. Sukhatme served as undergraduate advisors during the year. The following 17 students received the B.S. degree during the period July 1, 1980 to June 30, 1981.

Mohamed Isa Ab-ghaffar
Teresa M. Brecht
Lisa M. Buelow (joint with Economics)
John R. Cook (joint with Sociology)
Bradley J. Dain (joint with Economics)
Betsy J. Folger
Marsha E. Kruse
Mohd Z. Hassan
Paula M. Lasack (Biometry)
Anthony Yuk-Leung Lui (joint with Computer Science)
Michael L. McCue (Biometry)
Halimatun Mohd-Tahir
Dean V. Neubauer
Dierick J. Oosten (joint with Industrial Administration)
Zainnuddin Bin Osman
Nik Rasli Nik-Mansor
Debra J. Schroeder

Mohamed Isa Ab-ghaffar, Anthony Lui and Debra Schroeder will continue at Iowa State as graduate students in Statistics. John R. Cook will continue as a graduate student in Sociology at Iowa State while Zainnuddin Bin Osman is in the Industrial Administrative Sciences M.S. program here. Mohd Z. Hassan and Nik Rasli Nik-Mansor will continue as graduate students in statistics at other universities. Teresa Brecht is a statistical programmer at the Mayo Clinic in Rochester, Minnesota. Betsy Folger is a statistician for Corning Glass Company at their plant in Parkersburg, West Virginia. Paul Lasack is working as a data analyst for the Crop Pro-Tech Corporation in Naperville, Illinois. Michael L. McCue will enroll in the Registered Nurses Program at the University of Iowa. Dean V. Neubauer is a statistician with Corning Glass Company in Corning, New York. Dierick J. Oosten works for the Geophysical Services Inc. in New Orleans, Louisiana in seismology.

Statistics Club

The objective of the Statistics Club is to promote interest in the field of statistics among undergraduates. This year's club activities began with a picnic at Brookside Park. Besides the food, club members enjoyed volleyball and frisbee games. The picnic provided an opportunity to meet with members of the faculty and to get acquainted with new students.

In October, students who held statistics-related summer jobs talked to the club about their work experiences. Carolyn Connor talked about her job with Johns-Manville in Denver, Colorado. She discussed a project on the effects of asbestos on workers. Marsha Kruse described her job with the U.S.D.A. Crop and Livestock Reporting Service in Des Moines. Dean Neubauer discussed his cooperative education experience with the Bureau of the Census in Washington, D.C. Debra Schroeder talked about her work at the Mayo Clinic in Rochester, Minnesota. She was involved with data retrieval, editing and analysis on their computer system.

During the winter term the club got together to go roller skating and begin planning for this year's Veishea display. The skating party provided a good opportunity for members to mix socially as well as discuss future plans. The club arranged for Charles Cowan to talk about the cooperative education program and other job opportunities at the Bureau of the Census. Federal budgetary restrictions resulted in the cancellation of Mr. Cowan's visit.

This year's Veishea display, "Take a Chance on Us," explained some notions of probability. Visitors were able to take a chance on drawing candy from an urn, to watch a ping pong ball machine generate a binomial distribution, and to match wits with the computer on a card game similar to blackjack. Following cleanup of the display, members got together to celebrate with a pizza party.

Carolyn Connor was named the recipient of the 1981-82 Statistics Club scholarship. The following were elected officers for 1981-82:
President—Amy Chen
Vice President—Carolyn Connor
Treasurer—Carl Fritz
Secretary—Rocky Bartos

Assistant Professor W. Robert Stephenson served as advisor to the Statistics Club during the year.

Seminars

H. A. David, Bob Stephenson, Bob Strahan, and student representatives George Ostrouchov and Jeanne Devin comprised the committee which planned the weekly non-credit departmental seminars.

Those seminars featured guest speakers, local faculty members, and students.

Topics and speakers for this year follow:

Statistical Laboratory Seminars

Summer, 1980

July 23 — Pooling means for normal populations, Antonio daSilva

30 — Cyclic group divisible designs, Chand Midha

August 5 — The analysis of covariance in the finite model, Winston A. Richards

6 — Sharp bounds for expected utility via mathematical programming, Michael D. Hale

20 — Uniform Bayes risk inequalities, Anuchit Lamyordmakpol

Fall, 1980

September 10 — The impact of the computer on research in statistics: a personal view, H. A. David

17 — Alternative sampling frames for telephone surveys, Roy Hickman

24 — Utilization of auxiliary information in survey sampling, T. J. Rao

October 1 — Little's relation in queueing theory, Thomas O'Donovan

8 — Nonparametric density estimation using kernels with variable size windows, Anil Londhe

15 — Heteroscedastic regression models and the estimation of expenditure functions, George E. Battese

22 — Applications of statistics in the research of the Agriculture Experiment Station, D. F. Cox

29 — A multi-disciplinary attack on the noisy duel, H. T. David

November 5 — Multi-machine flow-shops and Johnson's algorithm, Majid Dehghan-Nayeri

12 — Association models, the bivariate normal distribution, and canonical correlation in the analysis of cross-classifications having ordered categories, Leo A. Goodman, University of Chicago

Winter, 1981

December 1 — Hormones and breast cancer, Noel Cressie, Flinders University of South Australia

10 — Roots of the Iowa State Statistical Center, T. A. Bancroft

17 — Bootstrapping the ANOVA error term, Leone Y. Low, Wright State University

January 7 — Nonresponse in multiphase surveys, James H. Drew

14 — On faculty evaluations and the managerial process, Jack Menne, ISU, Department of Psychology

21 — An asymptotic stochastic view of split-second hesitation (II), J. C. Kegley, ISU Department of Mathematics

26 — Day to day variation in the adult sex ratio in univoltine populations, Michael A. Adena, The Australian National University, Canberra

28 — Tests and analyses for some treatment x experimental unit interactions in the completely randomized and randomized blocks designs, C. Z. Roux, Republic of South Africa

February 4 — Inventory management: an application of impulse control, Armand M. Makowski, University of Kentucky

6 — The G-spectral estimator: a parametric spectral estimator without calculation of parameters, Michael J. Morton, Southern Methodist University

9 — An asymptotic theory of systematic sampling with applications, Ronaldo Iachan, University of Wisconsin

11 — Assessing the incremental utility of performance tests in personnel selection, Paul M. Muchinsky, ISU Department of Psychology

13 — Spline interpolation for regression and stochastic processes, Ker-Chau Li, University of California, Berkeley

16 — Contextual classification of multispectral image data, Stephen Vardeman, Purdue University

18 A new Bayesian approach to estimating finite population parameters, Hui-Yuan Chiu, State University of New York, Albany

25 Estimation for the first order moving average process, Brian D. Macpherson

Spring, 1981

March 6 On techniques of re-randomization inference, K. Ruben Gabriel, University of Rochester, New York

11 New generators for permutation enumeration, Bud Meador

18 Lehmann alternatives, I. Richard Savage, Yale University

25 Recent developments in information theory, Krishna B. Athreya

April 1 On three methods for estimating mutation rates indirectly, Edward Pollak

8 Who is afraid of unbalanced data? Klaus Hinkelmann, Virginia Polytechnic Institute

15 Characterization of asymptotic independence in bivariate CDF iteration, Soetarto Sastrosoewignjo

22 Forecasting tax revenues for the Iowa Department of Transportation with ARIMA strategies, Mack C. Shelley

29 Linear models: some remarks on parametrizations, Justus F. Seeley, Oregon State University

May 1 Some pitfalls in statistical computing, Robert Odeh, University of Victoria

6 Optimum multiple- and single-stress accelerated life tests, Luis Escobar

13 Statistical methods for election estimates, Warren J. Mitofsky, Director, Election and Survey Unit, CBS News

June 24 Modified estimators of the parameter of a first order seasonal autoregressive process, E. Henry Lee

Statistics Graduate Student Seminar Series

A large number of Statistical Laboratory seminars, including those of nine Ph.D. candidates, were given; thus, this series was limited to four seminars during the year.

Topics and speakers for the year follow:

October 10 Nonresponse in surveys with callbacks or What if you gave a survey and (almost) nobody came? James H. Drew

November 7 A primer on nonparametric correlation and measures of association, W. Robert Stephenson

March 27 The early years of the Ph.D. program at Ames (a videotape of W. G. Cochran's seminar in April, 1978), with an introduction by H. A. David

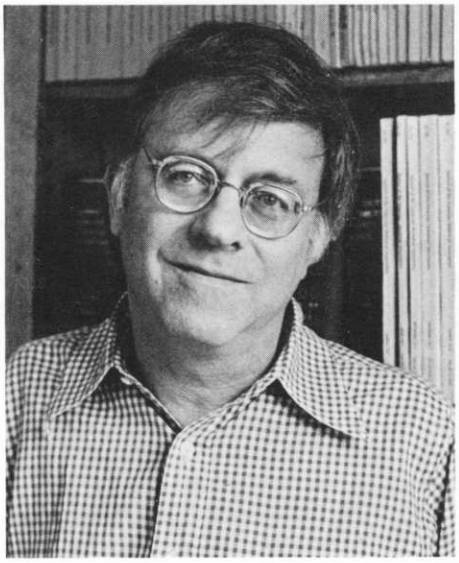
June 17 Analysis of ordered categorical responses, Robert Mee

Snedecor Lecture Series Inaugurated

With the help of continuing contributions from alumni and friends to the George W. Snedecor fund it has been possible to initiate a series of occasional lectures recognizing further George Snedecor's pioneering contributions to statistics in general and the Stat Lab in particular. Leading statisticians will be selected from time to time to present the lecture in Ames.

The first Snedecor Lecture was given in November by Leo A. Goodman, Charles L. Hutchinson Distinguished Professor of Statistics and Sociology, University of Chicago. He spoke on "The Analysis of Cross-Classifications Having Ordered Categories Using Log-Linear Models." Dr. Goodman is well-known for his many significant publications in the general area of the lecture. He is a member of the National Academy of Sciences.

Leo Goodman



Richard Savage

George Zyskind Memorial Lecture

I. Richard Savage, Chairman, Department of Statistics, Yale University presented the 6th George Zyskind Memorial Lecture. His topic was "Who Counts: The Undercount in the 1980 Census". Dr. Savage is a former editor of the *Annals of Statistics* and has served on the Committee on National Statistics and on the Assembly of Behavioral and Social Sciences, National Research Council.

Hazel Cook Honored

At the Iowa State University Alumni Association Awards Convocation on June 5, Hazel Cook was awarded the Association's Superior Service Citation. Hazel joined the Statistical Laboratory as a survey interviewer in the Survey Section in 1956. She became a survey supervisor in 1963 and held that position until her retirement in December 1980. Her responsibilities involved all aspects of sample surveys; project planning, preparation of questionnaires and field forms, training of interviewers and supervision of field data collection, preparation of data for analysis and preparation of project reports. During her years of service, Hazel demonstrated her ability to work with diverse individuals and groups and to manage large-scale sample surveys effectively. Her leadership in recruitment, training and supervision of survey interviewers has been a valuable contribution to survey research within the University.

Conference to Mark 50th Anniversary of Stat Lab

We are planning to celebrate the 50th Anniversary of the Stat Lab by a conference in Ames, June 13-15, 1983. The program will be far ranging. Professor D. R. Cox of Imperial College, London, has agreed to give the Snedecor Lecture which will launch the technical sessions. Please note the date and watch for further details. We hope to see many alumni and friends here on this historic occasion.

In Memoriam

Herman O. Hartley, 1912-1980

It is with great sadness that we note the death of Herman O. Hartley on December 30, 1980 in Durham, North Carolina from complications following massive open heart surgery. Hoh, as he was known to all his many friends, had been working with his usual vigor and enthusiasm until struck down by illness.

Born in Berlin, Germany on April 13, 1912 Dr. Hartley emigrated to England in 1934 with a fresh Ph.D. in Mathematics from Berlin University. In 1936 he interrupted research at the School of Agriculture, Cambridge to work as a consulting statistician at the Harper Adams Agricultural College, Newport, Shropshire, where he met his wife Grace. From 1938 to 1946 he held a position in L. J. Comrie's Scientific Computing Service, London, and became expert in the use of punched card equipment for large-scale computational work. This involved him in the analysis of war-time surveys and the preparation of bombing tables for U.S. Air Force flying missions over Germany and occupied Europe. Subsequently, until 1953, he was a Lecturer in Statistics at University College London, where a collaboration with Professor E. S. Pearson eventually resulted in the well-known two-volume *Biometrika Tables for Statisticians*. He received a Ph.D. in Mathematical Statistics from Cambridge University in 1940 and a D.Sc. from London University in 1954.

H. O. Hartley, soon after joining the Statistical Laboratory in 1953

After a year as Visiting Research Professor in Statistics in 1953-54 Hoh remained at Iowa State for another nine years. During this period he made an outstanding contribution to the Department and the University. He directed 17 Ph.D. and 11 M.S. theses, mainly in survey sampling and computing. In the area of survey sampling he was an excellent, stimulating teacher at all levels and was particularly notable at the advanced level. In the area of computing, talent and experience enabled him to take a prominent part in the development of computing for both scientific and administrative purposes. He was in charge of scientific computing consultations for the IBM 650 and Cyclone units, giving university-wide service in data processing and numerical analysis. In addition, he was a remarkably effective consultant on statistics to a wide diversity of scientists on the campus.

Dr. Hartley left Iowa State to become Distinguished Professor of Statistics and first Director of the Institute of Statistics at Texas A & M University. He continued his wide range of activities and quickly built up a strong Statistics department. After retirement from Texas A & M in 1979 he assumed a position as Visiting Professor of Mathematics and of Community and Family Medicine at Duke University and at the same time served as a statistician with National Testing Service, Durham, N.C.

From this record Hoh's extraordinary versatility will be clear. He gave unsparingly of himself and invariably did so in a friendly and cheerful manner. He was the author or co-author of 150 scientific papers and books and was internationally recognized as a leading statistician, receiving the Samuel S. Wilks Memorial Award in 1973. In 1979 he served a term as President of the American Statistical Association.

Friends, including many former students, honored Hoh by a Festschrift marking his 65th birthday. His loss is deeply felt and his lively presence will be missed at statistical meetings where he was a much sought after speaker and discussant. The statistical community owes much to this brilliant and kind man.

Our sympathies go to Grace Hartley and also to the children, Michael and Jennifer, and their families.

Lenore S. Bancroft, 1908-1981

Lenore Springer Bancroft died at Mary Greeley Hospital, Ames, January 28, 1981. She was born in Hartford City, Indiana and was a graduate of Indiana University, Bloomington. Prior to her marriage to Theodore A. Bancroft in December 1933, she taught in public schools in Indiana.

Many faculty members and alumni, as well as their wives, will remember Lenore Bancroft with affection and recall occasions of hospitality extended. She was responsible for the formation of Stat Wives, an organization which under the name Stat Women continues to bring together wives of Statistics faculty and students as well as female faculty and students.

We extend our deepest condolences to her husband, Ted, and also to her family.

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Iowa State University

Editor, Nancy J. Barry