STATISTICAL LABORATORY

established 1933

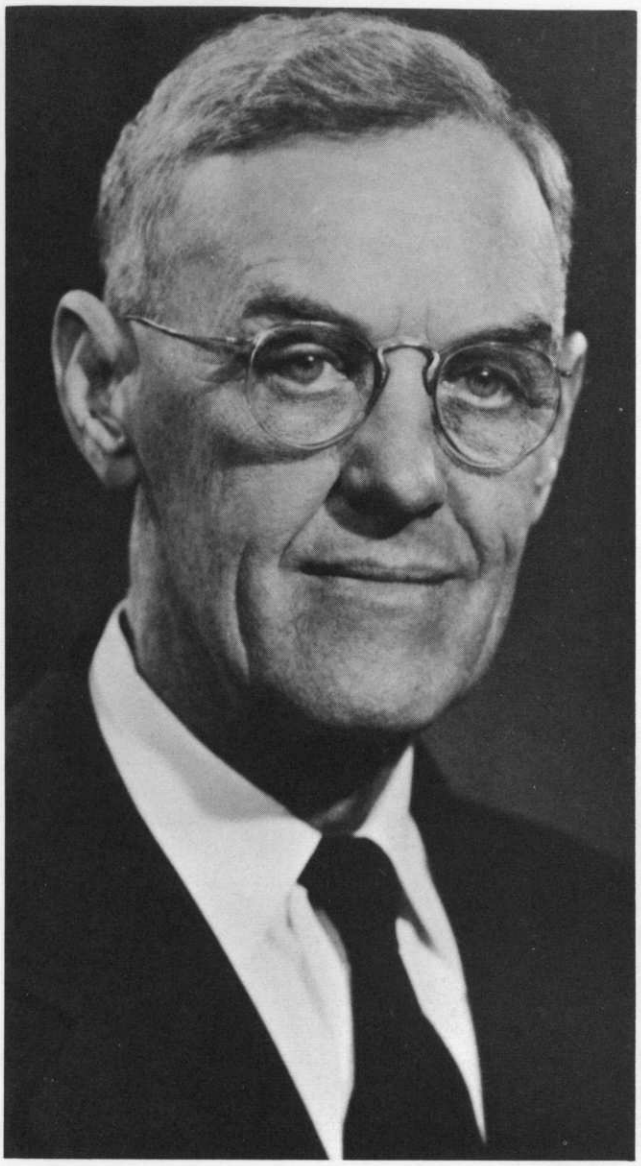
annual report

July 1, 1973 to June 30, 1974

IOWA STATE UNIVERSITY, AMES

THE STATISTICAL LABORATORY
Iowa State University
1973-74 Annual Report

Contents



George W. Snedecor founder and first director of the Statistical Laboratory, died in Amherst, Massachusetts, February 15 at age 92.

A native of Memphis, Tennessee, he received his education at the Alabama Polytechnic Institute, the University of Alabama, and the University of Michigan. In 1913 he joined the faculty at Iowa State University as an assistant professor of mathematics and remained at Iowa State for 45 years.

Shortly after his arrival at Iowa State, Dr. Snedecor took the lead in helping people with problems in statistical applications. Two of his early interests were the use of real data from research investigations in the classroom and the application of sound statistical methods in consulting with research scientists, primarily in biology and agriculture. Henry A. Wallace, then editor of *Wallaces Farmer,* was an early associate who shared an interest in applied statistics and rapid machine calculation in the field of agricultural research. In 1925, they published a bulletin, "Correlation and Machine Calculation," which attained worldwide distribution. In 1927, he and A.E. Brandt cooperated in staffing a Mathematics Statistical Service, established to supply the demand for professional help in statistics.

Snedecor was appointed the first Station Statistician of the Iowa Agricultural Experiment Station in 1933. In the same year the Statistical Laboratory was established as a research institute under the president, with Dr. Snedecor as its first director. Snedecor invited outstanding names in the field, R.A. Fisher, M.G. Kendall, Mahalanobis, Neyman, Wishart, and Yates, to visit Iowa State and lend their expertise to strengthen the Statistical Laboratory. Many other visitors were attracted from other universities and institutions; some were interested in returning home to establish similar institutes.

The publication of his first book, *Calculation and Interpretation of Analysis of Variance and Covariance,* was in 1934. During 1937, the first edition of *Statistical Methods* appeared. This book was Snedecor's greatest contribution to research workers. It became a worldwide best seller, being translated into Spanish, Hindi, and Japanese and selling more than 127,000 copies. W.G. Cochran is coauthor of the 6th edition.

Professor Snedecor was instrumental in the preliminary planning for a separate Department of Statistics at Iowa State University. However, he relinquished his administrative responsibilities in 1947, the year the Department became a reality.

Snedecor was named president of the American Statistical Association in 1948, the first person in the field of agricultural research ever to head the association. His national and international reputation is indicated by his election as an Honorary Fellow of the British Royal Statistical Society and an Honorary Life Member of the International Biometric Society. He was elected to membership of the International Statistical Institute and was a Fellow of the American Statistical Association, the Institute of Mathematical Statistics and the American Association for the Advancement of Science. He held memberships in the Iowa Academy of Science, Phi Beta Kappa, Sigma Xi, Gamma Alpha, Pi Mu Epsilon and Kappa Sigma.

He was awarded honorary doctoral degrees by North Carolina State University in 1956 and by Iowa State University in 1958, the year of his official retirement to professor emeritus status. He was awarded the Samuel S. Wilks medal in 1970. He received the Iowa State Faculty Citation in 1955, and in 1969 the building housing the Statistical Laboratory was renamed Snedecor Hall. In 1972 a festschrift, *Statistical Papers in Honor of George W. Snedecor,* was published.

Henry A. Wallace Room

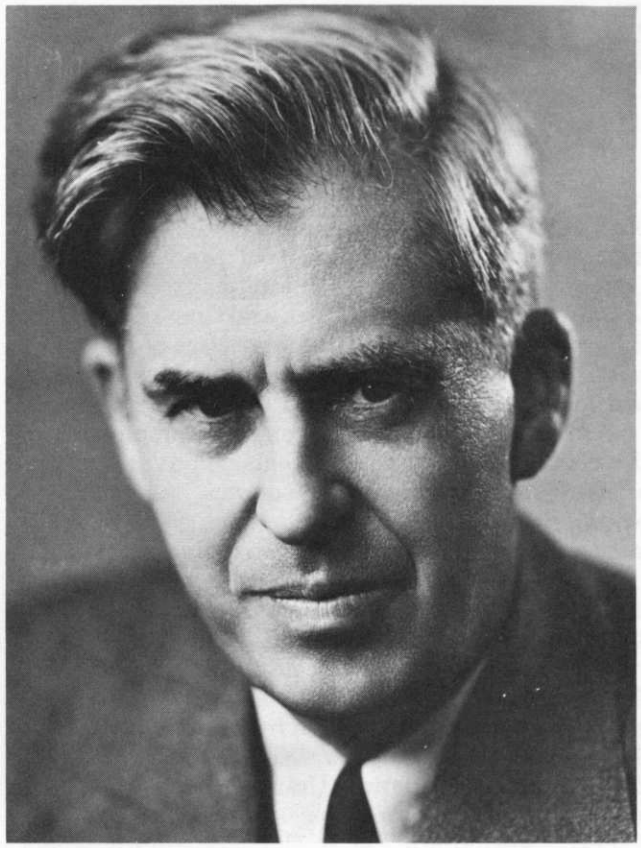
Friends of the Statistical Laboratory may remember a signed photograph of Henry A. Wallace in the photo gallery of the main conference room. Accompanying the photo is an explanatory note reading as follows:

> The real beginning of the Statistical Laboratory at Iowa State dates from the Winter of 1923-24, when the staff and graduate students met under Wallace's leadership to study methods of rapid machine calculation of correlation coefficients, partial correlation and the calculation of regression lines. One outcome of these meetings was the historic little booklet, "Correlation and Machine Calculation" by Wallace and Snedecor.

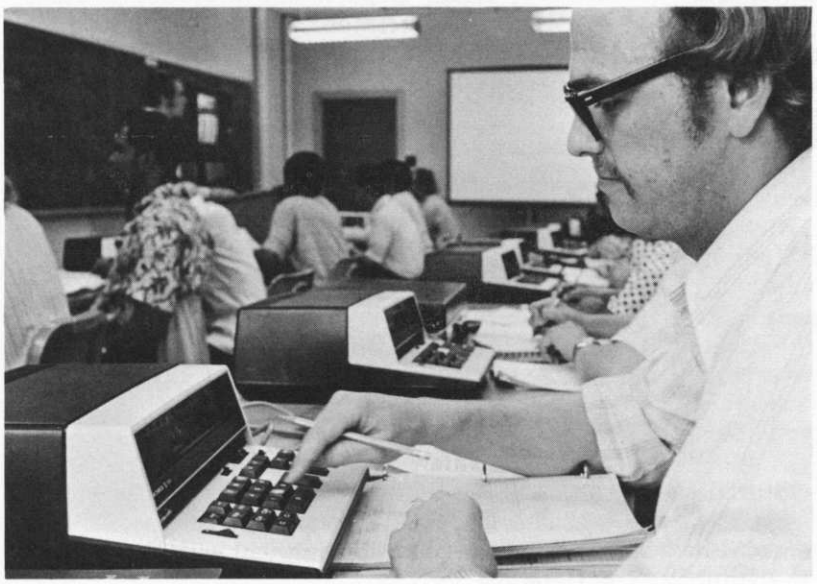
It is thus 50 years since Henry A. Wallace provided a critical stimulus resulting 10 years later in the founding of the Statistical Laboratory by George Snedecor. Correspondence in our files makes clear the great interest Wallace continued to take over the years in the progress of the Statistical Laboratory.

When Henry A. Wallace gave his important series of lectures, he came up from Des Moines being then Editor of *Wallaces Farmer*. In 1926 Wallace founded the Pioneer Hi-Bred Seed Corn Company. President Roosevelt named Wallace Secretary of Agriculture in 1932 and after eight years in this post he served one term as Vice President and finally was Secretary of Commerce under Truman. In spite of all these accomplishments, Wallace remained proud of the critical role he had been able to play in the development of Statistics at Iowa State University.

To mark the 50-year anniversary the Wallace Genetic Foundation, through the good offices of



Henry B. Wallace, President of Hy-line International Division of Pioneer Hi-Bred International, made a gift of $10,000 to the Statistical Laboratory for the purpose of equipping the main laboratory room with Monroe 900 electronic desk calculators. The room which also serves as the venue for the department's weekly seminars has been named the Henry A. Wallace Room.



A student operates one of the new calculators in the Henry A. Wallace laboratory.

Personnel

Iowa State University's statistical center is directed by H.A. David. This complex includes: the Statistical Laboratory, an institute under the president's office; the Department of Statistics in the College of Sciences and Humanities; the Statistics Department of the Agriculture and Home Economics Experiment Station; and the statistics participants in the Sciences and Humanities Research Institute and the Engineering Research Institute.

Personnel are shared among all components of the center; a staff member's salary may, therefore, be budgeted from several sources. As indicated below, several staff members have joint appointments with academic rank in two departments.

Other institutions and agencies recognize the professional competence exhibited by Iowa State statistical staff members and invite them to be visiting members of their staffs for short terms. Three members of the faculty have currently been granted leaves to accept such invitations. Dr. Oscar Kempthorne is serving as visiting professor in the Department of Statistics, University of Washington at Seattle, for a six-week summer session. Dr. George Zyskind will be on Faculty Improvement Leave. He participated in an invitational conference entitled "Prospects for Theoretical Turbulence Research" which was held at the Center for Atmospheric Research, Boulder, Colorado, June 18-23. Dr. Richard A. Groeneveld will be on a year's leave as a visiting associate professor of mathematics at Dartmouth College, Hanover, New Hampshire, beginning September 1.

Barry Arnold is on a two-year leave of absence from the Department, beginning June 1, to accept an appointment with the AID Peru Agrarian Reform project in Lima, Peru.

To recognize increased cooperation between the two departments, Paul Hinz was given faculty status in the Department of Forestry and Lawrence Promnitz received similar status in the Statistics Department.

Resignations occurring during the fiscal year include: George Battese, Gauri Ghai, Richard Heiberger, Kazimierz Karpinski, Jeff Meeker, James Mellon, and J. Richard Schmid. John Aleong was promoted from graduate assistant to associate with the AES staff, working with Dr. D.F. Cox. Randy Carter and Paul DuBose were new instructors this year. Jeffery Goebel was promoted to assistant professor beginning summer 74 after completion of his Ph.D.

Susan Alice Brown, technical writer-editor, is currently on disability leave.

Looking ahead to September, Mohamed El-Sabbagh and Prem Talwar will be visiting assistant professors with primary responsibilities in the area of economic statistics. El-Sabbagh recently completed a joint Ph.D. program in Industrial Engineering and Statistics. Talwar holds a Ph.D. degree in Statistics from Carnegie-Mellon University and has spent the past year as a post doctoral fellow at the University of Rochester. Joining on a regular basis will be James E. Gentle who is completing his Ph.D. dissertation under H.O. Hartley at Texas A & M. He will be working mainly in the area of statistical computing. Malay Ghosh will be visiting associate professor while on leave from the Indian Statistical Institute. He holds a Ph.D. degree in Statistics from the University of North Carolina.

Members of the statistical center, including its affiliated fellows and graduate students, are recorded here:

Statistical Laboratory Staff— Fiscal Year 1973-74

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; Director, Sciences and Humanities Research Institute
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

T.A. Bancroft
C. Philip Cox
David F. Cox
Herbert A. David
Herbert T. David—joint appointment with Department of Industrial Engineering
Wayne A. Fuller—faculty status in Economics as well as Statistics
Donald K. Hotchkiss
David V. Huntsberger
Oscar Kempthorne—Distinguished Professor, College of Sciences and Humanities
Edward Pollak—joint appointment with Department of Genetics

Norman J. Strand—Professor Emeritus—visiting, March, 1974
B.V. Sukhatme
Richard D. Warren—joint appointment with Department of Sociology and Anthropology
Leroy Wolins—joint appointment with Department of Psychology
George Zyskind

James L. Cornette—visiting, summer, 1974
K. Ruben Gabriel—visiting, summer, 1974
Janos Galambos—visiting, summer, 1973 and 1974
William F. Taylor—Collaborator (in residence at Mayo Clinic)

Associate Professors

Barry C. Arnold—joint appointment with Department of Mathematics
Richard A. Groeneveld
Chien-Pai Han
Roy D. Hickman
Paul N. Hinz—faculty status in Forestry as well as Statistics
Dean L. Isaacson—joint appointment with Department of Mathematics
William J. Kennedy
C.C. Mosier—joint appointment with Computation Center
Glen D. Meeden

Postdoctoral Associates

Gauri L. Ghai—through November
Willi Maurer—visiting through July

Collaborator

Charles Graham—USDA

Assistant Professors

Theodore Bailey
Harold D. Baker
Terry L. Dickinson—through August—joint appointment with Department of Psychology
Gauri L. Ghai—December through March
J. Jeffery Goebel—beginning June 1
Richard M. Heiberger—through August
Richard W. Mensing
Lawrence Promnitz—faculty status in Statistics as well as Forestry
Vincent A. Sposito—joint appointment with Computation Center
Shashikala B. Sukhatme

George E. Battese—visiting through May
Gordon Booth—USDA Collaborator
Gauri L. Ghai—visiting, summer, 1974
Melvin L. Moeschberger—visiting, summer, 1974
Peter C. O'Brien—Collaborator (in residence at Mayo Clinic)

Instructors and Associates

John Aleong—beginning August 1
Bruce L. Bowerman
Randy Carter
Michael Coveyou—joint appointment with Department of Political Science
David A. Dickey
Richard L. Dorsch
Paul DuBose
Mohamed El-Sabbagh—December 1 through May 31
J. Jeffery Goebel—through May
Joe E. Grimes—August, 1973
Kazimierz F. Karpinski—through December
Jeff B. Meeker—through September
James I. Mellon—through September
Martin J. O'Connell
J. Richard Schmid—through July
Wendell C. Smith

Experimental Design and Quantitative Analysis Group: John Aleong, Dr. Edward Pollak, Dr. George Zyskind, Winston Richards, Dr. Gauri I. Ghai, Ted Emigh, Dr. Oscar Kempthorne.

Graduate Assistants

(The status of graduate students often changes. Students who have held the title of graduate assistant during the year are listed here.)

John Aleong
Jerry A. Anderson
C. Asok
Harry Bonczkowski
Shriram H. Biyani
Richard Chung
Pamela Doctor
Frank Eaton
Mohamed El-Sabbagh
Ted Emigh
Devendra Hajela
Karen Hallaman
James Hansen
David P. Hasza
Michael Hidiroglou
Elizabeth Huang
Her Tzai Huang
Grace O. Iwuora
Steven R. Johnson (Undergraduate)
Robert W. Keyt
Gueng Ho Kim
Lawrence Kinyon
Rebecca Klemm
Ricky Knight
Anthony Lawrence
Tsuru Matsui
Gary F. McCormick
Thomas E. Moritz
Kenneth Offord
Antonio L. Oña
Hans Otte
Winston Richards
William Santy
Gordon Schmittling
Barry Simon
Ann Solomon
Melvin L. Stanard
Michael Szymczuk
Diane M. Tomasiewicz
Dale Umbach
George H.K. Wang
Shie-Shien Yang
Jinn-Yung Yen
James R. zumBrunnen

NDEA Fellow

Kirk Wolter

Supported Graduate Students

Carlos Acuña—Latin American Scholarship Program
Zeyad Al-Rawi—Government of Iraq
William Arends—USDA
Humphrey Arthur—Population Council
Gabriela Stangenhaus Carvalho—University of Campinas, Brazil
Jose Carvalho—University of Campinas, Brazil
Lal Chand—USAID
Jorge D. Fischman—FAO, United Nations
Alex Garcia—Government of Venezuela
Jino Gama—Government of Uganda
Santiago Gomez—USAID
Grace Iwuora—University of Nigeria
Ben Kiregyera—Government of Uganda
Anuchit Lamyordmakpol—Government of Thailand
Clifford Lee—Department of Mathematics
Omar Martinez—Centro de Investigaciones Agronomicas, Venezuela
Raphael J. Michalski (joint statistics-economics)—Department of Economics
Elsa Contreras Mundstock—Central Bank of Venezuela
Gilda Pareja—USAID
Keramatolah Parvin-Jahromi—Iran Ministry of Science and Higher Education
Margarita Perez—University of Puerto Rico
Surin Phoeyglin—National Research Council of Thailand
Julio Cesar Robles—AID, Peru
Dwight Rockwell—USAD
Preecha Sakarindr (joint statistics-economics)—Rockefeller Foundation, Thailand
A. Shawki Salem—UAR Government
Ming Lai Shen—National Science Council, China
Gary Sime—Department of Mathematics
David Sotres—National Council of Science and Technology and Ford Foundation
John Mark Trzeciak (joint statistics-industrial engineering) Engineering Research Institute
Choosak Udomsri (joint statistics-mathematics)—Chulalongkorn University, Thailand
Jose Villaseñor—Ford Foundation, Mexico

Unsupported Graduate Students

Sister Nona Mary Allard
Kou-Ping Cheng
Shyamal Chowdhury
Cynthia Clark
Francine Drake
Irma Fernandez
Mohamed Pashazadeh-Monajemi
Phantipar Sakarindr
Jia-Jinn Yueh

Statistical Data Processing Service

Bud J. Meador, Supervisor
Data Processors:
Charlotte Bentley
Diane Chien—through summer, 1973
Janice Offord
Mary Remsburg
Lana Thomas—through May, 1974

Survey Section

Sylvia McNulty, Secretary
Margaret Nichols, Secretary
Marjorie Mason, Survey Supervisor
Hazel Cook, Survey Supervisor
Evelyn Green, Survey Supervisor
Anna B. Woodrow, Survey Supervisor
Harvey Terpstra, Jr., Systems Analyst
Marcia Tilley, Statistical Data Processor
Marion Martin—beginning June, 1974, Statistical Data Processor

Statistical Clerks:

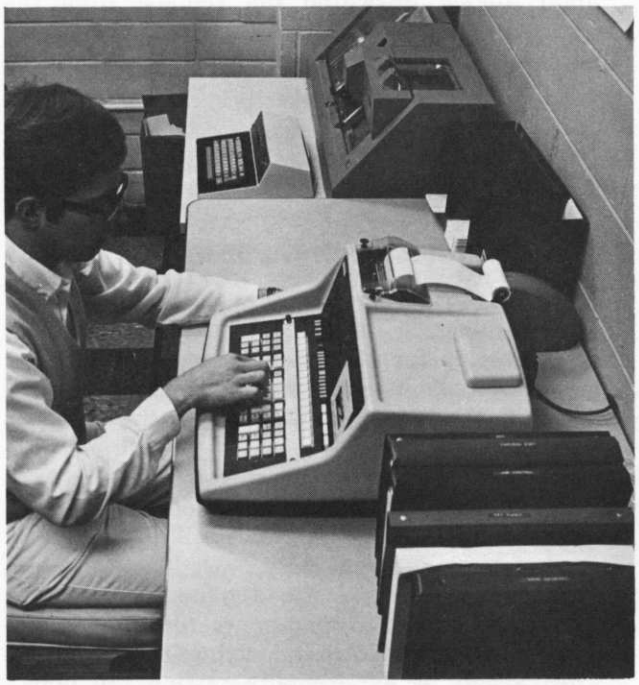
Anne Arends—through May, 1974
Carroll Arthur
Carol Bell
Ava Klopf
Sylvia Larson
Cindy Nussbaum—through May, 1974
Florence Osam
Helen Padellford

General Office Staff

Margaret G. Kirwin, Administrative Assistant
Avonelle Jacobson, Program Coordinator
Kathleen Ringgenberg, Accountant
Susan Alice Brown, Technical Writer-Editor—through March
Kathleen Shaver, Information Assistant—beginning May 1
Kristie Whitaker, Secretary, Statistical Numerical Analysis and Data Processing Section—through winter quarter
Carol Dunn, Secretary, Statistical Numerical Analysis and Data Processing Section—beginning spring quarter
Phyllis Carr, Secretary, Experimental Design-Genetic Statistics Section
Jan Ellsworth, Secretary—beginning fall quarter
Norma Elwick, Secretary
Marilyn Feistner, Secretary—through fall quarter
Laurel Kushner, Secretary—through summer, 1973
Karen Meimann, Secretary—beginning fall quarter
Peggy Nelson, Secretary
Nancy Orum, Secretary—through summer, 1973
Beverly Upchurch, Secretary—beginning winter quarter

Consulting Services and Cooperative Research

Statistical consulting services are provided to staff members and students who request assistance with research design, data collection, or data analysis and interpretation. Although all faculty members of the Statistical Laboratory are available for consultation, some staff members are budgeted to devote a major portion of their time to these services. Consulting statisticians in the laboratory are continually modifying existing statistical procedures, developing new techniques, and adding new equipment to enable them to keep abreast in their field and provide the highest quality consulting services.



Tom Moritz, graduate research assistant, operates the Wang 600.

The AES consulting section has acquired a Wang Model 600 electronic calculator. This machine will be used to supplement the computing facilities already available. Small jobs and special tasks can be handled more efficiently with such a machine than with the IBM 360 system. The graduate students assigned to the AES section are already familiarizing themselves with the capabilities of the Wang.

A program package designed at State University of New York, Stony Brook, has been acquired. The package has features useful in numerical taxonomy and multivariate analysis in general. It is hoped that the package will extend capabilities in this area of data analysis and make the displays such as those used in cluster analysis easily obtained.

With M. Stanard and R. Gallant, Dr. Vince Sposito developed a new version of TARSIER, a program to obtain regression estimates to nonlinear regression models. The new program will build three subroutines for the user. These subroutines involve derivatives and partial derivatives which are determined via IBM's FORMAC compiler. This program has been used extensively by members of the Agricultural Economics Department; i.e. determining nonlinear models to ascertain yields as a function of water and fertilizer.

While it is not practical in this report to enumerate all consulting which was done during the fiscal year, the following account illustrates the diversity and scope of the research projects. Many of the graduate students' studies culminate in theses or dissertations, while staff members' research is often presented in papers at conferences and/or published in professional journals.

Agriculture
Home Economics
Social Sciences

A Ph.D. student in agricultural economics investigated the use of the Mitscherlich function to plant-water-fertilizer relationship. The Tarsier-nonlinear regression process developed by Dr. Sposito was employed. Another study for the Department of Agricultural Economics involved a linear programming model with 47,000 variables. The researcher was a Ph.D. student who was analyzing the location of grain production and the transportation of it after production. The emphasis of the study was on the interrelationships of truck, rail, and water shipment of the grain.

Dr. Richard Warren, joint appointment with sociology and anthropology, served as statistical consultant for more than fifty research studies. Graduate students primarily from sociology, education, and family environment sought his assistance at various stages in their research ranging from the design of the experiment and data collection devices through the final analysis and interpretation of data. Robert Strahan, joint appointment with psychology, recommended a variety of statistical processes to students and faculty from the Departments of Psychology, Child Development, Home Economics Education, and other related areas in the social sciences.

Through an estimation of multiple regression models that have nested error structure, Dr. George Battese assisted the Food and Nutrition Department with their longitudinal study on the nutritional status of women during aging. Statistical theory of inbreeding was used by Dr. Oscar Kempthorne in consulting on an animal science research project which was designed to study the acceptability of skin grafts in poultry in relation to inbred lines, crosses, and progeny.

Michael Coveyou, who joined the staff in the fall of 1973 as a joint appointee with political science, filling a position which had been vacant during the previous year, consulted on over twenty projects primarily with staff members in political science. Researchers from that discipline and from history and town and regional planning sought his assistance in designing samples, constructing questionnaires, and data collection and analysis for studies on topics as diverse as the development of special governmental districts in Iowa, electoral coalitions in American politics, career patterns of Soviet political elites, career patterns in Pennsylvania General Assembly in the 1700's, delegate voting on the ratification of the U.S. Constitution, measurement of urban heterogeneity, and determinants of candidate success in gubernatorial elections. Statistical procedures recommended and employed on these studies included discriminant analysis, autocorrelation in multiple-regression analysis (including the Durbin-Watson statistic), and various nonparametric techniques. Additionally, advice on the computer processing of data with the *SPSS* and *SAS* computer packages was given on several of these projects.

Dr. Edward Pollak was director of Project 1448, Consultation and Research in Mathematical and Statistical Genetics. For a genetics research project, he applied the chi-square test to determine whether proportions of cells that fused with a certain treatment or control group differed over sets of data.

Dr. T.A. Bancroft, assisted by Drs. Chien-Pai Han and B.V. Sukhatme, was an outside examiner for a Ph.D. thesis, "Effects of Non-normality on Some Inferences Based on Pooling of Observations on the Basis of Preliminary Test of Significance," for a candidate from the University of Lucknow, India. Dr. Bancroft consulted with Dr. Boyd Harshbarger, Virginia Polytechnic Institute and University, on a paper entitled "History of the Early Developments in Modern Statistics in America."

John Aleong answered the request from the Virginia Institute of Marine Science, Gloucester Point, Virginia, for assistance with a chi-squared test of goodness of fit.

Engineering Research Institute

The Engineering Research Institute provides financial support for statistical consulting with the Engineering College. Some of this consulting, carried on by H.T. David and R.W. Mensing, involved the following:

The modeling of a shuttle system, and the traffic feeding into this system, by means of various techniques, including Markov chain imbedding, Weibull plotting and simulation.

The investigation of the applicability of Iowa Retirement Curves to personnel retirements experienced by certain Iowa industrial firms.

The design of experiments testing the homogeneity, in time and space, of various pollution-related substances carried in Iowa rivers.

The applications of regression analysis and analysis of variance to several experiments involving mixed material filter beds, with the aim of measuring the effects of process parameters such as stirrer speed, input gas velocity, and material moisture on filter performance.

Discussion of various aspects of error propagation and tail probability bounding techniques, as applied in the compositing of stress and strain distributions, and, generally, in probabilistic engineering design.

The design of experiments to test the efficiency of various layering techniques and geometries for municipal waste filter beds, controlling sludge concentration and backwashing frequency, and related factors affecting filter performance.

The application of variance stabilizing transformations and nonlinear regression in materials research, and the use of error propagation in problems related to soil stress and geodetic measurement.

Two book manuscripts were reviewed in connection with this consulting, one of these in the area of probabilistic design, the other in the area of design and analysis of engineering experiments and sampling inspection.

Agriculture and Home Economics Experiment Station

The Iowa Agriculture and Home Economics Experiment Station supports statistical consulting services for many staff members and graduate students in substantive areas. The Experiment Station budget also provides some funds for statistics research and the development of new statistical methods.

Project 101, Statistical Services in the Animal Sciences and Plant Sciences, has supported the consulting work of D.F. Cox, Paul Hinz, D.K. Hotchkiss, Ted Bailey, and five graduate assistants, John Aleong, Antonio Oña, Tom Moritz, George Yen, and Richard Chung. Researchers from the Iowa Conservation Commission and the Fisheries and Wildlife Biology Section of Zoology have sought consultation in data analysis of studies related to Rathbun Lake fisheries, toxicology of insecticides in pheasants, stream pollutants, waterfowl hunting success, water quality of streams flowing into Lake Okoboji, habits of penguins, and possible ecological problems related to the developing oil industry in Alaska.

The last project, currently in progress, is a study of wetlands and waterbirds at Point Stonkersen, Alaska's Prudhoa Bay oilfields. Of the 24 species of birds that nest in the study area, 11 were swimming types and four were sandpipers that often wade. A classification system for wetlands used by the birds was devised using the techniques of cluster analysis. Eight classes of wetlands, I to VIII, were defined based on physical characteristics, vegetation, specific conductance of water and water movement. Recommendations to reduce conflicts between waterbirds and oil development were focused on prohibiting or reducing activities near wetlands in classes IV-VII that are limited in numbers and intensively used by birds.

The AES consulting services are engaged mainly by the Departments of Animal Science, Veterinary Medicine, Home Economics, Agronomy, and Entomology. In veterinary medicine and animal sciences, assistance was given toward research studies involving mastitis in sows, lead influence on blood serum of sows, effects of restrictive feeding on the reproductive physiology of sows, plasma renin activity in dogs, resistance to antibodies in pigs, and shipping fever in cattle. Problems of assessing the effects of intra-uterine spacing of the embryos in pigs presented many statistical questions for Dr. D.F. Cox.

Dr. Paul Hinz consulted with researchers in the Department of Family Environment investigating the bacterial count of smooth versus carpeted kitchen floors. Statistical evidence supported the conclusion that carpeted floors have a significantly higher bacterial count than smooth floors within the limits of this experimental design.

The Departments of Agronomy, Botany, and Entomology requested consultation on a wide variety of research projects, including: digestibility studies of sorghum varieties, simulated hail damage in soybeans, analysis of treatments for Dutch Elm disease, effects of nemetode treatments on peony nursery stock, resistance to diseases in corn, hybridization in oats, light penetration in soybeans, fly spray potencies, and efficacy of herbicide treatments. A two-act sequence analysis was utilized to gain insight into the functions of sounds and other acts in intraspecific communication of two species of leafhoppers.

Dr. D.F. Cox and John Aleong served as consultants on studies of the genetic and environmental factors influencing the life cycle of European corn borers. An understanding of this system is sought for the purpose of biological control. Some of the statistical problems involved the design of an experiment using four large growth chambers whose individual differences were substantial. Within the chambers there were also temperature gradients and location effects. Several checks or controls were used to assess these factors and adjust the main experimental material. Regression model building techniques were employed. Many other studies on the European corn borer were handled during the year.

Dr. P. Hinz and Tom Moritz served as consultants for a study to analyze hunter success in a waterfowl area near the Mississippi River. Cluster analysis was used to classify blind sites to determine factors influencing the degree of success at each blind site.

Dr. Ted Bailey consulted with plant scientists in a large study investigating the relationship of 28 reproductive and growth characters with yield. An OMNITAB program was written that calculated all possible genetic correlation coefficients from analysis of variance data. The study involved two crosses each grown for five years.

In a cooperative research effort, several multiple linear regression models were studied for their ability to predict leaf areas of soybean plants. Using linear measurements, models for predicting areas of individual leaflets, trifoliolates, and total plant leaf area were developed and evaluated. Results indicated that leaf areas can be determined with sufficient accuracy using only measures of lengths or widths of leaflets, and that total plant area can be predicted accurately using estimated areas of only a few leaflets.

The techniques of correlation and regression analysis were used to derive equations predicting total leaf area of corn plants. The estimated plant leaf areas were used to determine Leaf Area Indexes which were used in evaluation of experimental lines of corn.

In a plant physiology study of 30 soybean genotypes, covariance analysis was recommended to adjust for uncontrolled differences in two chambers used to determine photosynthetic rate. In addition, results from the statistical analysis of this field study were used in making recommendations for the experimental design to be used next year. It was decided to increase the number of plants per family and decrease the number of determinations per plant.

Statistical Numerical Analysis and Data Processing Section

The Statistical Numerical Analysis and Data Processing Section has the primary mission of assisting research workers with scientific computer applications. William J. Kennedy is in charge of the section. Professional staff members of the section also conduct research and teach courses on scientific applications of digital computers.

Section personnel were actively involved in work on more than 135 different projects during the year. Approximately ninety percent of these projects were in support of research conducted on campus. In addition to these projects, section personnel served as consultants on the computer related aspects of several other research projects.

The Computer Science and Statistics: Seventh Annual Symposium on the Interface was organized, and local operations were conducted, by the section. All members of the section were involved in the planning and conduct of the symposium. Those most heavily engaged in symposium-related activities were Dr. Kennedy (symposium chairman), Dr. Sposito (Co-chairman of Decision and Environmental Analysis workshop), Wendell Smith and Bud Meador (transportation and local operations) and Kristie Whitaker (registration). Proceedings of the symposium were subsequently published and distributed. Orders for copies of these proceedings were still being received and processed at the end of the 1973-1974 fiscal year.

Three shortcourse type instructional units, one on the use of each of the programs SAS, OMNITAB, and SPSS, were completed and placed on video tape, utilizing the WOI television production facilities. Each shortcourse is approximately 2½ hours long. Instruction presented on the video tapes is given by Dr. Heiberger (SAS), Jeff Meeker (OMNITAB), and Tom Bubolz (SPSS). Copies of these tapes, and SONY cassette tape players, are available in the ISU main library. Feedback from staff, faculty, and students on campus indicates that this method of instruction on the characteristics and use of computer programs is very successful when there is some consulting support available to assist with specific problems encountered as the programs are being used.

The SAS and SPSS programs were further modified to better suit the needs of research workers on campus. Gary McCormick and Tom Bubolz did the bulk of the work on these programs. The PRINT and PLOT procedures in SAS were two components that received special attention. A third software system, the SOUPAC system developed at the University of Illinois, was also installed during the year. In addition to work on these large systems, several small programs for special applications were prepared and placed in the section program library. Included among these are some utility type programs, written by Gary McCormick and Bud Meador, which have proven to be very useful in data processing applications, and three programs for approximating probability distribution function values written by Wendell Smith, Gordon Schmittling, and Geung Ho Kim.

Processing of the 1970 U.S. Population and Housing census data continued throughout the year in response to a variety of different types of requests. Bud Meador and Lana Thomas were most heavily engaged in these activities. Much of the census data from counts one through four are stored on magnetic tape in the section's tape library.

Several large mathematical programming problems were solved on the computer, by Dr. Sposito, for research workers in economics. Section software for both linear and nonlinear optimization was revised and updated under the direction of Dr. Sposito. One product of these efforts is a new version of TARSIER, which is a program for determining regression estimates in nonlinear models. A feature of this new version is that it automatically produces needed partial derivatives whereas the older version required that these be supplied by the user. Mel Stanard, Bob Keyt, Geung Ho Kim, and Gary McCormick all assisted in these projects. Currently, a new algorithm for quadratic programming is being implemented. Rebecca Klemm is working with Dr. Sposito on this software development operation. The consulting workload in the area of mathematical programming was exceptionally heavy during the past year; hence, Dr. Sposito was very busy with consulting activities in addition to his other duties.

Jan Offord and Charlotte Bentley, working under the direction of Bud Meador, completed several projects for Agronomy and Plant Science. Included among these were the generation of randomized field trial specification data and the yearly reports on availability and classification of several different types of seed.

Work on the long-term patient care data analysis and reporting system continued throughout the year. This system is being developed for the Iowa Hospital Association under a grant from the National Institutes of Health. Section personnel assisting with this project include Dr. Kennedy, Wendell Smith (system development supervisor), Mary Remsburg, Larry Kinyon, and Jim zumBrunnen. The system is designed as a historical data-based analysis and reporting system for long-term care facility patient data. Another component of this work involved a study of staff attitudes in long-term care facilities. Dr. Wolins worked with members of the section, as did other persons from the Psychology Department, on the design, data collection, and data analysis for this study.

Wendell Smith, Geung Ho Kim, Rick Knight, Charlotte Bentley and Dr. Kennedy worked with biologists from the State Conservation Commission on analysis and report generation for six different wild game, waterfowl and fish studies. The larger studies pertained to hunter success for various species of waterfowl and small game.

During the past year all components of the Career Education Needs Information System were designed, programmed, and used in data analysis. This system, prepared for the Iowa Department of Public Instruction, utilizes sample data to study student interest, labor demand, labor supply, and student three-year followup information. The objective of this project is to provide more complete information to graduating high school students and to planners in the fifteen area community colleges about the projected needs of Iowa employers and the projected number of technically trained persons available to satisfy the needs. Jim zumBrunnen, Mary Remsburg, Charlotte Bentley, Bud Meador, and Dr. Kennedy worked jointly on this project.

The continuing need for a readily available index to all software and services available through the section was satisfied to a great extent by the publication of a new User Guide. Included in this guide is a description of all software, and documentation of the many small special purpose routines, in the section program library. This document is designed for ease in modification and extension so that it can be kept up to date.

Survey Section

Area sampling frame construction work continued under Agriculture Experiment Station Project 1753. Sampling frames formed on the basis of degree and type of cultivation will enable the Statistical Reporting Service, USDA, to design agricultural surveys at a minimum cost while reducing the variance of characteristics to be estimated. The Illinois frame was completed this year, and count units for the area frame for Texas were formed and the frame updated. Work has begun for the construction of the Ohio frame.

Update of the original data of the soil conservation needs inventory continued under Project 1753. Soil names have been added to all state data files, and update and revision of watershed and land resource areas continued. A description of standard computer programs available for use with the CNI data set was prepared and was distributed to all Soil Conservation Service state offices. Data processing work on storage and retrieval of the interpretative analysis of soils continued, and interpretative data on some 2,000 soils have been received and stored. Computer program development for production of soils interpretation tables for state soil correlations continued. Research effort was initiated in the area of sampling designs and procedures to be used in soil surveys such as the conservation needs inventory. Procedures for variance estimation of acreage estimates in cells in various two-way county tables were investigated, and some work was done on development of variance predictive function utilizing other characteristics of cell acreage estimates. Development of a computer program to produce weights for sample observations while controlling for known population characteristics was continued.

Research on the use of auxiliary data in survey design and analysis of survey data to increase efficiency of estimation continued under the direction of Dr. B.V. Sukhatme. An empirical study of the

bias and efficiency of several ratio-type estimators with reference to data on fruit crops is in progress. Preliminary results indicate that the convergence of estimated bias and mean square error to the true bias and mean square error is slow, and several thousand independent samples may have to be drawn to obtain conclusive results. In view of this, the comparison of the estimators in respect of bias and mean square error is being carried out using approximate expressions.

Data for the farmer refusal project was analyzed and the final report, to be made to the Statistical Reporting Service, USDA, is being prepared.

Assistance was provided in the designing and drawing of samples, recruiting and training of interviewers for the Department of Sociology's research project on environmental attitudes of Des Moines, Iowa, residents. For the Ames Community School District's biennial school census, recording forms were prepared, census takers were trained and supervised, data processed, and summary tables prepared. Under the auspices of the Community Action Program, a research project was developed in Southeastern Iowa involving citizens' assessments of community needs. Personnel from the Survey Section designed and drew the sample and conducted an interviewer training session. An ad hoc citizens group from Clear Lake, Iowa, was interested in perceiving the attitudes of residents toward possible construction of a swimming pool in Clear Lake. Survey Section personnel designed and drew a sample, helped develop a questionnaire, and conducted an interviewer training session.

Computer Science and Statistics: Seventh Annual Symposium on the Interface

A very successful national conference, Computer Science and Statistics: Seventh Annual Symposium on the Interface, was held in Ames, October 18 and 19, 1973. The Departments of Statistics and Computer Science, together with the Statistical Laboratory, acted as hosts. Dr. W.J. Kennedy was Program Chairman and edited the *Proceedings*. Drs. T.A. Bancroft and V. Sposito also played prominent parts in organizing the Symposium and served as workshop chairmen. The keynote address was given by Dr. Martin B. Wilk, a graduate of Iowa State University who completed his Ph.D. research under Dr. Kempthorne. Dr. Wilk is Director of Corporate Modeling for American Telephone and Telegraph Corporation.

The purpose of the Symposium was to encourage discussion, and exchange of experiences and ideas, in subject areas that are present in the rapidly expanding intersection of the disciplines called statistics and computer science. A concurrent workshop format was utilized to insure that sufficient depth in consideration could be made in selected subject areas. Each of the six workshops concentrated on a different subject area. In addition to the workshops, two general sessions, attended by all participants, served to cement the relationship between workshops.

Two hundred thirty participants represented all regions of the continental United States except Alaska, and several participants came from outside the United States. The distribution of participants among governmental, business, and university organizations was such that each group was adequately represented. The largest group was comprised of university faculty.

Wendell Smith and Bud Meador were in charge of local arrangements. Mrs. Kristi Whitaker served as administrative assistant to the chairman. Papers were presented by R. Heiberger, D.F. Cox, R.D. Warren, and Jeff Meeker. Abstracts of these papers appear in the publication section of this report.

Major financial support was received from the U.S. Army Research Office, Durham, (AROD) and International Business Machines (IBM). The Statistical Analysis and Data Processing Section of the ISU Statistical Laboratory provided the personnel resources needed to plan, coordinate, and conduct all aspects of the Symposium except the workshop programs which were planned by the workshop chairmen.

Current Research

Statistical research in theory, methodology, and applications is financed by various sources. Projects which are of specific interest to regular university research programs are supported by the Statistical Laboratory's budget. Cooperating campus research institutes and the agricultural experiment station provide additional funds. Off-campus contracts and grants continue to be a major source of funds for research of both graduate students and staff members.

AES Project 1806

Dr. Wayne Fuller was Project Director for Agriculture Experiment Station Project 1806. Transformations useful in the estimation of regression models with nested or crossed error structure were developed. Estimation of regression equations for survey data was investigated. Procedures recognizing the correlation associated with cluster sampling and errors of measurement have been developed. The limiting properties of some of these estimators have been derived. Estimators for the errors-in-variables model given that the covariance matrix is not constant were developed.

Order Statistics and Nonparametric Statistics

Considerable activity under a grant with the above title from the U.S. Army Research Office took place in the summer of 1973 when Drs. Galambos and Maurer, as well as Dr. Barry Arnold, were supported by the grant for which H.A. David is principal investigator. Dr. Galambos wrote papers on asymptotic laws for the central terms of order statistics and on order statistics of samples from multivariate distributions, with emphasis on asymptotic theory. He also collaborated with Dr. David on a paper concerned with the asymptotic theory of concomitants of order statistics. Uses of order statistics and concomitants in certain double sampling situations have been studied by Martin O'Connell and Dr. David.

Dr. Arnold investigated multivariate exponential distributions based on hierarchical successive damage and together with Dr. R.A. Groeneveld prepared a note on bounds for deviations between sample and population statistics in finite populations.

Knockout tournaments were shown by Dr. Maurer to be more effective under broad conditions than other tournament plans with fewer games than competitors.

Designing Sample Surveys and Analysis of Survey Data

Principal investigator, Dr. B.V. Sukhatme, continued research on the design and analysis of sample surveys supported by the U.S. Office of Education under contract No. OEC-0-73-6640.

Work continued on the use of preliminary test of significance in the analysis of survey data. A new regression-type estimator based on preliminary test of significance of the regression coefficient has been proposed and its efficiency investigated with respect to the difference estimator and the regression estimator currently in use. These results are continued in Joseph Grimes' Ph.D. thesis which is summarized in the publication section of the report. A paper based on this research was read at the annual meeting of the American Statistical Association, December, 1973.

Graduate student, C. Asok, continued research under Dr. Sukhatme's guidance on use of auxiliary data in sampling with unequal probabilities and without replacement. If data on an auxiliary variable X, correlated with the variable Y under study, is available for all the units in the population, it is often used in selecting a sample with probabilities proportional to X values. Numerous attempts have been made in recent years to develop practicable methods for this approach. However, many of them are not simple to adopt in practice and, further, very little is known about their relative performance.

Using the asymptotic theory of Hartley and Rao (1970), a compact expression for the inclusion probability π_{ij} has been obtained for Sampford's procedure for sample size $n \geq 2$ and used to investigate its efficiency with respect to other procedures suggested by Goodman and Kish, Hartley and Rao, and Hanurav.

As an alternative to the more complicated inclusion probability proportional to size schemes, Rao, Hartley, and Cochran suggested a scheme which is easy to operate in practice. However, the estimator proposed is not admissible. The scheme has been critically examined and its optimal properties brought out by suggesting more efficient estimators.

Further work on developing sampling procedures which are easy to operate and comparable in efficiency to the existing procedures is in progress.

Mathematical and Statistical Genetics

Drs. Oscar Kempthorne and Edward Pollak were co-leaders of a continuing research project to develop mathematical, probabilistic, and statistical theory of genetic populations. This research is supported by the National Institutes of Health and by Agriculture Experiment Station Project 1669.

T.H. Emigh and Dr. Kempthorne have studied the application of quantitative genetic theory as used in analyzing data on human intelligence. Basic problems revolve about the roles of environment of interactions of genotype and environments, of association of genotype and environment, and of assortative mating. Assumptions that are used in experimental quantitative genetics with animals and plants cannot be substantiated in the case of humans. Progress has been made in the logical analysis of Fisher's theory of assortative mating.

Dr. Pollak has studied survival probabilities and extinction times of lines of heterozygotes carrying a mutant gene. In this work it was assumed that there is a very large population, living in at least two incompletely isolated environments. Upper and lower bounds have been obtained for mean times to extinction, given extinction, when there are two environments, with the mutant favored in one environment and deleterious in the other. Numerical results indicated that as intensity of selection increases, the conditional mean time to extinction, given extinction, decreases, regardless of the environment in which the ancestral heterozygous individual lives. There seems to be little effect as probabilities of migrating from one environment to another are changed. Joint work was done with Barry Arnold on the problem of calculating the distribution of the number of times there is a particular number of genes of type A in a population that is always size N.

Dr. Pollak has also done work on the problem of computing inbreeding and variance effective population sizes, in finite populations. New derivations were given for a monoecious population and for an autosomal locus in a dioecious population. The inbreeding effective number was derived for a sex-linked locus.

G.L. Ghai and Dr. Pollak have obtained some results for a population with two types of individuals which do not interbreed. Probabilities that in the long run only one or the other type remains have been computed. They have also considered populations with two types, reproducing entirely by selfing, and have calculated the probability that there will ultimately be no heterozygotes. Randomness is incorporated into the theory by taking account of distributions of numbers of offspring of particular individuals. G.L. Ghai has also extended these results to populations with more than two types and has computed the probabilities of extinction of one or the other of the genes.

In addition, Mr. Ghai has obtained the frequencies of various genotypes in the long run in populations subjected to assortative mating. The results can be obtained for multilocus situations with linkage.

Work was done by T.K. Lin on mean times to fixation, given fixation, for a model due to Chia and Watterson. In this model there is a finite haploid population of size N. At times 0, 1, . . ., K individuals are randomly chosen to die and are replaced by K new individuals produced by the individuals present just before the birth-death event.

Publications and Professional Activities

Published Research

Statistical Laboratory staff members frequently have their research results published in professional journals or as conference proceedings from papers they have presented. They also serve in various professional roles relating to publication of journals. H.A. David is a member of the ad hoc committee to review the purpose and policies of *Biometrics*. Wayne Fuller continues to serve as an associate editor of the application section of the *Journal of the American Statistical Association*. Oscar Kempthorne was elected as an associate editor, commencing January 1, 1974, of *Theoretical Population Biology*. He also maintains his position as associate editor of *Biometrics*. H.T. David was appointed to the management committee of *Technometrics*.

Abstracts of papers published by staff members and graduate students, theses abstracts, and books reviewed during the fiscal year 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 and copies are available upon request. These are indicated by an asterisk (*).

Proceedings of the Computer Science and Statistics Seventh Annual Symposium on the Interface, Iowa State University, Ames, Iowa, October, 1973.

Heiberger, Richard (Assistant Professor of Statistics at the Wharton School, University of Pennsylvania): "Statistical Computing Through Statistical Packages," 218-222.

This paper describes an introductory course in statistical computing that focuses on the use and design of statistical packages. It fills the gap between statistical methods courses that use packages as calculating tools and computer science courses that discuss numerical methods without reference to statistical needs.

Cox, D.F.: "The Use of the Statistical Analysis System in Teaching," 236-237.

The Statistical Analysis System has been used in the courses on statistical methods at Iowa State. The limitations of the system for demonstrating the basis of the methods are recognized. The benefits of having students use a system they can utilize in their own research work are real.

Warren, Richard D.: "Using Statistical Package for the Social Sciences—SPSS—in Statistical Methods Courses," 243-244.

The use of SPSS in statistical methods courses for students in the social sciences is discussed. The statistical subprograms of SPSS are oriented toward the social sciences. Used effectively, basic statistical principles on data analysis and interpretation can be taught, in addition to basic programming skills.

Bancroft, T.A.: "Workshop 4: Education and Training in the Interface, Summary," 297-298.

The author summarizes the sessions of Workshop 4, which were divided into two broad categories: (1) Teaching of undergraduate and graduate level courses in computer oriented statistical numerical analysis, primarily for statistics majors, and (2) Development and usefulness of major statistical package programs in teaching undergraduate and graduate level courses in statistical methods and applications, primarily for non-statistics majors.

Locks, Mitchell O. and **V.A. Sposito:** "Workshop 5—Decision and Environmental Analysis, Summary," 376-378.

Eleven papers were presented in this workshop which concentrated upon managerial-type analyses, either deterministic or statistical, leading to decisions which control the behavior of organizations and environments. The papers were problem-oriented, with applications taken from industrial, governmental, agricultural, or educational environments. Brief summaries of each paper are included.

Meeker, Jeff B. (Florida State University): "Special Languages and Systems for Statistics," 427-432.

Special languages and systems for statistics are embodied within the several statistical program packages currently available. Four packages: Biomedical Computer Programs, OMNITAB, Statistical Package for the Social Sciences, and Statistical Analysis System are briefly discussed from both a language and a system standpoint to illustrate the techniques that have been used in these statistical packages.

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A special seminar series on the teaching of statistics, in conjunction with the inauguration of the new physical plant of the Statistical Center, National School of Agriculture, Chapingo, Mexico, was held November, 1972. The proceedings were published during the current fiscal year. *Seminario la Enseñanza de la Estandistica en America Latina Memoria, Centro de Estadística y Cálculo,* Chapingo, Mexico, 1974.

Bancroft, T.A.: "Statistics Education in Latin America: Some Comments Based on Personal Knowledge and Experience," 57-64.

Latin-American students have been and currently are encouraged to study statistics at Iowa State University Statistical Laboratory. These students are involved in graduate and undergraduate programs and a wide variety of short-term study and research activities.

Statistics personnel from Iowa State have assumed diverse statistical teaching, consulting, and research assignments in Latin-American countries for two decades. They have assisted in a substantial way in three special Latin-American educational programs. The most extensive program was the Joint ISU-Chapingo-Ford Foundation Project in Graduate Education and Research in Statistics during the period 1965-1970, with the author as the ISU project director. Under this joint project, a permanent statistical and computing center was established in Chapingo. Six ISU faculty members were assigned, at approximately two-year spaced

intervals with some overlapping, to the Chapingo staff as visiting professors to participate in the teaching, research, and consulting efforts during the center's developmental phase.

Suggestions for correlating and complementing future educational developments in statistics for Latin-American countries are proposed by the author.

Kempthorne, Oscar: "The Teaching of Statistics at the M.S. Level," 65-103.

The author believes statistics is an intrinsic component of many disciplines which can be seen when the philosophy of knowledge, mathematical ideas and statistical ideas are combined and integrated. Statisticians should teach students more on the broad problems of humanity and concentrate less on the mathematical problems. Statistical philosophy and processes should be embedded in basic epistemological questions and included in courses in logic and philosophy.

At the M.S. level, the basis of the teaching program must be a course in general theoretical statistics. "Looking" at a population is a very complex and difficult matter which has remained crucial for centuries. An important function of statistical education is to expose students to theory and application of procedures by which they may construct and validate models of reality that have predictive content. M.S. students should be exposed to basic probability theory, probability modelling, random sampling from finite and infinite populations, tests of various sorts—not only accept-reject rules, a variety of viewpoints on tenability of parametric values, and the basic ideas of decision making, both non-Bayesian and Bayesian. But throughout, there must be serious attention and not mere lip-service to philosophy of science and the scientific method.

Zyskind, George: "On Teaching Statistical Linear Model Theory," 189-212.

Linear model theory is centrally located within the field of statistical activities, having both strong theoretical content and strong applied interest.

The author believes a course in statistical linear model theory should strive to convey the relevance, power, and limitations of the general subject. It should also help develop aesthetic appreciation and develop enough manipulational ability in the student so that he feels confident to proceed on his own in studying literature and attacking new related problems.

Three teaching approaches which are both feasible and possible are discussed: 1) algebraic, 2) geometric, and 3) conditional inverses. The author's preferred mixed approach—one using vector space geometry, matrices, and conditional inverses—is illustrated through problem-solving techniques. Problems related to parametrically augmented models, model misspecification, and unavailable planned observations are presented. Some aspects of linear models connected with finite randomized experiments are discussed.

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Arnold, Barry C.: "Schwarz, Regression and Extreme Deviance," *The American Statistician,* 28:1, 22-23, February, 1974.

An inequality presented by Samuelson states that in a population with n individuals, no individual can be more than $\sqrt{n-1}$ standard deviations from the mean. This note includes two alternative derivations of this result. It is shown to be implied by the Schwarz inequality and to be a consequence of the non-negativity of the variances of residuals in simple linear regression. A p-dimensional generalization of Samuelson inequality is derived from the non-negativity of the variances of multiple regression residuals.

***Arnold, Barry C.:** "Independence of Squared Order Statistics," *Communications in Statistics,* 2:4, 357-362, 1973. Statistical Laboratory Reprint Series #321.

Suppose (X_1, Y_2) is a bivariate random variable with order statistics (Y_1, Y_2). In the case of independent symmetric X_i's, the squared order statistics are independent if the X_i's are identically distributed. This is a non-trivial counterintuitive example of statistical independence. It permits non-parametric tests of independence between two populations to be used as non-parametric tests of equality of symmetric populations. By considering differences between observations within normal populations, the result is used to develop a test for homogeneity of the variances of the populations.

Arnold, Barry C.: "Some Characterizations of the Exponential Distribution by Geometric Compounding," *SIAM Journal Applied Mathematics,* 24:2, 242-244, March, 1973.

If, for every $p \epsilon (0,1)$, p times a geometric (p) sum of independent identically distributed non-negative random variables has the same distribution as the individual random variables, then the random variables are exponentially distributed. The phrase "for every $p \epsilon (0,1)$" can be weakened

somewhat, and if first moments are assumed to exist, it can be replaced by "for some $p \epsilon (0,1)$." Related characterizations of the power function distribution and of the Poisson process are discussed, as are the effects of dropping the assumption of non-negativity of the random variables.

*Arnold, Barry C.: "Response Distributions for a Generalized Urn Scheme under Noncontingent Reinforcement," *Journal of Mathematical Psychology,* 10:2, 232-239, May, 1973. Statistical Laboratory Reprint Series No. 318.

The classical urn scheme is further extended to permit application to simple learning situations with arbitrary response and reinforcement spaces. The assumptions incorporated are those which, in the classical situation, are equivalent to (1) permitting the total number of balls added per trial to depend on the preceding reinforcement and (2) allowing the probability that a ball is drawn to depend on the time the ball has been in the urn. This results in a flexible family of models whose behavior is analyzed in the case of noncontingent reinforcement.

Bancroft, T.A.: "The Dual Nature of Statistics and the Role of a Complete Statistical Center in a Large University" (in Japanese), *Communication,* Hiroshima University, 1124-1127, November 15, 1973.

Statistics as a discipline serves a dual role: It is one of the mathematical sciences and it is an investigative procedure for obtaining new knowledge which is an important part of scientific methodology. A complete university statistical center should combine these aspects in a complementary program.

Academic courses, including theoretical and applied statistics, should provide training for graduate and undergraduate students who wish to specialize in this area. Service courses at all academic levels, on- and off-campus consulting, and cooperative research services should be available to research workers. A center's program needs to be completed by incorporating the necessary electronic computer hardware and software facilities.

Battese, George E. (Department of Statistics, University of New England, Armidale, Australia) and **Wayne Fuller:** "An Unbiased Response Model for Analysis of Categorical Data," *Proceedings of the Social Statistics Section of the American Statistical Association,* December 27-30, 1973.

The estimation of multinomial proportions is considered when the sample determinations contain classification or response errors. A classification model, for which the sample proportions are unbiased, is that in which the classification probabilities are given by

$$\beta_{ij} = \begin{cases} \alpha + (1-\alpha)P_j, & i = j \\ (1-\alpha)P_j, & i \neq j \end{cases}$$

where β_{ij} is the probability that a randomly selected individual belonging to class i is classified in class j; P_j, $j = 1,2,...,r$, denotes the true population proportions; and α is a constant between zero and one. With independent classifications of sample individuals from interview and reinterview trials of a survey, estimators of the parameters and tests for the model assumptions are defined.

Coveyou, Michael R. and David G. Pfeiffer: "Education and Voting Turnout of Blacks in the 1968 Presidential Election," *Journal of Politics,* XXXV: 4, 995-1001, November, 1973.

The authors examine the relationship of education to voting turnouts of blacks in the 1968 presidential election. It is found that turnout did not increase monotonically with education, contrary to previous findings in the literature. Various controls are applied, and a curvilinear relationship seems to emerge. Some tentative explanations of this pattern are suggested.

Anderson, L.L., J.J. Ford, R.M. Melampy, and **D.F. Cox:** "Relaxin in Porcine Corpora Lutea During Pregnancy and After Hysterectomy," *American Journal of Physiology,* 225:5, 1215-1219, November, 1973.

Relaxin activity in porcine corpora lutea was determined by measurement of interpubic ligament formation in mice. Relaxin levels remain low (e.g., 1-3 μg/g) throughout the estrous cycle. In mated pigs the levels of relaxin increase fourfold by days 20-29 and continue to increase steadily to peak values (>300μg/g) by days 110-115. Within 16 hours of parturition, hormone levels drop to low values (e.g., 12μg/g) and remain low during the first 2 weeks of lactation. In hysterectomized pigs, the corpora lutea are maintained beyond 128 days, and relaxin levels increase steadily to maximal values (e.g.,250μg/g) by day 110 and then decrease (e.g.,50μg/g) by day 128 even though the corpora remain large. Corpora lutea are maintained beyond 100 days by injecting estrogen during the luteal phase of the estrous cycle; relaxin levels in these corpora begin to decline by day 128 in a

manner similar to that found in hysterectomized pigs. These results suggest that relaxin levels may be an indicator of the aging process in the porcine corpus luteum.

David, H.A.: "Waiting Time Paradoxes and Order Statistics," *Journal of the American Statistical Association,* 68:343, 743-745, September, 1973.

It is well known that we tend to have to wait longer than we expect. Special cases of this paradox have been discussed by Feller and Zelen. Here the paradox is further explored, and generalizations are considered to describe the effect of the observer on the expected length of an interval between successive events in a life test.

Dickinson, T.L. (Department of Psychology, Colorado State University) and T.E. Tice: "A Multitrait-Multimethod Analysis of Scales Developed by Retranslation," *Organizational Behavior and Human Performance,* 10, 1973.

This study investigated the extent to which rating-scale dimensions obtained by the retranslation component of the Smith and Kendall (1963) procedure are used differentially by eventual raters. Performance dimensions and illustrative behavior descriptions for grade firefighters were generated by potential raters and ratees. Actual ratings of job performance based on the behaviorally defined worker dimensions were obtained by peer nominations, ratings by peers, and ratings by supervisors. Multitrait-multimethod analyses of the ratings indicated that retranslation resulted in dimensions with little discriminant validity and only a moderate degree of convergent validity.

Dickinson, T.L. and **L. Wolins:** "Least Squares Analysis of Repeated Measures and Other Designs," *Multivariate Behavioral Research,* 1973.

Procedures are discussed for using regression programs for the computing of analyses of variance. A procedure for coding matrices is described for experimental designs having nested and crossed factors; several illustrations are given. The limitation of the procedure with large repeated measures designs is explained. A second algorithm is offered for obtaining the sums of squares for nested factors and their interactions in such designs.

Dickinson, T.L. and T.F. Lyons: "A Comparison of Perceived and Computed Change Measures over a Three-Year Period." *Journal of Applied Psychology,* 1973.

Longitudinal data were gathered for a three-year period and used to assess the validity of retrospective reports of changes in job satisfaction, communication, and coordination. These data were collected from a large community-general hospital (over 400 beds) in which intervention occurred. The data were assessed using correlational and contingency analyses. Retrospective reports of change in job satisfaction and, to some extent, in communication were statistically related to before-after change. In an attempt to improve the accuracy of the retrospective measures, several moderators were investigated; years in the hospital was found to differentiate those accurately classified by the job satisfaction measure. It was concluded that retrospective reports of change are not merely reflections of final status but to some extent do measure before-after change. However, it was noted that retrospective measures are not presently accurate enough to be considered as substitutes for before-after change measures.

Dickinson, T.L. and R.J. Wherry, Sr.: "A FORTRAN Program for Generating Multiple Samples of Multivariate Data with Arbitrary Population Parameters," *Educational and Psychological Measurement,* 1973.

This article describes a procedure for producing sets of data matrices sampled from multivariate normal populations with specified parameters of intercorrelations, means, and standard deviations. A computer program is offered which implements the procedure.

Fuller, Wayne A. and **George E. Battese:** "Estimation of Linear Models with Crossed-Error Structure," *Journal of Econometrics,* 2, March, 1974. Journal Paper J-7530, Iowa Agriculture and Home Economics Experiment Station, Project 1806.

Sufficient conditions are presented under which the generalized least-squares estimator, with estimated covariance matrix, is unbiased for the parameters in the crossed-error model and has the same asymptotic distribution as the generalized least-squares estimator. The model permits the presence of independent variables that are constant over cross sections or time periods. The model does not require that the variance components associated with cross sections or time periods be positive.

Norma Elwick, secretary, shown proofing a paper, has colorfully decorated the Snedecor Hall reading room. This pleasant area which contains high-level reference books and statistical journals is appreciated by students and staff.

Fuller, Wayne A. and **George E. Battese:** "Transformations for Estimation of Linear Models with Nested-Error Structure," *Journal of the American Statistical Association,* 68:343, 626-632, September, 1973. Journal Paper J-7463, Iowa Agriculture and Home Economics Experiment Station, Project 1806.

Two linear models with error structure of the nested type are considered. Transformations are presented by which uncorrelated errors with constant variances are obtained. The transformed observations are differences between the original observations and multiples of averages of subsets of the observations. The transformations permit the calculation of the generalized least-squares estimators and their covariance matrices by ordinary least-squares regression. Regression-type estimators are presented for use when the variance components are unknown. Sufficient conditions are presented under which the estimated generalized least-squares estimator is unbiased and asymptotically equivalent to the generalized least-squares estimator.

***Ghai, G.L.** (Florida International University): "Limiting Distribution Under Assortative Mating," *Genetics,* 75, 727-732, December, 1973. Statistical Laboratory Reprint Series 327.

A multi-locus model for complete positive assortative mating is discussed. For a two-locus model, if the gene frequencies for two loci are different, as they are likely to be, it is shown that in equilibrium the population is not composed of only two homozygous types, as is usually thought. The limiting distribution will have three homozygous genotypes depending upon the initial gene frequencies. If there are m-loci such that gene frequencies at all loci are different, there will be $(m + 1)$ such homozygous genotypes present in the equilibrium population, one in each phenotypic group.

*Han, Chien-Pai: "Double Sampling with Partial Information on Auxiliary Variables," *Journal of the American Statistical Association,* 68:344, 914-918, December, 1973. Statistical Laboratory Reprint Series No. 324.

As is known, the precision of an estimator can be improved if auxiliary variables are used; if the relationship is linear, a linear regression estimator is constructed. When the mean of the auxiliary variable is completely unknown, double sampling techniques can be adopted. If the experimenter has partial information about the mean, he may perform a preliminary test and construct a preliminary test estimator. The bias, mean square error and relative efficiency are obtained for the preliminary test estimator. Recommendation of the levels of the preliminary test and optimum allocation of sample sizes are given. When the prior distribution of the mean of the auxiliary variable is normal, a maximum likelihood estimator is obtained.

*Han, Chien-Pai: "Regression Estimation for Bivariate Normal Distributions," *Annals of the Institute of Statistical Mathematics,* 25:2, 335-344, 1973. Statistical Laboratory Reprint Series No. 326.

In estimating the mean μ_y of one variable in a bivariate normal distribution, the experimenter can use the other variable, x, as an auxiliary variable to increase precision. In particular, if μ_x is known, he can use the regression estimator. When μ_x is unknown, a preliminary test can be performed and the estimator will be made to depend on the result of the preliminary test. The bias and mean square error of the preliminary test estimator are obtained and the relative efficiency is discussed.

Dawson, J., **P. Hinz,** and J. Gordon: "Hiking Trail Impact on Iowa Stream Valley Forest Preserves," *Iowa State Journal of Research,* 48:4, 329-337.

Manning, Glenn H. Henry H. Webster, Frederick S. Hopkins, Jr., and **Roy D. Hickman:** *Projecting Iowa's Outdoor-Recreation Needs to 1980.* Research Bulletin 575, 24 pp, Iowa Agriculture and Home Economics Experiment Station, Ames. 1973.

Survey data was used to develop estimates of outdoor recreation participation in selected activities by Iowa residents 12 years of age and older during the period Labor Day 1965 through Labor Day 1966 and to make projection estimates of participation for 1975 and 1980. The data consisted of 812 personal interviews from a multistage area sample of Iowa residents. Structural analysis was used to estimate the relationship between participation and various socioeconomic characteristics such as age, education and income. Estimates of the characteristics were made for the target years and then used in the estimated relationships to obtain per-capita participation in each activity in 1975 and 1980. These estimated rates of participation were applied to the expected state population in the target years to obtain estimates of participation during these years. A determination was made of the relative significance of independent variables affecting participation rates in the various activities.

*Jensen, Louis (University of Michigan): "Random Selective Advantages of Genes and their Probabilities of Fixation," *Genetical Research,* 21, 215-219. 1973. Journal Paper J-7350, Iowa Agriculture and Home Economics Experiment Station, Project 1669. Statistical Laboratory Reprint Series No. 319.

The question of what is meant by random fluctuations in selection intensities in a finite population is re-examined. The model presented describes the change in the frequency of a gene in a haploid population. The ultimate probability of fixation is computed, showing that variability in selection increases the chance of fixation of a rare gene.

*Jensen, Louis: "Solving a Singular Diffusion Equation Occurring in Population Genetics," *Journal of Applied Probability,* 11, 1-15, 1974. Statistical Laboratory Reprint Series 329.

A technique for solving a partial differential equation is presented. The technique is based upon the known solution of a singular equation. The method is used to attempt to solve the equation describing the change in the frequency of an allele in the presence of selection and random drift in a finite population. Two cases can be solved within a reasonable degree of approximation: (a) the viabilities are additive and (b) heterozygotes are symmetrically overdominant to the homozygotes. The solutions in both cases are compared with the exact discrete solutions found by powering the re-evant transition matrix.

*Pollak, Edward: "The Survival of a Mutant Gene and the Maintenance of Polymorphism in Subdivided Populations," *American Naturalist,* 108: 959, 20-28, January-February, 1974. Statistical

Laboratory Reprint Series 325, Journal Paper J-7381, Agriculture and Home Economics Experiment Station, Ames, Project 1669. NIH Grant GM-13827.

In this paper it is assumed that there is a large population that is divided into several subpopulations, between which there can be migration. It is shown that if heterozygotes carrying a new mutant gene differ in viability from the wild type in at least one subpopulation, conditions for the survival of the gene are the same as those presented in the deterministic theory of other authors for the instability of the trivial equilibrium associated with the gene being absent from all subpopulations.

The same analysis is also shown to apply in Levene's model if the mutant gene is recessive. Here, however, the survival probability is of a much smaller order of magnitude than it would be if the mutant gene showed some dominance.

Polo, R.J., **V.A. Sposito**, and T.T. Lee: "Modifications of Nonlinear Equality Constraints in Nonlinear Problems," *Journal of Engineering for Industry, Transactions of ASME 96,* (Series B, No. 1), 138-144, February, 1974.

This paper presents a technique for solving nonlinear programming problems with nonconvex feasible regions. The procedure expands the feasible region by replacing nonlinear equality constraints by appropriate inequality constraints. The expansion is used to solve two structural optimization problems using the sequential unconstrained minimization technique of Fiacco and McCormick, The solutions are compared with solutions obtained by classical mathematical methods.

Sukhatme, B.V., A.H. Manwani and R.S. Bapat: "Survey on Vegetables in Rural Areas of Delhi," Report, Institute of Agricultural Research Statistics, New Delhi, 1973.

The report describes Indian surveys carried out during the period 1964-1967 with special reference to 1) design of survey, 2) type of data collected, 3) organization of fieldwork, 4) analysis of data collected, and 5) feasibility of carrying out large-scale surveys on vegetable crops.

Mishro, G.K. and **B.V. Sukhatme**: "Efficiency of Cluster Sampling in Conjunction with Ratio and Regression Methods of Estimation," *Journal of Indian Society of Agricultural Statistics,* 24:2, 81-90, December, 1972..

Zarkovich and Krane (1965) have shown that the correlation between Y, the variable under study, and X, the auxiliary variable, increases if a cluster is taken as a sampling unit and that the correlation increases with the size of the cluster. The paper considers the problem of estimating the population mean $\overline{Y}$ and derives conditions under which cluster sampling in conjunction with ratio and regression methods of estimation is more efficient than simple random sampling with a single element as a unit of sampling in conjunction with ratio and regression methods of estimation even if the intra-class correlation coefficient is positive.

Sukhatme, B.V. and Isidoro P. David (University of the Philippines): "A Note on Koop's Approach for Finding the Bias of the Ratio Estimate," *Journal of the American Statistical Association,* 68:342, 405-408, 1973.

To find the bias and mean square error of ratio estimator, it is usually assumed that $|\bar{x} - \overline{X}| < \overline{X}$ for all possible samples. Koop (1951) suggested a new approach to overcome this assumption. This note examines Koop's approach and shows that the assumption is still necessary.

*Avadhani, M.S. and **B.V. Sukhatme**: "Controlled Sampling with Equal Probabilities and without Replacement," *International Statistical Review* 41:2 175-182, 1973. Statistical Laboratory Reprint Series No. 320.

The results obtained by the authors so far on controlled sampling with equal probabilities and without replacement have been consolidated in this paper in an integrated fashion, and used to propose a practical and convenient procedure for controlled simple random sampling. Notwithstanding the elimination of a large number of non-preferred samples altogether and reducing the probability of selection of the remaining non-preferred samples, the sample mean under controlled simple random sampling not only provides an unbiased estimate of the population mean but also has the same variance as that under simple random sampling. Further, it has been indicated how one can collect data on an ancillary variable in the course of survey operations and use it to provide estimates which are at least as efficient as in simple random sampling.

Wolins, L. and **T.L. Dickinson:** "Transformations to Improve the Reliability and/or Validity for Affective Scales," *Educational and Psychological Measurement,* 32, 1973.

The normal-deviate transformation is described as one which results in an increasing, monotonic relationship between reliability and the number of categories in a scale. Differences in the ends of the scale are weighted highly, and those in the center are weighted relatively lowly by this transformation. Also, it makes the mean and variance more nearly independent across items or stimuli. A computer program is offered to produce the transformation.

Book Reviews

Three books were reviewed by Statistical Laboratory staff members for the *Journal of the American Statistical Association,* 68:334, December, 1973.

Cox, D.F.: *An Introduction to Statistical Science in Agriculture,* 4th Edition, by D.J. Finney, 1029.

Pollak, Edward: *Multitype Branching Processes* by Charles J. Mode, 1023-1025.

Zyskind, George: *Estimation in Linear Models* by Truman O. Lewis and Patrick L. Odell, 1021-1023.

Theses Abstracts

Battese, George E.: "Parametric Models for Response Errors in Survey Sampling," Ph.D. thesis, Iowa State University Library, August, 1973.

The analyses of response error models and the estimation of population proportions in the presence of classification errors is considered. By defining probabilities of classification as a function of the true classification, expressions for the sample proportions are obtained. Parametric representations of classification models are presented. Given responses from two trials of a survey, estimation of the parameters of the classification models is considered.

A classification model, for which the sample proportions are unbiased, is presented. Maximum likelihood and Gauss-Newton estimators for the parameters in the classification model are presented.

In the investigation of the non-sampling variability of survey responses, the variability of response due to respondents and variability due to interviewers are considered. A method of estimating variance components that is closely related to maximum likelihood is outlined. The procedure yields estimates of the variances and covariances of the variance-component estimators under minimal assumptions. The method of estimation is illustrated with use of reinterview data from a survey of farm operators.

Eaton, Frank: "Estimation of Variances for Soil Surveys," M.S. thesis, Iowa State University Library, May, 1974.

Variance estimation procedures following the general technique of pseudo-replication were employed to investigate the efficiency of alternative sample designs for soil surveys. Data used was from the 1967 Conservation Needs Inventory of the Soil Conservation Service, USDA. Acreage estimates in cells of various two-way tables such as land use by land capability were produced for each of six counties, and the estimated coefficient of variation (CV) of each estimate was calculated using the method of jack-knife repeated replication for variance estimation.

Linear regression techniques were used to develop a "variance function," that is, a predictive relationship between the measures of variation of cell estimates and other variables related to the estimate. CVs were transformed such that, when plotted against the estimated acreage as expressed as a percentage of total acres in the county, approximately linear trends were produced. The final regression function of log(log CV) possessed an R^2 of .90 and included as predictor variables the percent of total county acreage, the number of cells in the two-way table, the number of such cells containing less than one percent of the total county acreage, total county acreage, and the sampling rate used within the county. The standard errors of the estimated regression coefficients were such that the ratios, b/s_b, were in all cases very large and beyond significance for a t-test that the population coefficients equal zero.

El-Sabbagh, Mohamed Fathi A.: "Aspects of the Convergence of Bayes Policies and Posterior Distributions for Markov Decision Processes," Ph.D. thesis, Iowa State University Library, August, 1973.

This thesis is concerned with a Markov decision process over a finite number of states, with a finite number of alternatives at each state, and a finite number of possible generalized transition matrices $\{\mathcal{P}_i\}$. Suppose that precisely one of

the possible generalized transition matrices $\mathscr{P}_t^*$ in fact governs the evolution of the process. This thesis has two main goals. The first is to investigate the rate at which a Bayesian decision maker's posterior distribution over $\{\mathscr{P}_t\}$, assigning some weight to $\mathscr{P}_t^*$, converges to the distribution $\mathscr{G}_o$ degenerate at the true transition matrix $\mathscr{P}_t^*$. The second goal is to investigate a sense in which this posterior convergence insures the near equality of the total discounted reward earned by the Bayesian decision maker, $\mathscr{D}_1$, and a decision maker, $\mathscr{D}_2$, who knows the actual transition matrix $\mathscr{P}_t^*$ and acts optimally accordingly.

The analysis begins by introducing the notion of large deviations for cumulative sums, $\mathscr{S}_n$, of scalar functions of transitions of stationary Markov chains. The analysis of such large deviations proceeds naturally in view of certain matrix-iteration expressions for the moment generating functions of $\mathscr{S}_n$ and in view of the fact that moment generating functions are commonly used in the study of large deviations generally. The main result here is that the probability of a deviation of $\mathscr{S}_n/n$ beyond a number Q exceeding the asymptotic expectation of an addend of $\mathscr{S}_n$ is essentially exponential in n.

Under a certain assumption regarding "state-stationarity" of the Bayes policy for a neighborhood $\mathscr{J}$ of $\mathscr{G}_o$, the above considerations regarding large deviations yield a rate-of-convergence result for the posterior distribution of essentially this form; there is a number m depending on all the possible generalized transition matrices such that the posterior approaches degeneracy at $\mathscr{P}_t^*$ at a rate arbitrarily near e^m, with probability arbitrarily near one. Finally two additional assumptions are introduced, the first of which pertains essentially to the independence from β of the above neighborhood $\mathscr{J}$. They insure for large β, together with posterior convergence, the near-equivalence in a certain sense of the total discounted rewards of the two decision makers, $\mathscr{D}_1$ and $\mathscr{D}_2$.

Goebel, John Jeffery: "Nonlinear Regression in the Presence of Autocorrelated Errors," Ph.D. thesis, Iowa State University Library, May, 1974.

The model

$$y_t = g(x_t;\theta_o) + Z_t, \qquad t=1, 2, \ldots,$$

where $\{Z_t\}$ is a weakly stationary time series, g(.) is a function that is known except for the parameter value θ_o, θ_o is an element of the compact set $\Theta \subset R^p$, and $\{x_t\}$ is a fixed sequence such that $x_t \epsilon X \subset R^k$ is considered.

The properties of the ordinary least squares estimator for θ_o are examined, where the ordinary least squares estimator is that value of θ in Θ that minimizes

$$Q_n(\theta) = n^{-1} \sum_{t=1}^{n} [y_t - g(x_t;\theta)]^2.$$

Under regularity conditions on $\{Z_t\}$ and g(.) it is shown that $\{\hat{\theta}\}$ is strongly consistent for θ_o and that the asymptotic distribution of $n^{1/2}(\hat{\theta}_n - \theta_o)$ is normal.

Two stage estimation procedures for θ_o are investigated. An estimator of the spectral density of the time series is constructed from the least squares residuals at the first stage. At the second stage the estimated spectral density is used in a computation analogous to generalized least squares.

Under certain regularity conditions the properly normalized two-stage estimators are shown to be asymptotically normally distributed. The variance-covariance matrix of this limiting distribution is that which one would obtain if generalized least quares with a known covariance matrix was used.

Grimes, Joseph E.: "Regression Type Estimators Based on Preliminary Test of Significance," Ph.D. thesis, Iowa State University Library, November, 1973.

If data on an auxiliary variable X is available, regression-type estimators are generally used to estimate the population mean $\bar{X}$. One such estimator is the difference estimator $\bar{y}_d$ which requires knowledge of β, the regression coefficient of Y on X. If β is not known, $\bar{Y}$ is estimated by the usual regression estimator $\bar{y}_\ell$ based on the sample regression coefficient. $\bar{y}_\ell$ is in general biased and less efficient than $\bar{y}_d$. It is often possible to make an intelligent guess of β, say β_O. If the guess is correct, $\bar{y}_d$ is an appropriate estimator, otherwise $\bar{y}_\ell$ may be more appropriate. Before deciding on the estimator, it is therefore proposed to test the hypothesis $\beta = \beta_0$. If the hypothesis is rejected, $\bar{Y}$ is estimated by $\bar{y}_\ell$, otherwise by $\bar{y}_d$. The dissertation derives the mean square error of the proposed regression-type estimator and investigates its efficiency with respect to other regression type estimators, y_d and $\bar{y}_\ell$. A further extension is made of this estimator to stratified sampling.

Karpinski, Kazimierz F.: "Conditional Cap Sigmas, Factorial Experiments, and Expectation of Mean Squares," Ph.D. thesis, Iowa State University Library, May, 1974.

This study relates to the ideas of experimental structure and randomization. In previous work cap sigmas were introduced and widely used for simplicity of expression of expectations of quadratic forms, primarily in random model situations. Specialized forms of the cap sigmas, called conditional

cap sigmas, are defined in this thesis. Using the conditional cap sigmas a simple general expression is derived for the expected value of the product of any two observations in a mixed model experiment. Also, general expressions for the product of two sample means are obtained. These results are useful in deriving the variance-covariance matrix, expected mean squares for single degree of freedom contrasts, and expected mean squares in the sample analysis of variance in mixed model situations. As an application, expected mean squares and tests of hypotheses are considered in the analysis of a randomized block design with a missing observation.

In many cases expected mean squares in mixed model situations can be expressed in terms of unconditional cap sigmas. Thus, relations among the conditional cap sigmas are explored. Using these relations a necessary and sufficient condition is obtained for the ordinary unconditional cap sigma expression of the expected value of a sum of squares of sample means to hold.

For p^n factorials additional cap sigmas corresponding to $(p - 1)$ degree of freedom interactions are defined. These quantities measure variation directly related to the interaction under consideration. Applications of these cap sigmas to factorials, fractional replication and confounding are examined. Randomized fractional replication is considered for the case in which a fixed aliasing system is used and for the case in which both the aliasing scheme and the fractions are chosen at random from some subset. General expressions for variances and expected mean sqaures are derived. Various tests of hypotheses for effects and interactions are considered under certain simplifying assumptions. Factorials with confounding are considered first for the case in which a particular confounding scheme is used. In the second case levels of treatment factors are randomly permuted in the experiment. This results in a random confounding scheme. General expressions for the expected mean sqaures are obtained.

Salem, A. Shawkie: "Alernative Multivariate Normal Admissibility Criteria," Ph.D. thesis, Iowa State University Library, February, 1974.

Let $X \equiv (X_1, \ldots, X_k)$ be distributed according to the k-variate normal distribution $N(\mu, I)$.

We find that, for all k, there exist estimators $T(X)$ such that $\Pr\{|T(X) - \mu| < |X - \mu|\} > 1/2$ for all μ. We note, since orderings of Pitman-closeness type are not transitive, that this cannot however, strictly speaking, be construed as a form of inadmissibility of X.

We also study admissibility when the risk associated with an estimator $T(X)$ is of the form $R_\lambda(T) = \mathrm{Med}_\mu[\lambda(|T(X) - \mu|)]$, λ monotone increasing.

We find that X is admissible for $k = 2$ in the class of estimators $T(X)$ satisfying the following conditions:

(i) $T(X)$ of form $X.\phi(|X|)/|X|$, with $\phi(y)$ eventually (as $y \to \infty$) continuously invertible.

(ii) $\epsilon(y) \equiv [\phi^{-1}(y) - y]$ eventually positive, tending to zero and satisfying certain additional regularity conditions related to the behavior of $y \cdot \epsilon(y)$.

We find that X is inadmissible for $k = 3$; an estimate dominating X is of the form $T(X) = X.\phi(|X|)/|X|$, where $\phi(y)$, a real-valued function defined on $[0, \infty)$ in terms of two positive parameters a and k, is 0 on $[0, k/a]$ and is defined on $(k/a, \infty)$ by the fact that $\phi_{-1}(y)$ on $(0, \infty)$ is $y + k/(a + y)$.

Schmid, J. Richard: "Solution Algorithms for Markov Decision Processes and Sequential Analysis," Ph.D. thesis, Iowa State University Library, November, 1973.

This dissertation deals with Markov decision processes with finite action spaces and with Bayesian sequential analysis. Total expected discounted reward and expected regret are the respective optimality criteria. Policies are defined and several methods reviewed for determining the optimal reward function and optimal policies for known-parameter Markov decision processes, and a cost analysis is suggested for selecting one policy from a certain family of policies. Identities, leading to natural "scalar" valuations of Markov and other decision processes, are given. Policy improvement and related algorithms are extended to Bayesian Markov decision problems. Bayes policies for such problems are shown to be complete in a certain natural sense. A form of policy improvement also is suggested for Bayesian binomial sequential analysis. New evaluations of SPRT ASN's and OC's are suggested, based on the form of the optimality principle that is usual for such problems. A new type of algorithm is given for Bayesian sequential analysis, which is based on policy "ties" at critical posterior points.

Trzeciak, John M.: "A Parametric Decomposition of Geometric Programs," M.S. thesis, Iowa State University Library, May, 1974.

This study extends the decomposition concept of linearizing a geometric program which was recently introduced by Duffin. In particular, Duffin has shown that if a geometric program is constrained by prototype posynomials, then one can decompose this problem to a special class of proto-

type posynomials involving monomials, or constraints of the form

$$C \prod_{j=1}^{n} x_j^{b_j} \leq 1$$

where the b_j 's are arbitrary real numbers, C is required to be nonnegative and x lies in the interior of the positive orthant of E^n. Relying on the results of Federowicz, it is possible to solve this special class of nonlinear problems since they are synonymous with linear programming through certain transformations.

This study extends the decomposition concept of Duffin to problems which are not necessarily of the classical prototype structure, in particular, constraints which are bound below by unity and constraints composed of the differences of posynomials.

Another facet of this study will show that it is possible to decompose a maximization problem in such a manner that if the decomposed problem has an optimal solution, $(\bar{x}_o, \bar{x})$, then the original problem has an optimal solution, $\bar{x}$.

Papers and Speeches

At the national meeting of the Rural Sociological Society, College Park, Maryland, August:

Richard Warren, David L. Rogers, and Frederick T. Evers: "Interrelationships Among Goals in Farmer Cooperatives";
Gerald E. Klonglan, **Richard Warren,** and Judy Winkelpleck: "Inter-Organizational Measurement: Difference Between Hierarchical Levels of Organizations";
Richard Warren, William Kuvlesky, and George Ragland: "Relationship of Selected Factors to Race Relation Orientations of Southern Blacks: A Metropolitan—Nonmetropolitan Comparison of Texas Homemakers."

At the biennial meeting of the International Statistical Institute and the first international meeting of the International Association of Survey Statisticians, Vienna, Austria, August 19-30:

H.A. David: "Concomitants of Order Statistics";
Wayne A. Fuller: "Regression Analysis for Sample Surveys";
I.B. David and **B.V. Sukhatme:** "Bias and Mean Square Error of Ratio Estimator."

At the national SIAM-IMS fall meeting in Iowa City, October:

Chien-Pai Han and **Lonnie C. Vance:** "Distribution of Discriminant Functions with Unequal Covariance Matrices Under Interclass Correlation Models" (Preliminary Report);
H.T. David: "The Distribution of Game Values and Program Optima."

At the Joint Annual Meetings of the Statistical Societies, New York City, December 27-30:

George E. Battese and **Wayne A. Fuller:** "An Unbiased Response Model for Analysis of Categorical Data";
Shawkie Salem and **H.T. David:** "Estimating the Multivariate Normal Mean; Alternative Admissibility Criteria";
Her Tzai Huang and **Wayne A. Fuller:** "Combining Two Responses Containing Response Errors";
Richard Mensing and **J. Schmid:** "Scalar Valuations of Multi-State Decision Processes";
Edward Pollak: "Effective Population Numbers and their Interrelations";
B.V. Sukhatme and **Joseph Grimes:** "A Regression-Type Estimator Based on Preliminary Test of Significance";
J. Seely and **George Zyskind:** "On the Mixed Linear Model."

At the Midwest Sociological Society meetings, Omaha, Nebraska, April:

Richard Warren, Gerald E. Klonglan, and Judy M. Winkelpeck: "Application of an Adoption Model to Smoking and Health: The Utility for Cessation Adoption";
Charles L. Mulford, William F. Woodman, and **Richard D. Warren:** "Content and Non-content Aspects of Consensus in Normative Organizations."

At the Institute of Mathematical Statistics—143rd Meeting, Central Region, Bowling Green State University, Bowling Green, Ohio, June 10-12:

H.A. David and **M.J. O'Connell:** "Theory and Applications of Concomitants of Order Statistics";
Dean Isaacson and Richard Madsen: "L_1 Ergodic Behavior of Non-Negative Kernels";
Edward Pollak: "Sojourn Time Distributions in Some Absorbing Markov Chains Arising in Genetics."

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Michael R. Coveyou: "Data Collection and Analysis," panel discussant, at the Midwest Political Science Association meeting in Chicago, April.

David F. Cox, J.H. Goodnight, and **Richard Warren:** "Development and Usefulness of Major Statistical Package Programs in Teaching Undergraduate and Graduate Level Courses in Statistical Methods and Applications Primarily for Non-Statistics Majors: SAS; SPSS," at the Computer Science and Statistics Seventh Annual Symposium on the Interface, Ames, Iowa, October 18-19.

David F. Cox, and K. Offord: "Quality Control in Medical Technology," presented seminars to training institutes of the American Society of Clinical Pathologists, Waterloo, Iowa, December; New Orleans, Louisana, May.

David F. Cox and **Paul Hinz:** "Statistical Workshop" for crop hail adjusters, Iowa State University, December 27.

H.A. David: "Parametric Approaches to the Theory of Competing Risks," at the conference on Biometry and Reliability, Florida State University, Tallahassee, Florida, July 18-19;
"The Theory of Competing Risks," seminar at Michigan State University, April 19, 1974, and presented as an invited paper at Carleton University Statistics and Probability Day, Ottawa, Canada, April 20;
"Concomitants of Order Statistics," at a conference on applied statistics, Dalhousie University, Nova Scotia, Canada, May 3-5.

H.T. David: "Random Thoughts at Noon," Milwaukee chapter of ASA, April;
"Introduction to Game Theory," and "Statistical Consulting Case Histories," at Bethany Lutheran College, Mankato, Minnesota, under auspices of the Visiting Lecturer Program, April 22;
"Mathematical Programming and Statistics," Mathematics Department at Marquette University, Milwaukee, Wisconsin.

Roy D. Hickman: "Estimation of Agricultural Areas and Crop Yields," workshop session at the Sampling Program for Foreign Statisticians, Institute for Social Research, University of Michigan, Ann Arbor.

Paul Hinz: "A Method of Cluster Analysis and Some Applications," at the Midwest Forest Mensurationist Meetings, Oshkosh, Wisconsin, September 5,
"Numerical Classification and Some Examples," seminar for the Department of Entomology, Iowa State University, January 21.

D.K. Hotchkiss: "Mathematics at Work—Statistics," at the National Conference of the School Science and Mathematics Association, Inc., Des Moines, Iowa, November 9.

Dean Isaacson: "Ergodicity of Non-Stationary Markov Chains," seminar given to the Department of Mathematics, Iowa State University, March 26.

Oscar Kempthorne: "The Controversies on Probability and Inference," presented at seminars at the University of Iowa and Pennsylvania State University and at a colloquim for the Mathematics Department, Temple University, November;
"The Analysis of Variance," and "What Is Statistical Thinking?" under the Visiting Lecturer Program at Luther College, Decorah, Iowa;
"The Analysis of Variance and Factorial Design," at the American Mathematical Heritage Symposium on the History of Statistics and Probability, Southern Methodist University; served as a panelist for this conference, May 27-29;
"Is Statistics Dead?" Southern Regional Education Board Summer Conference in Statistics, Rollins College, Winter Park, Florida, June 12.

Edward Pollak: "Some Results on Effective Population Numbers" and "Distributions of Times Spent in Various States in Some Absorbing Processes Arising in Genetics," at the Conference on Biomathematics and Biostatistics, Washington State University, Pullman, Washington, May.

V.A. Sposito, R.J. Polo, and T.T. Lee: "Modifications of Nonlinear Equality Constraints in Nonlinear Problems," at the International ASME Design Automation Conference, Cincinnati, Ohio, September 12.

B.V. Sukhatme: "A Fresh Look at Ratio-Method of Estimation," and "Controlled Selection and Balanced Incomplete Block Designs," at the University of Poona, Poona, India, September 5-6;
"Allocation in Stratified Sampling Based on Preliminary Test of Significance," and "Ratio Method of Estimation," at the Institute of Agricultural Research Statistics, New Delhi, India;
"Preliminary Testing and Allocation in Stratified Sampling," seminar presented for the Department of Statistics, University of Waterloo, Waterloo, Canada, June 20;
"Preliminary Testing and Designing of Surveys," seminar given for the Department of Mathematics and Statistics, Carlton University, Ottawa, Canada, June 24.

S. Sukhatme: "Modified Goodness-of-Fit Tests," at the Department of Mathematics and Statistics, University of Poona, Poona, India, August 2 and 6.

Richard Warren: "Measurement in Survey Research," seminar speaker at the Interunit Methods of Social Science Series, Prairie View A & M University and Texas A & M University, January 16.

Leroy Wolins: "Absenteeism, Grievances, and Resignations from More Than 80 General Motors Plants (September, 1969, through March, 1973)," at the Midwestern Psychological Association meeting in Chicago, May 2;
Carol S. Wedin, Lloyd L. Avant, and **Leroy Wolins:** "Communication of Residential Spaces by Architectural Graphics," at the Psychology Conference, Lund, Sweden.

Participation in Professional Activities

George Zyskind served the Institute of Mathematical Statistics as program chairman for their annual meetings December 26-30 in New York City. He is a member of the society's Nominating Committee for president and council members. H.A. David was elected to the council and appointed a member of the Committee on Tables.

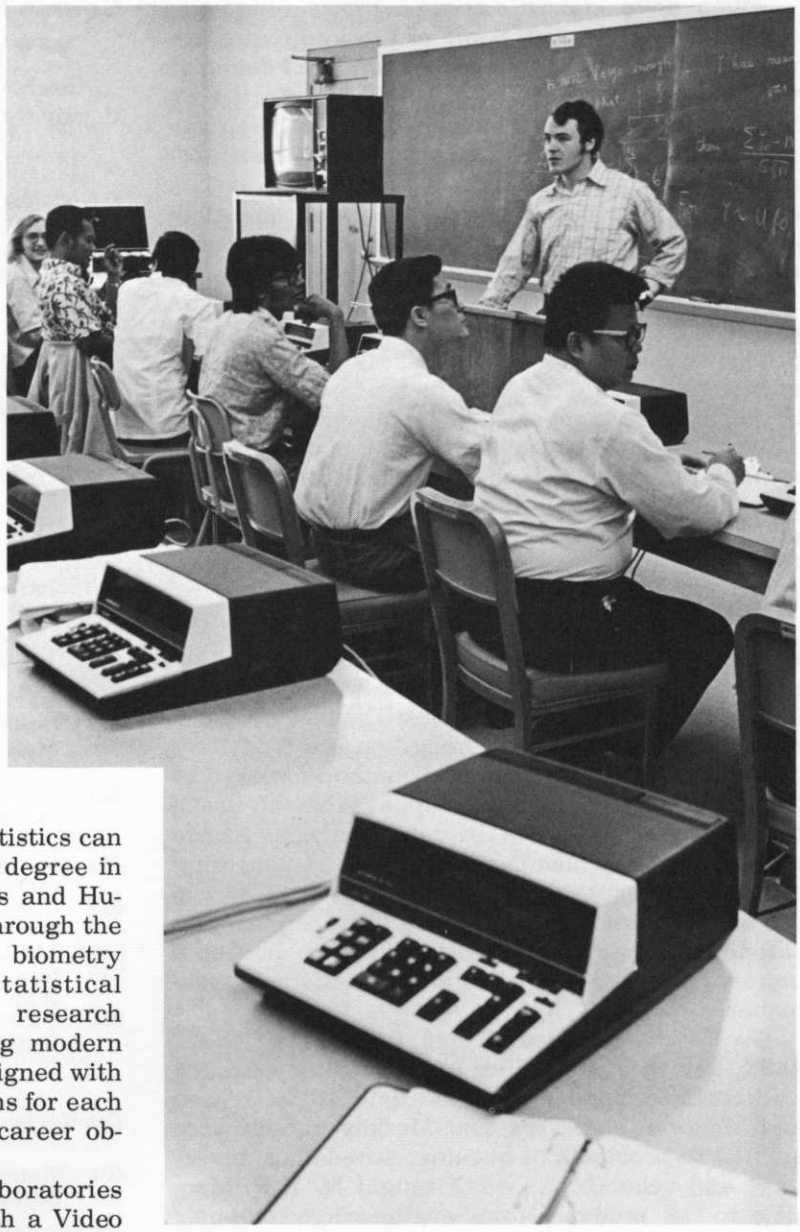
For the American Statistical Association, H.A. David is chairman of the Committee on Fellows; H.T. David is a member of the council; Richard Mensing serves on the Membership Committee; and George Zyskind is a member of the Executive Committee of the Section on Training Statisticians.

H.T. David was elected to membership in the International Statistical Institute. Dr. David continues to be actively involved with the Visiting Lecturer Program. He is a member of the Iowa State University Faculty Council, serving as chairman of the Committee on Faculty Development and Welfare and is a member of the ISU Standing Committee on Activities and Insurance.

Faculty members from the Statistical Laboratory and the Department of Statistics who serve on College of Science and Humanities committees are: Nominating, George Zyskind; Curriculum, Wayne Fuller; Special Programs and Projects, Richard Groeneveld; Honors Program, Barry Arnold; Academic Standards, Donald Hotchkiss; Graduate Curriculum, Wayne Fuller; Faculty Improvement Leaves, Herbert T. David; Nominating Committee for Distinguished Professorships and Outstanding Teacher Awards, Herbert T. David.

Susan Alice Brown was elected secretary of the home economics communications section of the American Home Economics Association. She was awarded a certificate of honor by the Ames professional chapter of Women In Communication, Inc., (WICI). The citation read: "In recognition and appreciation of services in advancing excellence in communications through Women In Communications, Inc., and for guidance and encouragement to members of the Ames student and professional chapters."

Department of Statistics



Paul DuBose, graduate teaching assistant, is photographed in his role as laboratory instructor. Two laboratories are now equiped with new Monroe 900 electronic desk calculators, as shown in the foreground.

Course work in the Department of Statistics can culminate with a B.S., M.S., or a Ph.D. degree in statistics through the College of Sciences and Humanities or a B.S. in biometry offered through the College of Agriculture. The specialized biometry program enables students to utilize statistical methods in biological and agricultural research projects. A program of study combining modern statistical theory with application is designed with core courses plus individualized variations for each student to meet personal interests and career objectives.

Each of the third floor statistical laboratories in Snedecor Hall has been equipped with a Video Systems Corporation VST/2000 Cathode Ray Tube terminal and three mobile television monitors. This equipment has been obtained under a NSF contract, administered by Richard Groeneveld, under the Undergraduate Instructional Scientific Equipment Program. The equipment provides the capability of instantaneous display of conversations with the IBM 360/65. It has been used in laboratories in statistics 101, 127, 327, and 401 to illustrate ideas such as the meaning of confidence intervals, the sampling variability of statistics, and the central limit theorem. In addition routine, but tedious, calculations with small data sets have been carried out and displayed in the classroom with apparent instantaneous response. A terminal and an associated TV monitor were used as a feature of the Veishea exhibit, displaying statistical calculations with sample data provided by the public.

Dr. D.K. Hotchkiss, who was awarded an innovative teaching grant, continued his efforts toward preparation of color video tape materials that can be used in the laboratories of the introductory statistical courses to introduce the laboratory exercise. By using the video presentation, beginning students are able to relate statistical procedures to applications in a variety of fields and see staff members they recognize who are collecting data and are interested in the statistical evaluation.

Films have concentrated on topics related to agricultural examples. Some of the interesting experiments include comparison of wild and domestic turkeys; testing corn vigor as it is affected by variety, location, and other factors; identifying and measuring fish that are collected by the shocker apparatus; observing meat spoilage and the growth of bacteria obtained from the meat; and comparing observations of live animals with measured carcass characteristics.

These experiments provide data usable for histograms, group comparisons, analysis of variance problems, regression and correlation. Student response has been difficult to measure; however, the initial reaction appeared to be an interest in the experiment and an ability to sort out sources of variability suggested in the films. It is believed that the student puts more effort into drawing proper conclusions for the experimenter than in a traditional laboratory setting.

Six experimental courses were offered during the winter quarter, two for the first time. D.F. Cox taught 26 students in 500X which will replace 402 for graduate majors in statistics. The new course is designed to expand and strengthen the treatment of standard applied statistical methods related to least squares, with special emphasis on the use of the computer as a tool in data analysis. At the request of faculty members in industrial engineering a one-credit experimental laboratory, 342LX, was initiated by Bruce Bowerman to allow engineering students taking 342, a theory course, to develop a better understanding of applied statistical techniques.

Given for the second time were 407X, 422X, 432X, and 645X. Paul Hinz introduced ten research workers to techniques of multivariate, 407X. Poisson and renewal processes and Markov chains were applied to problems of queuing, scheduling, inventory, and reliability in 432X taught by R.W. Mensing to 15 students from engineering, computer science, and statistics. A primary objective of 422X was to provide training in the design and construction of household survey samples for students in the social sciences. Harold Baker was the instructor for a class of 13. H.A. David treated the theory and application of order statistics in 645X taken by six advanced graduate students.

Most of the experimental courses are slated to become regular offerings on an annual or alternate year basis.

The past year also saw the conversion of 327 from an elective to a core course for industrial administration majors. Two or three sections were taught each academic quarter to about 75 students and attendant laboratories were provided. To handle this increase in load, the department was granted an additional faculty position.

Course Offerings in Statistics

Courses offered by the Department of Statistics during the 1973-74 academic year were:

Courses for Undergraduate Students Only

100	Orientation in Statistics	R	F*	Hotchkiss
101	Principles of Statistics	5	FWS	B. Bowerman Dickey DuBose Groeneveld Huntsberger O'Connell
104	Introduction to Statistics	5	WS,SS_1	Dickey El-Sabbagh Ghai Hotchkiss Huntsberger Otte Simon S. Sukhatme
105	Introduction to Statistics	3	FS	B. Bowerman C.P. Cox Groeneveld Huntsberger S. Sukhatme Umbach
127	Business Administration Statistics	5	FWS	Carter Karpinski Umbach
327	Elementary Business Statistics	4	FWS	Battese Groeneveld Simon
341	Introduction to Theory of Probability Statistics	3	FW	B. Bowerman Huntsberger
342	Introduction to Theory of Probability Statistics	3	WS	B. Bowerman Huntsberger
342X	342 Laboratory	1	W	B. Bowerman
343	Introduction to Theory of Probability and Statistics	3	S	Huntsberger
380	Statistical Applications of Digital Computers	3	FWS	Kennedy Smith

Courses for Graduate Minors and Undergraduates

401	Statistical Methods for Research Workers	4	FWSS_1	Arnold Bailey Coveyou C.P. Cox D. Cox Groeneveld Hickman Hotchkiss Meeden Strahan Warren Wolins

*Because the fiscal year began July 1, 1973, and ended June 30, 1974, the courses taught in the second summer session of 1973 through the first summer session of 1974 are reported here. Symbols indicate the quarter each course was taught: SS_2-Second Summer Session, F-Fall, W-Winter, S-Spring, SS_1-First Summer Session.

402	Statistical Methods for Research Workers	4	WS,SS_2	Bailey Bancroft Battese Coveyou D. Cox Groeneveld Heiberger Hotchkiss Meeden Strahan Warren Zyskind
407X	Methods of Multivariate Analysis	3	W	Hinz
411	Experimental Design for Research Workers	3	S,SS_1	D. Cox Hinz Hotchkiss Strahan
421	Survey Design for Research Workers	3	S,SS_2	B. Sukhatme
422X	Survey Sampling for Social Scientists	4	W	Baker
431	Elementary Statistical Quality Control	3	S	Mensing
432X	Applied Probability Models	3	W	Mensing
436	Genetic Statistics for Research Workers	3	F	Bailey
446	Statistical Theory for Research Workers	3	F	Hinz
447	Statistical Theory for Research Workers	3	W,SS_1	Bancroft Mensing
448	Statistical Theory for Research Workers	3	S,SS_2	Hinz Huntsberger
481	Processing of Statistical Data	2	W	Mosier
482	Processing of Statistical Data	2	S	Mosier
490	Special Problems	Arr.	F	Wolins
490H	Special Problems (Honors Program)		F	Bailey

Courses Primarily for Graduate Students, Major and Minor

500X	Statistical Methods	4	W	D. Cox
501	Intermediate Statistical Methods	3	F	Bancroft
506	Factor Analysis	3	F	Wolins
508	Sociometric Statistics	3	F	Warren
511	Design of Experiments	3	S	Kempthorne
521	Design of Surveys	3	W	Han
522	Design of Surveys	3	S	Han
533	Industrial Statistics: Reliability	3	F	Mensing
535	Biological Statistics	3	S	C.P. Cox
536	Genetics Statistics	3	F	Pollak
537	Genetics Statistics	3	W	Pollak
538	Econometric Statistics	3	F	Battese
539	Operations Research	3	W	H.T. David
540	Operations Research Methods and Economic Analysis	3	SS_1	Sposito
541	Theory of Probability and Statistics	3	F	H.A. David
542	Theory of Probability and Statistics	3	W	Meeden
543	Theory of Probability and Statistics	3	S	Arnold
544	Statistical Decision Theory	3	S	H.T. David
545	Stochastic Processes	3	SS_2	Isaacson
546	Nonparametric Statistical Theory	3	S	S. Sukhatme
549	Mathematical Programming	3	S	Sposito
580	Statistical Computations on Digital Computers	3	W	Kennedy
581	Statistical Computations on Digital Computers	3	S	Kennedy
590	Special Topics	Arr.	SS_2,FWS,SS_1	
	A. Theory			H.T. David Isaacson Meeden Mensing
	B. Methods			D. Cox H.T. David Fuller Heiberger Sposito Warren
	C. Design of Experiments			Kempthorne
	D. Design of Surveys			B. Sukhatme

Courses for Graduate Students, Major or Minor

601	Advanced Statistical Methods	3	F	C.P. Cox
621	Advanced Design of Surveys	3	W	B. Sukhatme
622	Seminar on Design of Surveys	3	S	B. Sukhatme
638	Advanced Econometric Statistics	3	W	Fuller
639	Stochastic and Continuous Programming	4	F	H.T. David
641	General Theory of Linear Hypotheses	3	F	Zyskind
642	Probability and Distribution Theory	3	W	Isaacson
643	Theory of Estimation and Testing of Hypotheses	3	S	Meeden
645X	Order Statistics	3	W	H.A. David
647	Multivariate Analysis	3	F	Han
648	Seminar on the Theory of Statistics and Probability	3	S,SS_1	Arnold Meeden
699	Research	Arr.	SS_2,FWS,SS_1	Arnold D. Cox H.A. David H.T. David Fuller Han Hickman Hinz Hotchkiss Isaacson Kempthorne Mensing Sposito B. Sukhatme Wolins Zyskind

Graduate Students

Fifteen M.S.'s and seven Ph.D.'s were earned by graduate students in the Department of Statistics this year. Abstracts of theses written in partial fulfillment of graduation requirements appear in the publications section. Positions accepted by graduates are reported as follows:

M.S. Degree Recipients

Frank E. Eaton (May, 1974, under Roy Hickman) is employed as a statistical consultant for a governmental agency in Ottawa, Canada.

Jorge Daniel Fischman (November, 1973, non-thesis, under Richard Mensing) returned to Argentina, National Institute of Statistics and Census, Buenos Aires.

Alix M. Garcia (August, 1973, non-thesis, under D.K. Hotchkiss) returned to Venezuela as a consulting statistician.

Rebecca Klemm (August, 1973, non-thesis, under Vince Sposito) taught in Des Moines, Iowa, school system through May and is now studying in the Department toward a Ph.D. degree.

Clifford Joseph Lee (August, 1973, non-thesis, under Richard Groeneveld) is employed as a consulting statistician.

Ting Kwong Lin (August, 1973, non-thesis, under E. Pollak) attends graduate school in Oregon.

Omar Estban Martinez (August, 1973, non-thesis, under D.F. Cox) returned to Venezuela, Centro de Investigaciones Agronimicas.

Antonio O. Oña (May, 1974, non-thesis, under D.F. Cox) is employed by Lockheed Electronics Co., Inc., Aerospace Systems Division, Houston, Texas.

Phantipar Sakarindr (August, 1973, non-thesis, under D. Isaacson) returned to Thailand and her job with the Royal Thai government.

William Santy (May, 1974, non-thesis, under D.F. Cox) is working for the U.S. Bureau of Mines, Denver, Colorado.

Gary E. Sime (May, 1974, non-thesis, under Richard Mensing) does not have current employment on file.

Melvin Stanard (February, 1974, non-thesis, under Vince Sposito) is a statistician, General Motors Proving Grounds, Milford, Michigan.

John M. Trzeciak (May, 1974, joint industrial engineering and statistics, under K.L. McRoberts and V.A. Sposito) remains at Iowa State to work toward a doctorate.

Tetsuo Yamada (November, 1973, non-thesis, under Richard Mensing) continues graduate study at South Hampton, England.

Dale E. Umbach (May, 1974, non-thesis, under Glen Meeden) remains at Iowa State as a doctoral student and instructor in the Department.

Ph.D. Degree Recipients

George Battese (August, 1973, under Wayne A. Fuller) remained in the Department through May as a visiting assistant professor. After June, he is lecturer in economic statistics at the University of New England, Armidale, N.S.W., Australia.

Mohamed El-Sabbagh (August, 1973, joint industrial engineering under A.C. Kleinschmidt and statistics under H.T. David) remains in the Department as an instructor.

John Jeffery Goebel (May, 1974, under Wayne A. Fuller) remains in the Department as a visiting assistant professor.

Joseph Edward Grimes (November, 1973, under B.V. Sukhatme) is an assistant professor, Department of Computer Science and Statistics, California Polytechnic State University, San Luis Obispo, California.

Kazimierz F. Karpinski (May, 1974, under George Zyskind) joined the Health and Welfare Agency of the Canadian government at Ottawa.

A. Shawki Salem (February, 1974, under H.T. David) is employed as Assistant Director, Biometrics, American Hoechst Pharmaceutical Corporation, Somerville, New Jersey.

J. Richard Schmid (November, 1973, under H.T. David) is employed by Autonetics, Clearfield, Utah.

Graduate students with a major in statistics who were enrolled during the fiscal year are:

M.S. Degree Candidates

Al-Rawi, Zeyad R.
Anderson, Jerry
Arends, William
Arthur, Humphrey
Bonczkowski, Harry
Cheng, Kou-Ping
Eaton, Frank
Fernandez, Irma
Fischman, Jorge D.
Gama, Jino V.
Garcia, Alix M.
Gomez, Santiago
Hallaman, Karen
Hansen, James
Huang, Cheng-Chi
Iwuora, Grace
Keyt, Robert
Kinyon, Lawrence
Kiregyera, Ben
Knight, Ricky
Lamyordmakpol, Anuchit
Lee, Clifford
Lin, Ting Kwong
Martinez, Omar
Matsui, Tsuru
McCormick, Gary
Michalski, Raphael J.
Moritz, Thomas
Mundstock, Elsa Contreras
Oña, Antonio
Otte, Hans
Pareja, Gilda
Parvin-Jahromi, Keramatolan
Pashazadeh-Monajemi, Mohamed
Perez, Margarita
Phoeyglin, Surin
Robles, Julio Cesar
Rockwell, Dwight
Sakarindr, Phantipar
Santy, William
Schmittling, Gordon
Sime, Gary E.
Simon, Barry
Solomon, Ann
Stanard, Melvin
Szymczuk, Michael
Tomasiewicz, Diane
Trzeciak, John
Udomsri, Choosak
Umbach, Dale
Yach, Jia Jinn
Yamada, Tetsuo
Yang, Shie-Shien
Yen, George
zumBrunnen, James

Ph.D. Degree Candidates

Aleong, John
Asok Chaturvedula
Battese, George
Bowerman, Bruce
Carter, Randy
Carvalho, Gabriela Stangenhaus
Carvalho, Jose
Chand, Lal
Chowdhury, Shyamal
Chung, Richard
Clark, Cynthia
Dickey, David
Doctor, Pamela
Dorsch, Richard
DuBose, Paul A.
El-Sabbagh, Mohamed
Emigh, Ted
Goebel, Jeffery
Grimes, Joseph
Hajela, Devendra
Hidiroglou, Michael
Huang, Elizabeth
Karpinski, Kazimierz
Kim, Gueng Ho
Klemm, Rebecca*
Meeker, Jeff
Mellon, James
O'Connell, Martin
Offord, Ken
Richards, Winston
Sakarindr, Preecha
Salem, Shawkie
Sotres, David A.
Schmid, J. Richard
Smith, Wendell
Villasenor, Jose
Wang, George
Wolter, Kirk

*Received M.S. during year.

Special post-doctoral student: Allard, Sister Nona Mary

Snedecor Award

Bruce L. Bowerman was selected by the graduate faculty as the recipient of the George W. Snedecor award for 1974. The award, established in 1954 to honor the founder and first director of the Statistical Laboratory, is given annually to the most outstanding candidate for the Ph.D. degree in statistics.

Bowerman, who received a year's membership in the Institute of Mathematical Statistics and a cash award, has been an instructor at the Statistical Laboratory since 1971. He earned a B.S. at Miami University and an M.S. at Purdue University. He served two years on the faculty of Bowling Green State University as an instructor in statistics.

Bancroft Award

Two doctoral candidates in forestry, Timothy Max and Hans Zuuring, were named joint winners of the 1974 T.A. Bancroft Statistics Award. The award which honors T.A. Bancroft, director of the Statistical Laboratory and head of the Department of Statistics from 1950-72, recognizes doctoral candidates who have a joint major or declared minor in statistics.

Max received a B.S. from Iowa State and now serves as a research assistant in forestry. Zuuring, who earned a B.Sc. from the University of Toronto, Canada, was employed as a research officer for three years with the Biometrics Branch of the Canadian Department of Fisheries and Forestry. During 1972-73 he was an associate with the Department of Statistics and is now a research assistant in forestry. The students each received a year's membership in the Biometric Society and a year's subscription to *Biometrics*.

Undergraduates

The cooperative work-study program has been continued this year with Steven Johnson and Gordon Meyer taking GS-4 traineeship positions as agricultural statisticians beginning June, 1974. Their positions are with the Office of the Statistical Reporting Service (USDA) in Des Moines headed by Duane Skow. Both students have completed their junior year and will gain practical experience in the application of statistical sampling methods.

Two undergraduate statistics majors, Mary Carter and Mary Jane Coulson, were honored by election into the Zeta Section in Iowa of Phi Beta Kappa. Mary Jane was one of 15 students elected as a junior. At the May scholarship recognition dinners, Nancee Toft, Mary Carter, and Mary Jane Coulson were recognized for their outstanding scholastic achievements.

Nancee Toft, a sophomore in biometry, received a $900 Goke Estate Advanced Curriculum Scholarship in Agricultural Science. Nancee is the second biometry major to receive this award; Diane Fitz also studied under this scholarship which provides $200 support for the sophomore year, $300 for the junior year, and $400 for the senior year.

Talents demonstrated by our undergraduates extend beyond the quantitative. For example, Mary Jane Coulson was piano soloist for the Iowa State University symphony orchestra's spring concert. She played Schumann's Concerto for Piano in A Minor, Op. 54.

Francis Diaz and Mary Jane Coulson, juniors, were inducted into Lampos, a science and humanities honorary society, May 19, 1974. Selection was made on the basis of scholarship, participation in campus activities and personal character references.

Kay Bassett, statistics major, was initiated into Alpha Lambda Delta, freshman women's honorary. Freshman women earning a 3.5 or higher are eligible for membership.

D.V. Huntsberger, D.K. Hotchkiss, and Richard Groeneveld are undergraduate advisors. Students who received the B.S. degree during the year include:

Howard James Nam, August
Jack Shoemaker (joint computer science), August
Roger Deaton (joint industrial administration), August
Steven K. Christensen (joint computer science), November
Mary Carter, February
Diane Fitz (biometry), February
Steven Kadolph, May
David Lowe (joint psychology), May
Raymond Ko (joint computer science), May
Paul Westra (joint computer science), May
Mark Steven Rees (joint economics), May

Statistics Club

Statistics Club initiated its fall activities by welcoming new freshmen to a get-acquainted picnic. Later in the fall, the students traveled to Ankeny to hear Dr. W.D. Guthrie discuss phases of the design and analyses of research projects which are conducted at the USDA research facility for biological and chemical control of corn borers.

Dr. H.T. David met with the club winter quarter to describe his experiences at the Wilton Park Conference, Steyning, England. "Employment Opportunities for Statisticians with the Federal Government" was discussed by Duane Skow who directs the Iowa Livestock and Crop Reporting Service (USDA) for the state of Iowa.

In the spring, Dr. Vernon Wright from the Boone office of the Iowa Conservation Commission spoke on "Sampling Wildlife Populations." The Veishea display, which was the principal project during spring quarter, was planned by president Gary McConnell who was assisted by Kevin Anderson, Gail Seeley, and all club members.

McConnell is the recipient of the 1974-75 Statistics Club—Science Council $100 scholarship, and Steven Johnson was awarded the $600 IBM— Statistics Club scholarship for the 1974-75 year.

Officers elected for 1974-75 are: Martha Johnson, president; Rich Zimmerman, vice president; Nancee Toft, secretary; Steve Johnson, treasurer. Dr. Hotchkiss will continue as club advisor.

Mu Sigma Rho

Joseph Grimes, who received his Ph.D. from Iowa State in 1973 and is now an assistant professor of computer science and statistics at California Polytechnic State University, was the first recipient of the newly established Mu Sigma Rho Award. The honoree's name was engraved on a plaque which is displayed in the main office of the Statistical Laboratory. Selection was made on the criteria of academic excellence, ability and background, and contributions to Mu Sigma Rho.

National officers for 1973-1976 from the Iowa State chapter include: Holly Fuchs, President; T.A. Bancroft, Vice President; Edward Pollak, Secretary-Treasurer; Oscar Kempthorne and D.V. Huntsberger, Board of Directors; and Don Hotchkiss, Past President.

At the spring meeting, Morris H. Hansen, Westat, Inc., Rockville, Maryland, reviewed principles, methods, and applications of sample surveys. He was extended an honorary membership in the organization. Ten student members and one faculty member, C.P. Han, were initiated at this meeting. Officers elected for 1974-75 academic year are: David Dickey, President; Francis Diaz, Vice President; Barry Simon, Secretary-Treasurer. Don Hotchkiss is the faculty advisor for the coming year.

A new chapter of MuSigma Rho was organized during the year at McNeese State University, Lake Charles, Louisiana.

Seminars

Weekly noncredit seminars were planned by Barry Arnold, George Battese, and C.P. Cox, assisted by Tom Moritz, student representative. Sponsored by the Statistical Laboratory and the Department of Statistics, these seminars were designed for all faculty and students. Reports and discussions on current research in statistics and statistical theory and methodology were presented. Several prominent guest speakers from other universities and organizations were featured. Topics and speakers for the fiscal year were:

Statistical Laboratory— Department of Statistics Series

Fall Quarter, 1973

September 12	Opening Seminar. H.A. David.
September 19	The Use of Interactive Computing in the Statistics Classroom. Richard A. Groeneveld.
September 26	Panel—Statistical Questions on Goodness of Fit. H.T. David, Wayne Fuller, Oscar Kempthorne.
October 3	Randomization Analysis of Experiments. Kazimierz Karpinski.
October 10	The Technology of Thought. J.M. Hammersley, University of Oxford, England.
October 24	Careful, There May Be Errors in Your Variable. Wayne Fuller.
October 31	Multiplicity Estimators in Sample Surveys. Monroe G. Sirken, Director, Office of Statistical Methods, National Center for Health Statistics.
November 7	The Errors in Variables Model when the Covariance Matrix Is Not Constant. Gordon Booth.

Winter Quarter, 1974

November 28	Power of AOV Test Procedures for Incompletely Specified Fixed Models. T.A. Bancroft.
December 5	The Theory of Competing Risks. H.A. David.
December 12	Fisher's Information Function, the Cramer-Rao Inequality and Efficiency. E.J.G. Pitman, Emeritus Professor of Mathematics, University of Tasmania, Australia.
December 19	Estimating the Multivariate Normal Mean—Alternative Admissibility Criteria. Shawki Salem.
January 9	Double Sampling with Partial Information on Auxiliary Variables. C.P. Han.
January 16	Problems of Individual Choice Under Uncertainty. Clifford Hildreth, Past President, American Statistical Association and Professor of Economics, University of Minnesota.
January 23	Early Incidents in Statistics at ISU. Jay L. Lush, Department of Animal Science, ISU.
January 30	The Ratio Estimator: Some Recent Developments. B.V. Sukhatme.
February 6	Validation of Dynamic Econometric Models. George Ladd, Department of Economics, ISU.
February 13	Goodness of Multivariate Fit. H.T. David.

Spring Quarter, 1974

February 27	Maximum Likelihood Estimation in a Stationary Distribution of Gene Frequencies. Robert J. Meier, Kansas State University.
March 6	Solving Sequential Decision Problems. R.W. Mensing.
March 13	Mohammad Huque, University of Missouri.
March 15	Sample Dependent Studentization and Tests for Outliers. James E. Gentle, Texas A & M University.

March 30	The Use of Alphabetic Segments as Sampling Units. Morris H. Hansen, Senior Vice President, Westat, Inc., Rockville, Maryland.
April 3	Topics in Stationary and Nonstationary Markov Chains Related to Computing the Expected Average Cost Associated with a Markov Chain. Bruce Bowerman.
April 10	Equivalency of Two Discrimination Procedures. Ersen Arseven, Texas A & M.
April 17	Operations Research in Water Resources Planning. Wilbur L. Meier, Jr., Department of Industrial Engineering, ISU.
April 24	Penalized Likelihood. I.J. Good, Virginia Polytechnic Institute and State University.
May 8	Concomitants of Order Statistics. Martin O'Connell.
May 15	Nonlinear Regression in the Presence of Autocorrelated Errors. Jeff Goebel.

Summer Quarter, 1974

June 18	Record Values and Record Times. Janos Galambos, Temple University, Philadelphia.
June 25	The Biplot and Some of Its Uses. K. Ruben Gabriel, Hebrew University, Jerusalem, Israel.
July 2	Concomitant Information in Competing Risk Theory. M.L. Moeschberger, University of Missouri.
July 16	Characterizations of Probability Distributions by Properties of Order Statistics. Janos Galambos, Temple University, Philadelphia.
July 22	Rao, Hartley, and Cochran's Procedure of Unequal Probability Sampling Without Replacement. Chaturvedula Asok.
July 23	The Combination of Statistical Tests of Significance, Wendell Smith.

Quantitative Genetics Series

Oscar Kempthorne and Edward Pollak organized a series of seminars on Quantitative Genetics for staff members and graduate students primarily in the disciplines of statistics, genetics, animal science, poultry science, agronomy, and horticulture. Four off-campus speakers particpated in this year's program:

February 5	The Effect of More than Two Alleles on Selection and Linkage. Dr. Marcus W. Feldman, Department of Biological Sciences, Stanford University, Stanford, California.
April 23	Gene Flow and Selection in a Cline. Dr. Montgomery Slatkin, Department of Biophysics and Theoretical Biology, The University of Chicago, Chicago, Illinois.
May 7	Use of Genetic Models in Medicine and Psychiatry. Dr. Theodore Reich, Department of Psychiatry, Barnes and Renard Hospitals, St. Louis, Missouri.
May 14	Drift Variances of Heterozygosity and Genetic Distance. Dr. Masatoshi Nei, Center for Demographic and Population Genetics, The University of Texas, Houston, Texas.

GEORGE ZYSKIND 1929-1974

We have just received the sad news of the death of George Zyskind on September 13. Dr. Zyskind died of a heart attack in Israel on his way to a faculty leave position at the Hebrew University, Jerusalem. He was born on 21 October 1929 in Lodz, Poland. With his parents and a brother he was put in Nazi concentration camps and he was the sole survivor. It may be recalled that he described some of his experiences during Holocaust Week in the Spring Quarter. After being rescued from concentration camp, he spent a short time in France, and then went to his adoptive family in Canada.

Dr. Zyskind's academic program went with great success; he received the B.Sc. from McGill University in 1953, the M.S. from Toronto in 1954, and, under the supervision of Oscar Kempthorne, the Ph.D. from Iowa State in 1958. After a post-doctoral year at the University of North Carolina, Chapel Hill, he joined the Statistical Laboratory as assistant professor and became a full professor in 1967. He directed eight students in their Ph.D. research. His professional work was recognized by the awarding of the title of Fellow in both the American Statistical Association and the American Association for the Advancement of Science. He contributed to statistical societies on several committees and was program chairman for 1973 Annual Meeting of the Institute of Mathematical Statistics. He gave greatly to the Statistical Laboratory and Iowa State University in committee activities. He contributed extensively to professional journals and meetings.

Dr. Zyskind was deeply interested in Ames community life and was president of the Ames Town and Gown Music Association from 1972 to the present.

He is survived by his wife, Judy, and two daughters, Aviva, 6, and Joy, 5, in California; several members of his adoptive family in Canada; and a cousin and aunt in Haifa, Israel.

A George Zyskind Memorial Lecture Fund has been established with the Iowa State University Alumni Achievement Fund. Contributions may be sent to room 242, ISU Memorial Union.

A publication of the Statistical Laboratory
Iowa State University