STATISTICAL LABORATORY

established 1933

$$\sigma^2 \mu \Omega \sum \chi^2 \beta$$

annual report

July 1, 1989 to June 30, 1990

IOWA STATE UNIVERSITY, AMES

Contents

THE STATISTICAL LABORATORY
Iowa State University
1989-90 Annual Report

Mission and Reassessment

The ISU statistical center, like the rest of the university, and like its counterparts elsewhere in the state, has been involved in a prolonged period of self-study and reaffirmation. The university's long-range strategic planning discussions have led to some positive recommendations for the mathematical sciences.

Teaching, research, and consulting are essential to the mission of a land-grant institution. The departments of Computer Science, Mathematics, and Statistics are all being encouraged in their efforts to strengthen those areas. Upgrading and expansion of computational facilities on campus continues, and includes specific improvements for the three mathematical science departments.

The College of Liberal Arts and Sciences (formerly Sciences and Humanities, renamed July 1990) is formulating a strategic plan for the college that supports growth and development in the three departments. This plan, to be released in fall 1990, is based on the detailed planning phases carried on in the last several years by departments, programs, and broader divisions of the university.

An overall goal of the university is to become a top-rank institution of higher learning. It is recognized that statistics at ISU continues to be a strong, internationally known area of excellence and that statistics plays a significant role in research efforts throughout the university. At the same time, the department is understaffed in both its disciplinary core and its joint appointments with other parts of the university. In view of this dilemma, we look forward to support that will allow the department to grow and meet the increased demands in research, teaching, and consulting.

The need for strengthening research in the mathematical sciences goes beyond ISU. The 1990 National Research Council report, *Renewing U.S. Mathematics: A Plan for the 1990s,* updated the 1984 "David Report." While reporting on some exciting recent achievements in mathematical sciences research, it makes an urgent call for "further corrective action . . . to ensure the vitality of U.S. mathematics." The persisting need for increased research support for individual investigators and the critical shortage of qualified researchers in the mathematical sciences are emphasized. If this need is addressed by the federal government through additional funding, we expect that the mathematical sciences at ISU will be positioned to be part of that research effort.

The teaching responsibilities for the Department of Statistics continue to grow, especially in the area of undergraduate service teaching. We have requested a faculty position joint with the College of Business Administration for assistance with Stat 227 and Stat 328. Some progress has been made with the College of Engineering through a joint appointment with the Department of Chemical Engineering for next year (see p. 4). An added joint appointment is being sought for someone with a primary area of application in mechanical engineering or electrical engineering— to assist with Stat 305 and Stat 333. Other needs specified by the department are for more teaching assistants to handle the rest of the increased teaching load from undergraduate engineering and business administration students and to expand the use of computers in the laboratory sections of statistics courses.

As agricultural and biological research takes new directions, the Department of Statistics and the Statistical Laboratory must be ready to help. The need for statistical help in the social sciences continues to grow. A third area of emphasis is in applied research in the physical and engineering sciences. These areas of cross-disciplinary collaboration provide challenges to the statisticians to improve theory and methods that could be applicable.

Furthermore, Iowa State recognizes that the other components of the mathematical sciences— mathematics and computer science—need to be strengthened. Staff additions and increased support for research and researcher training have been proposed at both the national and college levels. One major purpose of the increased level of funding is to encourage young people to enter and remain in mathematical sciences careers, targeting especially women and minorities. The retention of students in the mathematical sciences is a national issue, since the pool seems to shrink markedly every year.

The problem of attracting young people into the field of statistics is particularly difficult. We not only need to keep students in the mathematical sciences, but we also must introduce them to statistics as a field of study. Unfortunately, most high school counselors and instructors are not familiar enough with statistics to recommend it. The American Statistical Association sees this as an important issue for the 1990s and is introducing programs to make us more visible at the high school, and even junior high, level.

At Iowa State, we are increasing our efforts in this area (see p. 42). The field of statistics would benefit if more professional statisticians communicated with high school teachers and counselors to introduce them to the challenges and rewards offered by statistics. Perhaps more students will continue to study the mathematical sciences if they realize it leads naturally to jobs involving research in the health sciences, social sciences, agricultural and biological sciences, and engineering sciences.

Now that the Durham Center for Computation and Communication has been completed, a suite of rooms on the second floor of Snedecor Hall has been

turned over to the statistical center. This has provided much needed offices, but we must improve the quality of our space. A plan to remodel Snedecor Hall was drawn up in 1988 and needs to be implemented soon.

At the American Statistical Association Sesquicentennial at the 1989 joint statistical meetings, we reviewed our history. *The Amstat News* September-October 1989 issue singled out the ISU poster for special mention among those at the historical poster session. (See pp. 21-23 of this annual report.) The purpose of our strategic planning is to ensure that several decades from now we can look back on a similar outstanding history.
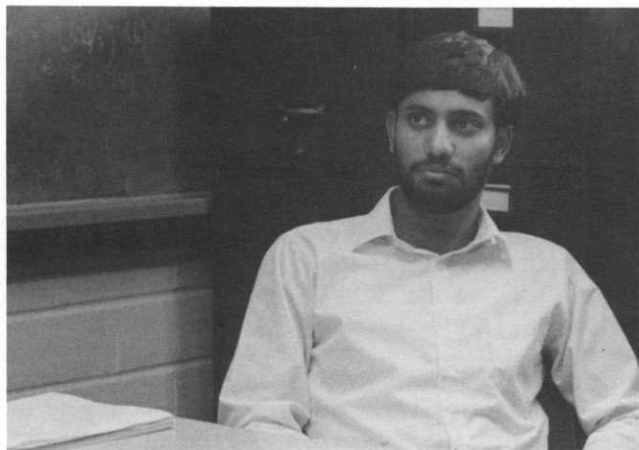
Soumendra Lahiri (above), who joined the faculty in August 1989, has research interests in bootstrap approximation, asymptotic expansions, sequential point estimation, and limit theorems in dependent setup.

Glen Meeden (L below) confers with graduate student Alan Zimmermann at a Stat Lab fall picnic.

Leroy Wolins (R below) muses aloud concerning his family, his career, and his future at a dinner held in his honor at the Gateway/Holiday Inn.

Personnel

Glen Meeden completed a six-month period as an American Statistical Association research fellow on July 14, 1989. He had been stationed at the Bureau of Labor Statistics, Washington, D.C. Meeden subsequently resigned from ISU to accept a position as professor in the Department of Theoretical Statistics, University of Minnesota, beginning September 1, 1989. A dinner in his honor was held at the ISU Memorial Union on October 7. He had been on the statistics faculty here since 1968.

Soumendra Lahiri joined the Department of Statistics in August as assistant professor to fill the position left vacant by Meeden. Lahiri completed his Ph.D. degree in statistics at Michigan State University in 1989 and had received earlier degrees in statistics from the Indian Statistical Institute, Calcutta.

W. Robert Stephenson was on faculty improvement leave for the 1989-90 academic year, to teach in the Department of Statistics, University of Newcastle, New South Wales, Australia, and consult on quality control problems in the Newcastle area.

Mack C. Shelley II was on faculty improvement leave for the fall semester primarily for research on congressional influences on public policy.

Leroy Wolins retired from the faculties in psychology and statistics effective December 31, 1989. He was honored at a reception in December and a banquet on
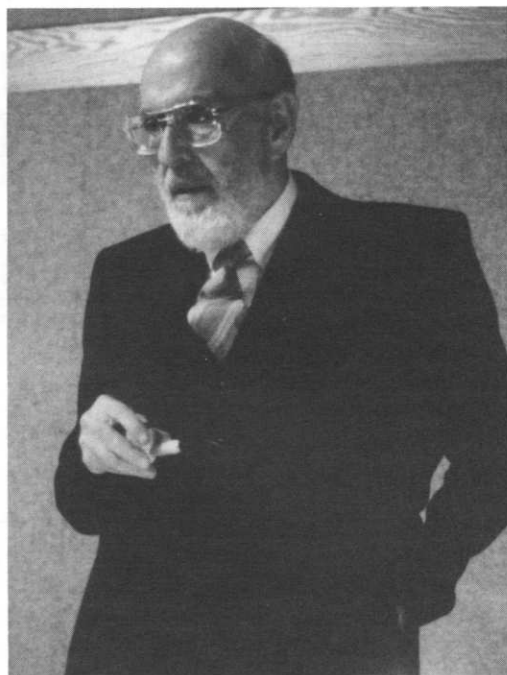
February 27, 1990. He has been named professor emeritus.

Wolins came to Iowa State on a joint appointment as assistant professor in 1957, from Chicago, Illinois, where he had been assistant director of the Test Research Department, Science Research Associates. He has taught mainly courses in statistical methods and psychological measurement. He was a guest professor at the University of Bern, Switzerland, in 1969-70 and at the University of Marburg, Germany, in 1973 and 1975. His research has been primarily in the area of psychological statistics. A particular interest was the critical evaluation, or secondary analysis, of others' research. This led to his book, *Research Mistakes in the Social and Behavioral Sciences* (Iowa State University Press, 1982). He has engaged in extensive offcampus consulting on statistical methods with industry and plans to continue this activity.

C. Philip Cox retired from the faculty on May 20, 1990. He joined the Statistical Laboratory and the Department of Statistics in 1961 as associate professor of biological statistics, and became co-director of the National Institutes of Health-supported graduate training program in biostatistics at Iowa State for the period 1961-1972. Previously he had been a postgraduate research scholar at Rothamsted Experimental Station and, for a number of years, head of the Section of Statistics, National Institute for Research in Dairying, University of Reading, England. He had been a visiting associate professor here in the 1959-60 year.

Cox has taught a variety of courses in statistical methods, biological assay, and biomathematics. His research has concerned design of experiments, linear and nonlinear regression, multivariate analysis, ratio estimation, and sequential analysis. He is author of the 1987 Wiley textbook, *Handbook of Introductory Statistical Methods,* and plans to continue professional writing as professor emeritus.

Stephen Haslett, associate professor in the Survey Section, remained in New Zealand, on leave without pay from ISU, while waiting for his green card to emigrate to the U.S.

Sushama Bendre accepted a six-month appointment as postdoctoral research associate, beginning July 16, 1989, to work on order statistics, under H. A. David's research grant. She has been a lecturer in statistics in the University of Bombay, India, since 1985 and holds a doctorate in statistics from the University of Poona.

Christopher J. Skinner joined the Statistical Laboratory Survey Section as visiting associate professor for the period January 1-May 31, 1990. He is on leave from the position of senior lecturer, Department of Social Statistics, Southampton University, U.K. Skinner received his Ph.D. degree at Southampton in 1982.

Alicia Carriquiry accepted a temporary position as postdoctoral associate with the ISU Center for Agricultural and Rural Development (CARD), beginning January 15, 1990, to provide statistical expertise for projects in which both the center and the Statistical Laboratory Survey Section are involved.
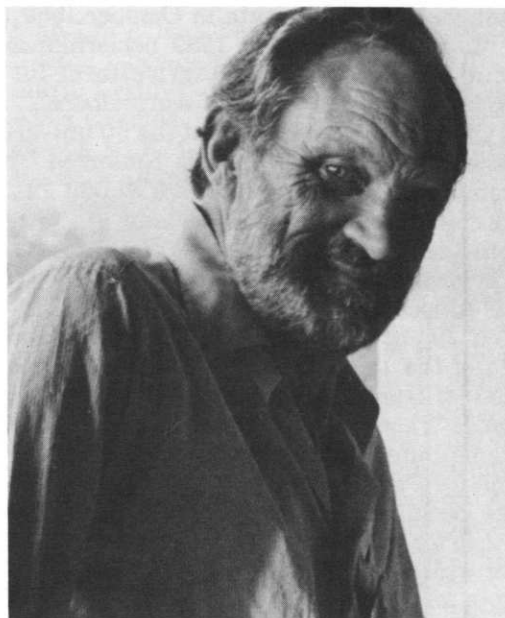
C. Philip Cox formally retired at the end of the academic year, but we expect him to remain a familiar figure in Snedecor Hall.

Patrick Homblé was appointed as a temporary instructor for spring and summer 1990. He completed the requirements for his doctorate in statistics and probability in mid-May.

Several visiting scholars spent part of the year in residence. Kermit G. Clemans, emeritus professor of statistics at Southern Illinois University-Edwardsville, was here from August 29 until December 22, 1989, primarily studying order statistics. Kwang-Hun Kim, associate professor of statistics at Hyosung Women's University, Tae-Gu City, South Korea, completed a year in residence on December 27; his research has been primarily with John Stufken in the field of experimental design (see p. 13). In August 1989 Xiu-chi Wang completed an eight-month stay here to do study and research in quality control and reliability, and returned to his position as engineer in the Guizhou Provincial Bureau of Standards, People's Republic of China. Che-Ping Lee, on leave from the position of professor, Department of Applied Mathematics, National Chung-Hsing University, Taichung, Taiwan, arrived August 15 to engage in research in probability and stochastic processes and their applications, collaborating with Krishna Athreya. Lee returned to Taiwan May 31, 1990. Byoung Jin Ahn came here on January 1, 1990 to do research in statistics with Herbert T. David. He is on leave from the Department of Applied Statistics, Kon-kuk University, Seoul, Korea, on a one-year postdoctoral fellowship from the Korea Science and Engineering Foundation.

Subhash Lele came for two weeks beginning on November 5, 1989, mainly to do joint research, under Noel Cressie's National Science Foundation grant project, on construction of models for Markov random fields and on spatial bootstrapping. Lele is an assistant professor in the Department of Statistics, Johns Hopkins University.

Krishna Athreya was elected as a member of the

International Statistical Institute in October 1989.

Jerome M. Sacks received a 1989 performance rating of "outstanding" from the Agricultural Research Service, U.S. Department of Agriculture.

William Q. Meeker, Jr., won one of the 50 university-wide teaching excellence awards conferred by ISU in December; the award includes a $1,000 gift.

Roy Hickman and William J. Kennedy, Jr., were inducted into the 25-Year Club at its 57th annual banquet on February 26. The club is sponsored by the ISU Alumni Association.

On March 29, H. A. David and his wife, Vera, received one of the 1990 Human Relations Awards given by the ISU Human Relations Committee. The annual awards "recognize groups and individuals who have contributed significantly to the advancement of human relations within and among all segments of the campus community." The nominators cited the couple for what they have done individually and together while at ISU. H. A. David was honored for working to foster diversity in the Department of Statistics and for attracting international students and faculty to the university. His wife, honored for her work with Amnesty International and her work against sex discrimination, was the driving force for years in a campus group known as Statistics Women, made up of faculty, graduate students, and spouses. This group organized departmentwide functions, such as the winter party (now hosted by Iowa STAT-ers), that have become traditional events in the statistical center. Also noted was the Davids' custom of inviting international statistics graduate students into their home each year for Thanksgiving dinner. Plaques were presented to the award winners in a ceremony at the home of ISU President Gordon Eaton.

Krishna Athreya went to India on May 23, primarily to visit the Indian Statistical Institute in Bangalore and Calcutta during the summer.

Looking toward next year: Alicia Carriquiry has been appointed assistant professor of statistics, effective August 21, 1990, as a joint appointee with CARD. She will be teaching courses in statistical methods and working with the Center for Agricultural and Rural Development and the Survey Section of the Statistical Laboratory on joint projects. She received a doctorate in statistics and animal breeding from Iowa State in 1989.

Derrick Rollins has been appointed assistant professor of statistics and chemical engineering, effective August 21, 1990. Another new joint appointment with engineering was not filled this year but will be opened again next year.

Mack C. Shelley II has been promoted to professor of political science and statistics; Carl W. Roberts, to associate professor of statistics and sociology with tenure.

Noel A. C. Cressie will be on faculty improvement leave for the calendar year 1991 to conduct research on spatial statistics while at the Australian National University and Stanford University. Debapriya Sengupta and Stephen J. Haslett will be on leave without pay during the fall semester of 1990-91.

Statistical Laboratory Staff—Fiscal Year 1989-90 under the administrative direction of:

Gordon P. Eaton, Ph.D.—president of the university

Norman L. Jacobson, Ph.D.—associate provost for research; dean of the Graduate College (until September 30)

Patricia B. Swan, Ph.D.—vice provost for research and advanced studies; dean of the Graduate College (beginning October 1)

David F. Bright, Ph.D.—dean, College of Sciences and Humanities; director, Sciences and Humanities Research Institute

David G. Topel, Ph.D.—dean, College of Agriculture; director, Iowa Agriculture and Home Economics Experiment Station

Dean L. Isaacson, Ph.D.—director, Statistical Laboratory; head, Department of Statistics; head, Statistics Department, Iowa Agriculture and Home Economics Experiment Station

Professors

Krishna B. Athreya, joint appointment with Department of Mathematics

Theodore B. Bailey, Jr.

C. Philip Cox

David F. Cox

Noel A. C. Cressie

Herbert A. David, Distinguished Professor in Sciences and Humanities

Herbert T. David, joint appointment with Department of Industrial and Manufacturing Systems Engineering

Wayne A. Fuller, Distinguished Professor in Sciences and Humanities; faculty status also in Department of Economics

Richard A. Groeneveld

David A. Harville

Roy D. Hickman

Paul N. Hinz, faculty status also in Department of Forestry

Donald K. Hotchkiss

David V. Huntsberger, professor emeritus

Dean L. Isaacson

Oscar Kempthorne, emeritus Distinguished Professor in Sciences and Humanities

William J. Kennedy

Kenneth J. Koehler

Glen D. Meeden

William Q. Meeker, Jr.

Edward Pollak, joint appointment with Department of Genetics

Jerome M. Sacks, USDA collaborator

Vincent A. Sposito, joint appointment with Computation Center

Robert F. Strahan, joint appointment with Department of Psychology

Norman V. Strand, professor emeritus

Stephen B. Vardeman, joint appointment with Department of Industrial and Manufacturing Sys-

tems Engineering

H. Samuel Wieand, Mayo Clinic collaborator

Leroy Wolins, joint appointment with Department of Psychology

Associate Professors

Yasuo Amemiya

Frederick O. Lorenz, joint appointment with Department of Sociology and Anthropology

Mervyn G. Marasinghe

Mack C. Shelley II, joint appointment with Department of Political Science

Christopher J. Skinner, visiting

W. Robert Stephenson

Shaskikala Sukhatme

Temporary Associate Professor

Stephen J. Haslett

Assistant Professors

Harold D. Baker

Carl W. Roberts, joint appointment with Department of Sociology and Anthropology

Temporary Assistant Professor

Soumendra N. Lahiri
Debapriya Sengupta
John Stufken

Temporary Instructor

Patrick Homblé

Resident Collaborator

Dean Thompson, USDA Soil Conservation Service

Visiting Research Scholar

Byoung Jin Ahn
Kermit G. Clemans
Kwang-Hun Kim
Che-Ping Lee
Xiu-chi Wang

Postdoctoral Research Associate

Sushama M. Bendre

Graduate Assistants

The status of graduate students often changes. Students holding appointments as graduate teaching or research assistants in statistics for part or all of the year are listed here.

Scott Andersen	Todd Borchert
Douglas Andrews	Linda M. Brands
Lori Becker	Michael R. Carley

Man-Lai Alice Cheng
Risana Chowdhury
Marie Coffin
Alice Cramer
Joseph H. R. Croos
Barbara Dombroski
(Corning Glass scholar)
Karen Drinkwater
Dawn DuBois
(Shell scholar)
Shelly L. Gregory
(Shell scholar)
Richard R. Griffiths
Jeffrey Helterbrand
Jeffrey D. Hofer
Susan L. Holman
Sarah F. Howard
(Corning Glass scholar)
Philip W. Iversen
Mark S. Kreisberg
John P. Lagus
Ding-Hwa Dean Lei
Klaus W. Lemke
Seung-Chun Li
Chiou-Hua Lin
Jingyu Liu
Cynthia Long
Thomas M. Loughin
(Corning Glass scholar)
Chi-hsien Joseph Lu
Chueck-Wah Stella Luk
David G. McDonald
Jae P. McKeown
Frederick M. Medak
Carol Anne Meeter
Rochelle L. Milbrath
Daniel Mundfrom

Hamid Navvabpour
Bryan D. Olin
(Shell scholar)
Heon Jin Park
Robert L. Parker
Peter B. Peterka
Amanda Prestwar
Stephen Rathbun
(Shell fellow)
John T. Reese
Paul J. Roback
Philip H. Ross
Leroy N. Rushing, Jr.
Todd M. Sanger
(National Science Foundation fellow)
Sahadeb Sarkar
Mary E. Sayler
Dongwan Shin
Diane S. Sly
Kai-One Sriplung
David D. Steenhard
Gary R. Sullivan
Wendy J. Swanson
James T. Symanowski
Teresa A. Takle
Margot Tollefson
Daniel E. Walczak
Chung-Ching Morgan Wang
Kui-Jang Wang
Amy Hewitt Weaver
Steven Wilmarth
Barbara J. Worth (Corning Glass scholar)
Ibrahim Yansaneh
Seongmo Yoo
Yunn-Hwu Yu
Alan G. Zimmermann

Supported Graduate Students

Abdoulaye Adam—USAID-Niger and U.S. Department of Agriculture

Maria Theresa Agatep—USAID-PIET

Mahmood Ahmad—USAID-Pakistan

Aminul Akbar—MUCIA-USAID-Indonesia

Abdullah Al-Shiha—Kingdom of Saudi Arabia

Munther Ali A. Al-Zaid—Kingdom of Saudi Arabia

Victor Brescia—Center for Agricultural and Rural Development, ISU

Abderrahmane Chakak—Fulbright

Paula Lasack Davis—Department of Entomology, ISU

Mary Anne Dellva—Veterinary Medicine Research Institute, ISU

Djamal—Government of the Republic of Indonesia

Gerri M. Dunnigan (Shell scholar)—ISU Center for Nondestructive Evaluation

Cathalina M. Garcia—USAID and University of Costa Rica

Christian Garrigoux—Monterrey Institute of Technology, Mexico, and Institute for Physical Re-

search and Technology, ISU

Mu-Yeh Huang—Department of Industrial and Manufacturing Systems Engineering, ISU

Ihsan Karabulut—Gazi University, Turkey

Yung-Seop Lee—Department of Textiles and Clothing, ISU

Carlos Moreno G.—USAID/FES

Yvon Nininahazwe—USAID-Burundi

Sarah Nusser (Shell fellow)—ISU Center for Agricultural and Rural Development

Dwayne Pepper—Engineering Research Institute, ISU

Beta Putranto—MUCIA-AID-Indonesia

Jennifer Riddell—Department of Child Development, ISU

Abdul Wajid Rana—USAID-Pakistan

Sallem Remadi—USAID-Tunisia

James Robison-Cox—Department of Entomology, ISU

Ann C. Russey—College of Family and Consumer Sciences, ISU

Muhamad Sabran—Government of Indonesia

Theresa Scheetz—Department of Psychology, ISU

Blake A. Smith—College of Business Administration, ISU

Harouna Soumare—USAID-Dakar

Ibrahim Talib—Kingdom of Saudi Arabia

Muhammad Tiro—MUCIA-AID-Indonesia

Scott Vander Wiel—ISU Center for Nondestructive Evaluation and General Electric Company

Jay Ver Hoef—Department of Botany, ISU

Anand Vidyashankar—Department of Mathematics, ISU

Mark Wellman—Department of Industrial and Manufacturing Systems Engineering, ISU

Christine M. Whitney—Iowa Quality Coalition

Abera Wouhib—UN FAO

Ilker Yalçin—Hacettepe University, Turkey

Self-Supporting Graduate Students

Ahmad M. A. Al-Mahmoud	Bojein Kuo
Jonathan Biele	Shou-Ren Lai
Chao-Yin Chen	Kye-Don Lee
Ching-Ju Diane Chen	Ming-Yu Lee
Kehang Chen	Shu-Hua Lee
Shih-Neng Chen	Chia-Lin Li
Yi-Ju Chen	Kuo-Chin Lin
Jia-Chyi Chiu	I-Ming Liu
Jihwan Cho	Dze-Hwei Lyan
Tae-Kyoung Cho	Chuan-Chuan Ma
Ching-Yi Chung	Barnabas Misambo
B. Keith Cranford	Chongsun Park
Clarice Freire	Sangun Park
Geun Shik Han	Ru-Shuo Sheu
Seung-Ho Han	Suharno
Khalifa M. A. Hassanain	Pei-Ying Sun
Taekyu Hwang	Hiroshi Takahashi
Shin-Soo Kang	Steven Wall
Yu-Ling Kao	Wei Wang
Georgene Kelly	Shu-Yuan Yen
Seoung-Gon Ko	Yung-Li Yen

Professional and Scientific Staff

Dianne G. Anderson, research associate, Survey Section

Marvin S. Beck, programming consultant, Survey Section, joint appointment with Computation Center, until April 30, 1990

Richard Dorsch, programming consultant, Survey Section

Mary Genalo, survey projects coordinator, Survey Section

Edith Landin, administrative assistant

Marie Loughin, research associate, Survey Section, for December 1989

Bud Meador, supervisor, Statistical Data Processing Services

Deborah Reed-Margetan, analyst, Survey Section

Janet L. Schultz, programmer, Survey Section

Kathleen Shelley, specialist, Statistical Numerical Analysis Services

Melissa J. Swanson, programmer, Survey Section

Harvey Terpstra, data systems manager, Survey Section

Douglas L. Tschopp, programmer, Survey Section

Jauvanta Walker, information specialist

General Office Staff

Rose Ann Anderson, secretary

Norma Elwick, secretary

Janice Franklin, account specialist

Brenda Hewitt, clerk typist

Jeanette Lagrange, clerk typist

Denise Riker, secretary

Sharon Shephard, clerk typist

Margaret Wheelock, clerk typist

Darlene Wicks, clerk typist, Statistical Numerical Analysis and Data Processing Section

Survey Section Staff

Glenda Ashley, key entry operator

Kathryn Bottorff, field interviewer

Jean Carey, telephone interviewer

Lee Chu, research assistant, until August 15, 1989

Dorothy Edwards, statistical clerk

Sharon Erbach, telephone interviewer and supervisor

Marcia Fuze, field interviewer

Vimlesh Gupta, key entry operator

Nancy Heathman, account clerk

Marlys Huff, field interviewer

Helen Nelson, secretary

Christine Olson, clerk typist, until September 22, 1989

Kathie Reinertson, data technician

Jasmine Seagrave, data technician

Judy Shafer, clerk-typist, beginning October 16, 1989

Susan E. Verkade, data technician

Karon White, key entry operator

Consulting and Cooperative Research

Statistical consulting and research services are provided to other parts of the university and to local, state, and federal agencies as time and funds permit. Some of this work is supported by contracts and grants.

■ 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 the biological, agricultural, and health sciences. The core statistical consulting staff in these areas consists of T. B. Bailey, D. F. Cox, Paul Hinz, and D. K. Hotchkiss, who were assisted this year by graduate students Mary Anne Dellva, John Lagus, Tom Loughin, and Barbara Worth. (Dellva was supported by the College of Veterinary Medicine.) Other members of the statistical center interact with the consulting group and, as needed, consult with experiment station researchers.

Taxonomic data from a large number of South American grass species were analyzed to determine groups of taxonomic measurements that gave similar information and to place species in taxonomic groups. Paul Hinz used the techniques of principal components analysis and factor analysis in this study.

Jeff Hofer, a graduate student supported by the U.S. Department of Agriculture, and Paul Hinz traveled to the McNay research farm in southern Iowa to observe two field experiments that were designed to study how weed populations were affected by tillage, crop rotation, and herbicide application methods. Hofer analyzed two years of data from these experiments and was confronted with the problem of how to summarize the information in measurements made on the number of different weed species. That problem was solved by using principal components analysis on the treatment means of the major weed species. Principal components were then calculated for the treatments and correlated with the average grain yields for those treatments.

Barbara Worth analyzed data from a Department of Food and Nutrition study on the oxidation of soybean oil in storage. The study used two commercial antioxidants and an oat extract and exposed the oils to three levels of temperature. The rate of oxidation is initially slow during the so-called induction period and then changes quickly to a rapid rate. The relationship was approximated by two straight lines that were fitted by use of nonlinear least squares. The variables analyzed in the study were the length of the induction period and the slope of response during the period of rapid oxidation.

Field experiments that compare soybeans for iron chlorosis often encounter great heterogeneity in soil conditions. One way of accounting for the heterogeneity is to use a nearest-neighbor type of covariate. John Lagus compared the effectiveness of four different covariates in data from an experiment that used 620 varieties in four randomized complete blocks. He found that an average of 14 residuals from nearby plots was the most effective in reducing the mean square for error.

A series of experiments were conducted to determine if the amount of carryover of a soybean herbicide from the previous field season could be detected by raising corn in a greenhouse using soil samples from the affected fields. The experiments used known rates of herbicide and measured plant properties such as height and weight. Mary Anne Dellva analyzed data from these experiments by use of linear calibration techniques. She concluded that the rate of herbicide application cannot be reliably predicted from plant measurements.

Tom Loughin analyzed data from a study in the Department of Animal Ecology on the nesting and fledging characteristics of the kestrel, a small falcon. Kestrels are unusual in that they will nest in boxes attached to the back side of highway signs along the interstate highways in Iowa.

■ Statistical Computing Section

The name of the Statistical Numerical Analysis and Data Processing Section of the Statistical Laboratory was changed to the Statistical Computing Section in October. The new name is more consistent with the section's activities and with terminology in current use in the statistics community. The previous name was adopted more than 25 years ago.

The section continues to provide statistical computer programming and data processing support for research projects conducted both on and off campus. Its members develop software for special applications, design and install databases for general use, maintain general-purpose software systems, and consult on problems related to scientific applications of digital computers. Teaching and research activities for the section are led by William J. Kennedy, Vincent Sposito, and Mervyn Marasinghe.

Project Vincent, named for John Vincent Atanasoff, is the major new development in computing beginning on campus this year. Announcement came in May 1990, along with a call for proposals for workstations. This project will implement a campus-wide network of hardware services and system software based on the design of Project Athena at the Massachusetts Institute of Technology. The new ISU network will feature a 100-megabits-per-second fiber-distributed data interface to augment the interbuilding ethernet service now available. Project

Vincent will also include a major infusion of high-performance UNIX-based RISC workstations.

The proposal submitted by the Statistical Computing Section has been funded; accordingly, a DEC 5000 workstation and two DEC 2100 workstations are scheduled for installation during summer and fall 1990. The Statistical Laboratory and the Department of Statistics will receive six additional workstations of various sizes during the next year. These machines, operating in the campus distributed computing network, will significantly increase the amount of computing support available for research in statistics.

The consulting workload of the section continues to increase. Heavy involvement with computing hardware components is unavoidable now that very portable devices are in widespread use. Even a few years ago, support requirements in this area did not exist. That fact, coupled with the arrival of hundreds of new software systems on campus, has produced a continual stream of consultees with a wide variety of problems.

Programming service support requirements have also changed with the changing computing environment. The section is still organized into two groups, supervised by Bud Meador and Kathy Shelley, respectively, and this organizational structure continues to work well. The effects of changes in the computing environment, however, become apparent in the work done within these groups. Specific projects supported by the section in 1989-90 are described as follows.

Dan Walczak transferred from the Department of Mathematics to Meador's group in the middle of the fiscal year, replacing Dave Steenhard who graduated with an M.S. degree in December. Both Walczak and Steenhard spent considerable time on the annual Iowa Corn Yield Test Report. This effort covered the analysis of the 1989 yield data collected from seven areas of the state, and the preparation of tables, graphs, and other data for the final report. The Iowa Corn Yield Test, now in its 71st year, provides corn growers with unbiased information on which varieties to plant. The supporting data and tables in the 1989 report were edited into text files on floppy diskettes as a supplemental distribution medium.

Phil Iversen spent most of his time on the State Forest Nursery Project, a dynamic data system which Meador's group has been involved with for a number of years. His programming and system development work supported new reports, changes in the billing procedure, and installation of new equipment and programs associated with bar-code technology. The need for more timely information, such as the status of a specific order for trees, led to a decision to revise the computer software and data structure to permit multi-user access via a Local Area Network. The experience and knowledge gained on the Nursery LAN Project will be useful in the immediate future when Project Vincent applications begin arriving in the Statistical Computing Section.

Klaus Lemke, Dave Steenhard, and Dan Walczak worked on transfer of the CIRAS database from the

Kathleen Shelley and Morgan Wang share the distinction of having won first-place in Zenith's Masters of Innovation competitions. Wang, a 1990 winner, was awarded a Zenith 386/20mhz computer with a VGA monitor and some software. Shelley was a 1989 winner.

mainframe computer to the PC. This transfer is virtually complete. Lemke handled much of the dBASE IV programming and data structure development, as well as dBASE III-to-dBASE IV upgrade. When CIRAS (ISU's Center for Industrial Research and Service) moved its office from "next door" to a more remote location in the ISU Research Park facility, the added distance put more urgent emphasis on data communications and control of remote computer processes. Three or four PC-to-PC communication programs have been tried so far, but no single system or program has provided an acceptable solution.

Bud Meador's group provides campus support for PC/SAS*. A portable (Zenith 386 Turbosport) machine is used to transfer new software releases PC-to-PC via direct coupling of serial ports. This has proved to be an effective means of file distribution.

In 1989-90, Kathy Shelley's group included Mike Carley, Morgan Wang, Dean Lei, Alice Cheng, and Rochelle Milbrath. PC Data System Design is one specialty of the group. This was exemplified by Morgan Wang's winning entry in the 1990 Zenith Masters of Innovation Contest. His paper was inspired by a Virus Identification Project for which he wrote a FORTRAN program to estimate the bonding relationship between antigens and antibodies for various varieties of corn and soybeans. Kenneth J. Koehler provided statistical consulting on the virus project, which involved estimation of both the dependent and independent variables. Wang's Zenith paper proposed a PC parallel computing model to multi-task the intense computations and graphics for the project. He used Windows 386 for his operating environment and remote PC communications software as his networking device, so that this is a viable solution for using home and office computers simultaneously to solve computer intensive problems. A user-friendly graphics system is currently being developed that will enable nonprogrammers to overlay desired antigen/antibody combinations easily on a PC screen.

Dean Lei translated a FORTRAN program into the PC/SAS* language and designed an interactive input screen to enable nonprofessional programmers to modify or enhance the SAS* code. This program estimates nest survival rates for certain species of birds.

Alice Cheng redesigned a mainframe SAS*/Wylbur Execute system to run totally on a 386-based PC using only PC/SAS* code. As the amount and complexity of code was greatly reduced, the result was an efficient personal computer application with an interactive, windowed, user interface.

Rochelle Milbrath spent the major part of the academic year designing a data entry and reporting system to assess variability in tree seedling measurements. This user-friendly system uses dBASE IV for data entry, PC/SAS* for data analysis, and Harvard Graphics for species-related comparative graphs.

Alice Cheng and Kathy Shelley worked on various projects involving survey data. SAS* was used to analyze these data. The projects included a questionnaire survey of middle and upper management regarding leadership training for corporate managers, a study of motor carriers' use of EDI (Electronic Data Interchange) technology, a laboratory experiment that attempted to identify observer biases in evaluating substantive educational material presented by two different personality types, comparison of tenure and promotion criteria for design faculty from U.S. and Canadian colleges and universities, and evaluation of Flex Plan participation and nonparticipation for Mary Greeley Hospital employees. Mack Shelley provided statistical consulting on most of these projects.

Mike Carley provided continuing technical support in WordPerfect™ for the secretaries. Because of his and Mervyn Marasinghe's expertise, the typing of technical journal articles and manuscripts is now more easily accomplished by the department's professional secretarial staff.

Presentation graphics has been an important part of the section's services and is often integrated into data analysis system design. Two projects that emphasized graphic design were the development of a prototype SAS*/Graph Iowa map, programmed by Morgan Wang, for use by ISU extension economists, and a multipaneled graph, displaying bird hunting attempts and success rates, designed by Rochelle Milbrath using William Cleveland's framework for presentation graphics development. Milbrath used Harvard Graphics and Wordperfect™ in her project.

Kathy Shelley gave a SAS*/GRAPH short course both semesters in the ISU Computation Center. Training in Harvard Graphics was given on a less formal basis to people in statistics, plant pathology, corn breeding, and the Center for Industrial Research and Service.

During fall 1989, Mervyn Marasinghe provided extensive consulting in FORTRAN programming for Sushama Bendre, who was visiting the department. This involved computation of multiple integrals using numerical quadrature routines available in IMSL$_R$.

■ Survey Section

The Survey Section of the Statistical Laboratory, under the direction of Roy D. Hickman, provides consultation and direct operational assistance to research workers in sample design and the planning and execution of sample surveys and censuses. Section staff engage in all areas pertaining to the operational conduct of surveys. Professional staff members also conduct research and teach courses in the areas of sampling, survey design, and statistical methods.

The section completed the second wave of data collection for two longitudinal studies of Iowa rural families. The section is collaborating with the Rural Health Center and the departments of Family Environment, Sociology and Anthropology, and Child Development in these studies.

The first project combines research supported by the National Institute of Drug and Alcohol Abuse, the National Institute of Mental Health, and the U.S. Bureau of Maternal and Child Health. The major objectives of the study are to assess the resilience of families to economic stress, to identify the nature, origins, and consequences of the conceptions of parenting, and to investigate the impact of economic stress on emotional and behavioral functioning of parents and adolescents. In each family included in the study, both parents and two of their natural children (one of whom must be an eighth grader) are participating in a multifaceted interviewing approach. Personal interviews, audiotaping, self-administered questionnaires, and videotaping of family discussions are being used to meet research objectives.

Section staff were responsible for recontacting families, conducting personal interviews, administering the audiotaping and portions of the self-administered questionnaires, coding the data, and data entry. Data collection was completed for 424 families, which comprised 94 percent of the families interviewed in the first wave of the study. The third wave will begin in December 1990.

The objective of the second study, funded by the National Institute of Mental Health, is to assess differences between farm and nonfarm adolescents as they make the transition from elementary to secondary school. Economic hardships and their possible impact on children's coping and adjustment patterns are being evaluated. Survey Section staff reinterviewed 96 percent of the 398 Wave I families, and coded and entered the data. The final wave of this study will begin in September 1990.

Survey personnel have been collaborating with the University of Iowa, Department of Preventive Medicine, on two health-related studies. For the first study, Toni Genalo, survey projects manager, consulted on questionnaire design and methodology, and trained University of Iowa staff to complete telephone interviews with 300 mothers of children born with cleft lip and/or cleft palate, and 300 control mothers selected from the state birth records. Analysis of the data will attempt to assess the impact of genetic factors and environmental exposure during a mother's pregnancy.

The second health-related project is a methodological investigation to improve data collection from farmers and proxy respondents in epidemiologic studies concerning pesticide exposure. Funded by the National Cancer Institutes, the study is now in the pilot stage. Staff in the Statistical Laboratory are providing expertise on questionnaire design, control selection, and methodology. Staff field interviewers will complete 70 pilot study interviews this year and 200 regular interviews in 1991.

Data collection is in progress on a study designed to assess public awareness of and concern about radon gas in the environment. Results will be used by staff in ISU Energy Extension to develop an educational program on radon and its effect on the environment and public health. A random-digit dial sample of 500 Iowa households was selected for study.

In a study of current farming practices and farmers' attitudes toward sustainable agricultural practices, a statewide sample was selected from Farm and Home directories for researchers in sociology. Although initial contact was by telephone, a subsample will be selected for personal interview later. For this reason, a two-stage sampling procedure was used. At the first stage, 15 counties were selected with probabilities proportional to their sizes in terms of number of farms. Within these counties, names were selected at rates such that a uniform sampling rate was maintained. Telephone interviews were obtained from 1,066 farmers; the response rate was 88 percent.

A sample of individuals was selected to serve as controls in conjunction with a study of child abuse. Screening was done by telephone to identify persons within specified age by sex categories that match subjects of the original study, who have already been interviewed. To reduce travel costs, a sample of Iowa counties was selected at the first stage. The eight largest counties were included with certainty; 10 more counties were selected at random with probabilities proportional to their estimated numbers of households. Random-digit dialing techniques were used within counties to identify a pool of eligible persons from which the final sample of controls was selected. A total of 125 control subjects were interviewed in person, and the Survey Section also completed coding and data entry.

A statewide sample was selected for researchers in agronomy asking Iowa farmers what varieties of corn and soybeans they are planting in 1990. Independent area samples were selected from each county. From Farm and Home directories, lists of names of residents of these sample areas were compiled, and questionnaires were mailed to the residents. In addition, a similar sample selected two years ago was updated to reflect changes in the directories. This survey is carried out biennially, and each sample is used two times. The total sample size was about 21,000.

The biennial school census of households for the Ames Community School District was completed by the Survey Section during the spring. The census is conducted to help estimate future enrollment from the current preschool population in the community.

Advice and assistance were given on the design of two samples of households in Ames (one for a researcher in family environment and one for a local volunteer group)—a statewide sample of high school students and a sample of 4-H leaders. Consulting assistance on various aspects of survey research was also provided for a user survey for the Iowa State University library, a study of mentoring in private industry, an evaluation of recent graduates of the College of Veterinary Medicine, a study of the attitudes of university faculty and professional and scientific staff members regarding the employee benefits currently provided by ISU, and an investigation of the needs of the Iowa sheep industry.

Statistical assistance in preparing research proposals was provided for a student interested in measuring nurses' job satisfaction, a student studying roadside litter, a researcher in family environment looking at expenditure practices in households at or near the poverty level, a researcher in sociology investigating social distancing and stereotyping, another sociologist studying Iowa's black population, researchers at the Rural Health Center examining smokers' reactions to antismoking messages and investigating health characteristics in families with children, a researcher in animal science wishing to survey horse owners in Iowa, and a group at the Mayo Clinic planning a sequel to a blood pressure study first carried out in 1986 with assistance from the Survey Section.

◼ Industry and Engineering Sciences

The Statistical Laboratory, the Engineering Research Institute, and joint faculty appointments in statistics and industrial and manufacturing systems engineering support statistical consultation with engineering and physical science faculty and graduate students. Consulting with industry is provided through a program of collaborative and affiliate research and consulting.

Dean Isaacson has continued to serve as the representative of the Regents' institutions on the board of directors of the Iowa Quality Coalition, a statewide quality improvement group that consists of representatives from industry, labor, public universities, private colleges and universities, community colleges, and government. The 1989-1990 Iowa Quality Plan identified eight major efforts as goals and activities. One is to develop local or regional qualilty committees made up of business, industry, government, labor, and education leaders interested in promoting, coordinating, and implementing activities leading to continuous quality improvement. Another goal is to promote the continuation and development of productivity enhancement partnerships to train and retain a quality work force and improve management. Isaacson is serving on a committee involved in a third effort, promoting executive awareness.

Statistics is a central part of the Iowa Quality Plan, and the coalition now supports one graduate student, Christine Whitney, at Iowa State University (see below).

Engineering Research Institute

Herbert T. David, Stephen B. Vardeman, and Dwayne Pepper provided assistance on a number of engineering research projects. These included a chemical engineering project involving analytical work for corrosive pit counting and a civil engineering lead/copper waste extraction project that led to the testing of equality of two linear regressions. In another project, on Soil Conservation Service degradation studies, the statistical advice concerned finding a separation of regimes. An Instrument Services project in the Department of Chemistry involved a regression study for calibrating gaseous compound composition by wave length distribution.

Consultation on a project in the Department of Industrial and Manufacturing Systems Engineering concerned the use of tolerance intervals and discriminant analysis in a problem involving the fitting of Iowa survivor curves by using a moment ratio method. Another consulting project for that department involved data analyses and organization of data from prior studies on the development of robotic job aids for the disabled.

Industrial Consulting

William Q. Meeker, Jr., continued to serve as a consultant to the AT&T Bell Laboratories Quality Technology Center, Holmdel, New Jersey, throughout the year.

During his faculty improvement leave in New South Wales, Australia, W. Robert Stephenson has been involved with industrial consulting through NewStat: Statistical and Quality Consultants, an outreach program of the University of Newcastle. He consulted with the Cargo Services Branch of the Hunter Ports Authority, Maritime Services Board, on forecasting annual coal shipments from the Port of Newcastle. He also consulted with Tomago Aluminium, Raymond Terrace, New South Wales, on time to failure of aluminium smelting pots. He also consulted with Pasminco Mining, St. Leonards, on statistical analysis and graphical presentation of mining data.

The ISU Industry/University Affiliate Program in Productivity, Quality, and Reliability continued with minimal funding through summer and fall 1989. In November, statistical participation was transferred to the evolving Iowa Quality Coalition.

Christine Whitney and/or Stephen Vardeman visited three Iowa companies to work on quality improvement issues—the Laundry Division of White Consolidated Industries, Inc. (WCI), in Webster City; Associated Milk Producers, Inc., in Mason City, and Coilcraft in Hawarden.

Work with WCI so far has focused on training in the area of developing a vision for the procurement department, participating in a total quality management seminar, and advising on the design of experiments in the plastics department and the engineering department to meet certain goals. Coilcraft's Hawarden facility produces wire-wound coils and transformers for international distribution. Whitney assisted the plant with a company-wide employee assessment, orientation in the Deming philosophy, development of a mission statement for the plant, and team building. She conducted initial process improvement training sessions with two process improvement teams and met with the employee expectations team. At Associated Milk Producers, Inc., Whitney provided training in problem-solving techniques and concepts of continual improvement. This will be followed by more in-depth training through the local community college with Vardeman and Whitney providing direction/advice on problem-solving projects.

■ Social Sciences and Humanities

Carl Roberts has, as consultant for MetaText, Inc., worked closely in the development of PLCA, Version 1.0. PLCA (Program for Linguistic Content Analysis) is a computer aide that enables the user to encode both words and their syntactic interrelations prior to statistical analysis. The software makes archival data and data from open-ended interviews more accessible to business and academic researchers.

In July 1989, Roberts went to the Evergreen State College (TESC), where he demonstrated how his linguistic content analysis technique could be applied in an analysis of student and teacher evaluation materials. (At TESC all evaluations are written; there are no grades of any sort.) In response to the Washington State Legislature's recent request that all its state-subsidized institutions of higher education perform self-evaluations, administrators at TESC have decided to undertake an analysis of existing student and teacher evaluations. If funded, the analysis proposed by Roberts will likely be administered through the Center for the Study of Higher Education at Pennsylvania State University, where Roberts currently holds a position as faculty associate.

Frederick Lorenz's major consulting efforts in the past year have focused on methodological problems associated with the Iowa Youth and Families Project (IYFP). The IYFP is a panel study of 451 rural Iowa families, funded by grants from the National Institute of Mental Health, with additional funding from the John D. and Catherine T. MacArthur Foundation. The goal of the research is to understand better the mechanisms linking chronic and acute economic stress to mental and physical health outcomes in adults and to behavioral problems in adolescents. One of the important mechanisms is hypothesized to be the quality of family interactions. These interactions are observed by videotaping families in their homes. Lorenz's role in the research has been to advise colleagues in modeling substantive issues and to do research in methodological issues associated with method variance, measurement error, and the analysis of panel data.

Mack C. Shelley II, consulted with faculty, staff, and students in the departments of Architecture, Industrial Education and Technology, Family Environment, Sociology, Political Science, Professional Studies in Education, Freshman Engineering, Business Administrative Sciences, Industrial Relations,

and Agricultural Education, and the ISU Office of Institutional Research. Consulting was also done with an employee of the Iowa Department of Transportation and with the director and employees of the Center for Transportation, Council of State Governments, in Lexington, Kentucky.

Topics addressed included studies of student use of the Memorial Union, training industrial education students in Taiwan, life satisfaction and health, student debt and financial aid, satisfaction of retirement community residents, convicted sex offenders in Iowa, political information and voting behavior, federal housing programs in Iowa, management training programs, highway safety and traffic signs, child sexual abuse, student satisfaction with academic advising, and employment practices.

Also dealt with were methodological and analytical problems arising in research on senior citizens' control over their life-circumstances, intergenerational obligations, family financial management, hospital employee use of a flexible benefits plan, speed limits and traffic fatalities in Iowa, adoption of farming practices in Turkey, norms of international interaction, and roll call voting cohesion in the Iowa General Assembly.

Robert Strahan consulted on assessment of the effectiveness of a summer orientation program for minority students; examination of the factors parents weigh in buying children's toys; describing characteristics of Taiwanese mathematics teachers; a follow-up survey of ISU students' degree of substance use; examination of the personality correlates of alienation and depersonalization; assessment of a community college's impact on later bachelor's degree work; a survey of Iowa athletic directors' perceptions of their jobs; the relative effectiveness of full-day versus half-day children's day care centers; and testing prospect theory in decision making.

■ Other Consulting/Cooperation

Statistical guidance and improved statistical methodology are provided to research staff of the Agricultural Research Service, USDA, under a five-year contractual agreement between the USDA-ARS and the Department of Statistics. Resident collaborator Jerome Sacks leads this project and supervised research assistants Jeff Hofer and Amy Weaver during 1989-90. Much of the work related to investiga-

tions at the National Animal Disease Center. In the 1989-90 year, Theresa Scheetz worked as consultant on an investigation of coccidiosis prevalence in swine. She analyzed and interpreted data collected at monthly intervals, over a one-year period, on prevalences of *Isospora suis* and *Eimeria* among five age groups of swine from a sample of 35 Iowa farms. Missing data complicated the analysis. Results showed distinctly different age and seasonal patterns for both infections, although the two infections seem to be independent of each other.

Noel Cressie consulted with a researcher in the Damadian Foundation for Basic and Cancer Research, Long Island, New York, on testing for whether a regression line is straight or curved. The application was to testing whether cells were cancerous or normal.

He also consulted on problems arising in botany and agricultural engineering. The first concerned use of nominal variables in a stepwise regression procedure, where the application was to modeling the probability of finding a species from roughly 200 species occurring at approximately 800 sites. The second problem involved methods for fitting variograms to characterize spatial dependence of various soil properties.

H. Samuel Wieand has overall responsibility for the statistical conduct of roughly 100 active clinical trials as director of the Cancer Center Statistics at Mayo Clinic and group statistician for the North Central Cancer Treatment Group. He was a co-author on eight medical publications during the July 1989-June 1990 period.

Alicia Carriquiry was involved in an ongoing joint project between the ISU Center for Agricultural and Rural Development and the Survey Section. The project consists of developing methodology for estimating usual nutrient intake distributions. (See p. 15.) She consulted with the Environmental Protection Agency on an atrazine policy evaluation project and with animal breeding faculty in the Universidad de la Republica, Montevideo, Uruguay, on genetic evaluation of dairy bulls and cows. Other consulting, with a Fulbright scholar in anthropology at the University of Iowa and an ISU agronomist, respectively, concerned household composition and fertility levels in rural Iowa and Nebraska, 1900-1910, and the effect of chromosomal substitution on flour characteristics of wheat.
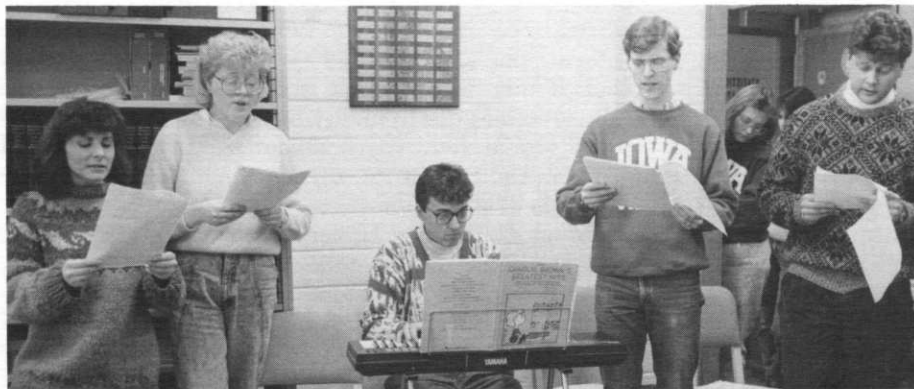
The newly formed Stat Family Singers in performance at the department's holiday open house, from L to R: Chris Whitney, Rochelle Milbrath, Dan Walczak, Phil Iversen, and John Lagus.

Current Research

Research projects supported by grants or contractual agreements and individual research are summarized in this section. Within the university, funds were provided by the budgets of the Statistical Laboratory, the Iowa Agriculture and Home Economics Experiment Station (AES), the Sciences and Humanities Research Institute, and the Engineering Research Institute.

■ AES Project 2588

Project 2588 of the Iowa Agriculture and Home Economics Experiment Station supports research by Edward Pollak on mathematical and statistical genetics. In the 1989-90 year Pollak continued research on age-structured populations. In the previous period he had derived a general expression for the effective population size of an age-structured population with a sex-linked locus. This was supplemented in early 1990 by the derivation of a special case that applies when there are approximately Poisson offspring distributions at any specific age and independent distributions of numbers of male and female offspring of females.

Pollak also worked on the calculation of equilibrium probabilities of identity in state of random sets of genes in finite subdivided populations. It was assumed that there is an infinite number of possible neutral alleles. A general approximation was derived for two subpopulations of possibly unequal sizes when there are two alleles in samples of four genes, two of which are one allele and the other two a second allele. This leads to approximations to steady state variances of some measures of genetic identity and genetic distance.

Joint work was also done with T. Helms, a former agronomy student. The problem addressed was the elucidation of circumstances under which the partial quadratic regression coefficient of heterozygous contributions regressed on cycles of recurrent selection measures mainly effects of genetic drift or mainly quadratic effects due to selection.

■ Design of Experiments

Research by John Stufken on topics relating to the design of experiments is supported through the statistics department of the Iowa Agriculture and Home Economics Experiment Station under Project 101. In the 1989-90 academic year, the research topics included optimal and efficient block designs for comparing test treatments with a control, orthogonal arrays, sampling designs that exclude contiguous units, and topics relating to factorial designs.

Research on optimal block designs for comparing test treatments with a control as reported in the 1988-89 annual report has been continued this year. Two papers based on this research, one on the use of group divisible treatment designs, the other on optimal designs under a Bayesian approach, have been submitted for publication. Joint work with Kwang-Hun Kim on this topic is still in progress.

Joint work with A. Hedayat on the preparation of a book on orthogonal arrays remains a challenging but at times frustrating task. Several chapters have been completed during the past year, but a considerable amount of work remains to be done.

When using factorial designs, it is possible that an experimenter would like to avoid certain treatment combinations. For a given fractional factorial design and a specified model, it is therefore of interest to study methods that generate other designs with the same information matrix for the factorial effects of interest as the given design under the given model. A study of this problem was started and will continue during the next year. This is joint work by John Stufken and Kui-Jang Wang.

■ National Resource Inventories and Soils Data Bases

The Survey Section continued cooperative research with the Soil Conservation Service (SCS), U.S. Department of Agriculture, through Project 2739 of the Iowa Agriculture and Home Economics Experiment Station. Directed by Roy D. Hickman, this joint work has been an important part of the work of the Statistical Laboratory since 1956. Dean Thompson serves as resident SCS collaborator on this project.

The SCS conducts a National Resources Inventory (NRI) of the country's soil and water-related resources every five years. During the past year, Survey Section staff worked on data processsing and estimation for the 1987 NRI. That inventory was specifically designed to estimate changes in land use and cover that had occurred during the past five years. Because of the change aspect, the field work consisted of both recording current information and verifying and updating data from the 1982 NRI.

Two main types of data are associated with the 1987 National Resources Inventory. County base data provide total acreages for each county in the United States for categories such as land area, water area, federal land, roads, and railroads. Primary Sampling Unit (PSU) data for a set of randomly sampled locations throughout the U.S. provide information, for example, on soil characteristics, land use, and soil erosion. The 1987 NRI sample was a stratified sample of PSUs from those used in the 1982 NRI, supplemented with new PSUs in swiftly urbanizing areas.

Richard Dorsch is in charge of data processing activities, assisted by Melissa Swanson, Kathie Reinertson, and Sue Verkade. The PSU data, originally entered by SCS field personnel on AT&T 3B2 minicomputer systems in the state SCS offices, had

been transmitted to the Statistical Laboratory on floppy disks or cassette tapes, then uploaded to the ISU mainframe computer for editing, correction, and analysis.

During the past year, the estimation procedures for the 1987 NRI were completed. These were rather complex because of the change aspects of the inventory. Weights for estimation of totals were constructed using control variables from the larger sample (330,000 PSUs) of the 1982 NRI. Software was developed for weight construction, and small area estimation techniques were incorporated into PC CARP. Two of the major components of the estimation procedure were (1) the verification and updating of the geographic information: county, Major Land Resource Area (MLRA), and Water Resource Council Hydrologic Unit associated with each sample, and (2) estimation of the change in urban acres for all MLRA portions of counties in each state. Wayne Fuller directed the work on estimation, assisted by Harold Baker and Fred Medak. Other staff members working on inventory projects during the year were Lee Chu, Dorothy Edwards, Mark Kriesberg, Marie Loughin, and Christopher Skinner.

Tabular summaries of the data were produced and sent to state, regional, and national SCS personnel for review. Upon completion of this review, the database was put in final form and the results were published in the *Summary Report 1987 National Resources Inventory,* USDA Statistical Bulletin Number 790. Individual state databases were prepared for use with National Resources Inventory Information System computer software.

Other projects involving NRI data on which Survey Section staff have worked during the year include the following: an analysis of farmstead and field windbreaks; providing databases and tables to assist in the evaluation of the Great Plains Conservation Program; providing maps and databases for use in digitizing the location of NRI PSUs; a pilot project to determine if land cover and land use information can be reliably obtained using aerial photography and satellite remote sensing techniques; and a review of wetlands identified in the 1987 NRI.

Another important area of the SCS cooperative work is the maintenance, updating, and continuing development of the soil interpretations database of soil series in the United States. Harvey Terpstra directs this work, assisted by Deborah Reed-Margetan, Jan Seagrave, Janet Schultz, Douglas Tschopp, and Fred Medak.

With the addition of 2,000 new records, the soil interpretations database now contains nearly 32,000 records, occupying 220 million bytes of storage. With the addition of 60 survey areas, the soil map unit database now contains 2,750 survey areas, occupying 120 million bytes of storage. The soil series description database contains descriptions for over 13,000 soil series and occupies 200 million bytes of storage. This database is stored in the SPIRES database management system and contains the official soil classification for over 16,000 soil series. Jan Seagrave and the data entry staff of Glenda Ashley, Vimlesh Gupta,

and Karon White have worked on updating these databases.

Installing the data in an ORACLE relational database has continued. A complete ORACLE version of the soil interpretations database has been loaded and is available for querying both locally and remotely. A method of relationally linking the map unit database with the soil interpretations database has recently been developed and is operational. Deborah Reed-Margetan and Janet Schultz led the work on that effort.

The various programming efforts undertaken this year include a program written in C language to print soil interpretations on SCS Unix microcomputers, modeling programs to generate the K and T soil erosion factors, a program to produce interpretive ratings for several waste management applications, and programs to test various models for determining hydric soils. Douglas Tschopp and Janet Schultz have done the development work on those projects.

Downloading soils data to SCS state office microcomputers and providing guidance to remote SCS users continued as major activities of the group.

The staff made numerous trips in connection with resource inventory and soils database activities. Roy Hickman and Dean Thompson traveled to various sites in Utah, California, and Nevada on July 17-21, 1989, to observe and discuss field data collection procedures with SCS personnel. Wayne Fuller assisted with designing a national aerial photography study of urban change in Fort Worth, Texas, on August 3. He also met with SCS and U.S. Forest Service staff in Anchorage, Alaska, December 11-14 to discuss inventory procedures for Alaska. Harvey Terpstra, Douglas Tschopp, and Deborah Reed-Margetan traveled to Lincoln, Nebraska, August 14-17 to discuss progress and future work on the national soils databases. Terpstra also went to Champaign, Illinois, November 16-17 to discuss providing non-SCS users access to the soils databases; to Portland, Oregon, February 12-15, 1990, to attend a meeting of the SCS Western Region soil database managers; to Lincoln, Nebraska, March 19-21 to discuss procedures to provide soils data to the SCS National Soil-Range Team; and again to Lincoln on May 23-24 to discuss the soils databases with National Soils Laboratory staff.

Roy Hickman met with SCS and EROS Data Center staff in Sioux Falls, South Dakota, February 20-21, 1990, to discuss digitization of the NRI PSUs. He also attended the National SCS NRI Workshop in Denver, Colorado, June 11-30.

■ Measurement and Sampling Error

Joint research in measurement error models, time series, and survey design is supported by the U.S. Bureau of the Census and, through AES Project 2699, by the Iowa Agriculture and Home Economics Experiment Station. The bureau's support for the 1989-1990 year came through Joint Statistical Agreements J.S.A. 89-2 and J.S.A. 90-7. Wayne Fuller is principal investigator. Other personnel working on

the project include Joseph Croos, Heon Jin Park, Sahadeb Sarkar, Dongwan Shin, and Todd Sanger.

A study was made of the general problem of least squares estimation for the nonlinear model in which the sums of squares of the derivatives increase at different rates as the sample size increases. Some large sample results were derived. These results can be used to obtain the limiting distribution of the least squares estimator of the parameters of the autoregressive moving average in which the autoregressive part has a unit root. The results are also applicable to nonlinear models that contain time trends and random walks as explanatory variables.

The least squares estimator and the maximum likelihood estimator of the parameters of the autoregressive moving average model were studied. It was demonstrated that the estimators are strongly consistent for the model with an autoregressive unit root. Also the estimator of the unit root has the same limiting distribution as that obtained for the pure autoregressive part.

A study of alternative tests of the hypothesis of a unit root in autoregressive processes was conducted. Monte Carlo methods were used to demonstrate that the symmetric estimator provides a more powerful test than does the ordinary least squares estimator for the model with one intercept.

Research was conducted on the linear model in which the coefficients satisfy nonlinear constraints. Such models occur in time series analysis with lags of the dependent variable as explanatory variables.

The measurement error model with heterogeneous error variances was studied. Estimators that use estimated weights to weight the observations and estimators based on moments were investigated. Survey designs for data collected subject to measurement error were developed.

Research continued on the use of added error to avoid disclosure in microdata releases. The computer program that adds error to the original observations was refined and applied to some example data sets. Christopher Skinner joined in the study of the risk of disclosure of census microdata, adding a British perspective.

Skinner also extended work by Wayne Fuller and Tin Chiu Chua on measurement error and gross flows to logistic analysis of longitudinal survey data. He prepared papers on the effect of measurement error on event history analysis and on methods of analyzing complex survey data for conferences taking place in July and November 1990.

■ Dietary Intake Estimation

Wayne Fuller, Sarah Nusser, and Jeff Helterbrand continued their investigations on methods of estimating usual intake distributions for selected dietary components, where the usual intake of a dietary component for an individual is the long-run average of daily intakes for the individual. This research was supported by a research agreement between the Center for Agricultural and Rural Development (CARD)

at Iowa State University and the USDA Human Nutrition Information Service.

In one approach to the problem, observed daily intakes were assumed to follow a simple measurement error model in which the observed intakes are the usual intake plus a measurement error. Earlier work used the method of moments to construct estimates of usual intake distributions, assuming an underlying gamma or Weibull distribution. Extending the method to include a location parameter in the assumed distribution improved the fit, particularly with respect to the third moment.

Research on a second approach, which involves transforming the observed intakes to normality, continued. The measurement error model for observed intakes was assumed to hold in normal space, and normal theory was used to predict usual intakes in normal space. Predicted intakes were then transformed back to the original scale to provide a set of pseudo usual intakes. Refinements of this method included developing a smoother monotonic transformation to normality. In addition, a further transformation in the normal scale was derived to obtain data that more closely followed a multivariate normal distribution. The performance of two maximum likelihood algorithms for fitting a generalized gamma distribution to the pseudo usual intakes was also investigated.

■ Statistical Computing

William Kennedy and Morgan Wang addressed the problem of computing selected quantities to a guaranteed level of accuracy. This research project is funded by the National Science Foundation.

The primary objective of the research is to develop self-validating algorithms for computing probabilities in selected continuous univariate and multivariate probability distributions. Rounded interval arithmetic in an IBM compatible personal computer is employed to achieve this objective. Special software to cause directed rounding in the INTEL NPX hardware component was developed and used as a basis for all interval computations.

Work on the bivariate and multivariate normal distributions was completed during the year. Algorithms for computing probabilities over finite rectangular regions were developed. Extensive testing verified that these algorithms produce results with an accuracy of essentially machine precision, over large domains for the functions.

Other functions, including the complete gamma, incomplete gamma, and incomplete beta, were investigated. Self-validating algorithms for these functions were developed, and preliminary testing indicates that they perform satisfactorily.

V. A. Sposito with Stan Johnson of CARD (the university Center for Agricultural and Rural Development) continued research under a block grant funded by the ISU Computation Center through June 1990. This work involves restructure of large-scale agricultural models into diagonal form for CARD. It has been shown, using the diagonal structure of

CARD's models, that the total computational time needed to determine an optimal solution has reduced by 50 percent for models with 9,000 constraints and 130,000 variables.

■ CARP

Development of the CARP family of personal computer programs for complex surveys continued. Heon Jin Park and William Q. Meeker, Jr., prepared a supplement for the estimation of the proportional hazards model.

■ Spatial Statistics

Noel Cressie continued research in spatial prediction and inference for spatial point processes, with support from a National Science Foundation grant. Six articles were published, and considerable progress was made on a book, *Statistics for Spatial Data,* to be published by Wiley in 1991. Graduate assistants Stephen L. Rathbun and Jay M. Ver Hoef also worked on the grant project.

■ Census Undercount

Research by Noel Cressie on census undercount was supported by a joint statistical agreement between ISU and the U.S. Bureau of the Census. This research has concentrated on developing a heteroskedastic regression model for undercount adjustment factors. Robert L. Parker worked on the project, as research assistant, for part of the year.

■ Statistical Prediction

David Harville continued research in the area of statistical prediction with the support of a grant from the U.S. Office of Naval Research. He also worked with Alicia Carriquiry on classical and Bayesian prediction as applied to an unbalanced mixed linear model.

■ Bootstrap Asymptotics

Krishna Athreya and Ananda B. Weerasinghe (Department of Mathematics) are project leaders for a National Science Foundation grant project that supports research on bootstrapping asymptotics, stochastic differential equations and optimal control, and nonparametric estimation for diffusion processes.

Athreya and Weerasinghe have continued their investigations into optimal control of Ito processes, both with finite and infinite time horizons and with a finite amount of fuel. Under fairly general conditions, the optimal solution turns out to be a diffusion. Explicit computation of the value function was also completed.

Athreya and Cheng-Der Fuh considered the problem of establishing a central limit theorem for a double array of Harris chains, extending their earlier result on the countable state space case and motivated by bootstrap methods.

Research on bootstrap into U statistics with infinite variance was continued by Athreya, extending his earlier result on the mean in the p-stable case.

Athreya established a large deviation result for mappings on finite sets with applications to problems of computational complexity. This work was done in response to a query from a faculty member in the Department of Computer Science.

■ Order Statistics and Nonparametric Statistics

Moving medians and moving L-statistics have in recent years been studied intensively in the signal detection and image processing literature under the respective names of median filters and order statistics filters. H. A. David, principal investigator under a U.S. Army Research Office contract, has established some general properties of the spectral density function of such filters under white noise. The effect of outliers (impulses) on these filters has also been investigated.

Jingyu Liu, research assistant, is examining the following problem. In chess and various sports two teams are compared by matching the best player of one team with the best player of the other, down to matching the two weakest players. Is this in some sense an optimal procedure? What are the major properties of this and related matching procedures under suitable models?

H. A. David and Douglas M. Andrews (now at Wittenberg University) have continued their study of various methods for ranking objects from the results of unbalanced paired-comparison experiments.

■ Reliability and Nondestructive Evaluation

William Q. Meeker, Jr., coordinates the statistics staff's part of the National Institute of Standards and Technology (NIST) Program for Integrated Design, Nondestructive Evaluation (NDE), and Manufacturing Sciences. Meeker, along with Wayne Fuller, Steve Vardeman, Yasuo Amemiya, and graduate students Todd Sanger, Scott Vander Wiel, Mark Kreisberg, Christian Garrigoux, and Joseph Lu, have been doing and guiding research in planning in-service NDE inspections, applications of modern decision theory to NDE processes, advanced methods of NDE data analysis, and analysis of crack growth data.

Todd Sanger and Wayne Fuller worked on statistical methods that might be used with an eddy current inspection procedure. The research suggests that a method related to principal components can be used as a data reduction technique.

Yasuo Amemiya, Herbert T. David, and Gerri Dunnigan are working on a project under the Industrial Affiliate Program of the ISU Center for Nondestructive Evaluation. This project concerns developing nondestructive inspection plans for refinery pipe systems.

William Q. Meeker, Jr., continued joint research with colleagues at Bell Laboratories and some former students on statistical methods for the analysis of reliability data and on planning accelerated life tests.

■ Sciences and Humanities

Funds from the College of Sciences and Humanities help support research by Yasuo Amemiya, Krishna Athreya, H. A. David, Soumendra Lahiri, Mervyn Marasinghe, and John Stufken. Some of this work received support from federal grants or contracts in 1989-90 and has been described earlier in this section.

Yasuo Amemiya worked in the general area of multivariate regression. For the one-way fixed and random effect models with covariates, some test procedures for the dimensionality of the effect space were developed, and their properties were investigated. For a class of structural equation models, a modification of the usual estimator of the coefficient parameter that improves the finite sample properties was proposed.

Soumendra Lahiri's current research concerns second order analysis of stationary bootstrap, asymptotic expansions, and bootstrap for lattice data. It is well known that the classical iid bootstrap procedure proposed by Efron (1979) fails dramatically when the observations are not independent. Recently Künsch (1989) formulated a "block resampling" version of the bootstrap procedure to deal with stationary, weak dependent data. Lahiri's research focuses on the second order analysis of the Künsch procedure. It is observed that in the case of the sample mean, the original bootstrapped statistic proposed by Künsch fails to provide a second order correct approximation. A suitable modification is shown to remove this deficiency. The second order optimality of the procedure is also proved for smooth functions of the sample mean.

Under fairly general conditions, Lahiri has proved an Edgeworth expansion for M-estimators of the regression parameters of a multiple linear regression model. The first step in this derivation involves obtaining a sufficiently close stochastic approximation in terms of certain vectors of random polynomials. In the next step, an expansion is proved for this approximant. The proofs for both parts require some nonstandard methodologies for taking care of the nonidentical nature of the problem.

For the sample mean of lattice observations, Singh (1981) showed that Efron's (1979) bootstrap is only as good as the classical normal approximation when the error is measured in the supremum norm. However, Lahiri has observed that the error is significantly less for the bootstrap when the error of approximation is measured in some suitable metric. Similar optimality of bootstrap is also shown to hold for expectations of smooth functions.

Mervyn Marasinghe began research in the area of statistical expert systems. Initially he is investigating ideas for incorporating knowledge about analysis of experiments into such systems.

Work by John Stufken on sampling designs that exclude contiguous units was in part supported by a summer salary support grant for research. Work on this topic continues earlier joint research with A. Hedayat, and A. Hedayat and C. R. Rao.

■ Other Research

At Mayo Clinic, H. Samuel Wieand has been investigating ways of assessing the effectiveness of diagnostic markers for recurrence of disease when these markers are obtained at repeated times. The work has been supported in part by grants from the National Institutes of Health.

Alicia Carriquiry engaged in interdisciplinary research with ISU faculty in veterinary anatomy and mathematics on a mathematical approach to modeling dendritic growth. The objective of the study is to develop two unified mathematical models of dendritic growth called the tree-pattern and tree-growth branching process models. This should enhance the understanding of dendritic growth behavior and, hopefully, reduce the number of animals used in biological experiments.

Individual research by Richard Groeneveld was conducted during the year on a special topic in paired comparisons, namely, the ranking of teams in a league with an equal number of teams in each of two divisions. Groeneveld also continued research in the area of skewed distributions.

Robert Strahan participated with other faculty in research aimed at identifying driving impairments in the elderly and providing corrective measures. Some preliminary data were gathered and analyzed.

Another research activity of Strahan's was devising methods for handling equal-valued data in the measurement of vocational consistency, an interest inventory concept of how stabilized or crystallized a person's occupational or career choice is. Still other work dealt with graphical perception, teaching aids, and personality assessment.

Frederick Lorenz is one of three co-principal investigators on a five-year study, which began in 1988, of rural family resilience to economic stress.

Mack Shelley's current research emphasizes public policy questions relevant to biotechnology and transportation planning. Other areas of interest include content analysis, legislative elections and voting behavior within legislatures, interstate migration, and public budgeting, employing a wide variety of statistical methods. Shelley continues research on bioethics under grants from the Northwest Area Foundation and the Joyce Foundation.

While on faculty improvement leave during the fall semester, Shelley conducted research on congressional influences on public policy. This work will be presented in part at the 1990 joint statistical meetings in a paper applying vector autoregressive methods to the analysis of congressional voting behavior from 1953 to 1988. Other related research papers are planned.

Professional Activities

Three ISU faculty have been elected to American Statistical Association section offices for 1990: Stephen B. Vardeman, chair-elect of the Section on Physical and Engineering Sciences; W. Robert Stephenson, chair-elect of the Section on Statistical Education; and Noel A. C. Cressie, secretary-treasurer of the Statistical Computing Section.

William Q. Meeker, Jr., served as president of the Iowa chapter of the American Statistical Association (ASA) for 1989/90. In April, he was reelected for a second term of office.

As part of the ASA sesquicentennial celebration, chapters were invited to name outstanding members for special recognition. The Iowa chapter designated Theodore A. Bancroft (1906-1986), citing him as "the instigator of the founding of the chapter, originally named the Central Iowa chapter, in 1958." The citation adds: "He gave strong leadership to the chapter during his tenure as professor of statistics, head of the Department of Statistics, and director of the Statistical Laboratory at Iowa State University. He contributed to statistics at the national and international levels in ways too numerous to list. He was the 1970 president of the American Statistical Association."

H. A. David is vice-chair of the Committee on ASA Archives and Historical Materials. In 1989, Stephen B. Vardeman completed his term as chair of the Committee on Award for Outstanding Statistical Application. Since December 1988, Mervyn Marasinghe has been serving as the ASA representative on the Education Committee of the American Federation of Information Processing Societies, Inc.

On August 31, Wayne Fuller and Kirk Wolter of A. C. Nielsen taught a one-day short course on Variance Estimation in Complex Surveys prior to the 47th session of the International Statistical Institute, in Paris, France.

Wayne Fuller attended meetings of the Statistics Canada Advisory Committee on Statistical Methods on October 26-27 and April 23-24 in Ottawa, Ontario, Canada. He completed service on the National Research Council Panel on Decennial Census Methodology.

At the 33rd Annual Fall Technical Conference sponsored by the American Society for Quality Control and the American Statistical Association, in Houston, Texas, William Q. Meeker chaired the *Technometrics* invited paper session on October 27, 1989.

Noel Cressie served on the American Statistical Association's Advisory Committee on Energy Statistics, which met in Washington, D.C., on November 2-3 and on March 29-30. He attended a meeting of the ASA's Advisory Committee for the Ecological Monitoring and Assessment Program of the Environmental Protection Agency, in Washington, D.C., on October 29-31, and in Dallas, Texas, on April 19-20.

Cressie also served on the National Research Council Panel on Spatial Statistics and Image Processing during the year, attending a meeting in Seattle, Washington, on April 17-18.

Mack Shelley II continued to serve as the Iowa State University Official Representative to the Inter-University Consortium for Political and Social Research. He also continued to serve as a member of the ISU Ethical Issues in Biotechnology Committee.

W. Robert Stephenson was a guest lecturer for a statistical consulting course on September 18-22, 1989, at the University of Newcastle, New South Wales, Australia. On October 31 he gave a one-day short course on industrial experimental design at the Newcastle Technical College, Tighes Hill, New South Wales. During the February-June 1990 term, he taught a course on statistical consulting for the Department of Statistics, University of Newcastle. In February and March, he and colleague Dennis Sinclair gave two separate short courses on Experimental Design Techniques for Process Improvement to people from industry in the Newcastle region.

Alicia Carriquiry presented two short courses in South America. The first one, Analisis de Modelos Lineales Mixtos Desbalanceados, was given for the Department of Statistics, Instituto Nacional de Tecnologia Agropecuaria (INTA), Buenos Aires, Argentina, September 4-15, 1989. The second short course, Curso-Taller Interamericano para Usuarios de Analisis de Datos, was given for the Organization of American States/CIENES, Santiago, Chile, June 11-29, 1990.

Paul N. Hinz served as instructor for a continuing education course sponsored by the Illinois chapter of the American Fisheries Society, the Illinois Natural History Survey, and the Illinois Department of Conservation, and presented on January 8-12 in Champaign, Illinois. The title of the course was Statistics in Fisheries Management and Research: An Introduction and Review of Statistical Methods for Managers and Researchers.

Herbert T. David attended a meeting of the American Statistical Association/National Institute of Standards and Technology/National Science Foundation Visiting Fellow Program Advisory Panel, March 2, 1990, in Washington, D.C., as a member of the panel's advisory board.

For the 1989 joint statistical meetings in August, Glen D. Meeden served as program chair for the Institute of Mathematical Statistics. H. T. David organized and chaired an invited papers session on Archives and the History of Statistics in America. William Q. Meeker, Jr., organized and chaired the *Technometrics* Invited Paper session. W. Robert Stephenson organized and chaired an invited papers session on Undergraduate Statistical Education: Inventing a Better Wheel.

At the joint spring meetings of the Biometric Society (ENAR), Institute of Mathematical Statistics, and the American Statistical Association, held in Baltimore, Maryland, April 1-4, 1990, Noel Cressie organized and chaired an ENAR session on Statistics for Spatial Data and chaired an IMS session on Methodology for the Analysis of Shapes with Biomedical Applications.

Cressie also was organizer and chair of the July 13 session on Robustness in the Presence of Unequal Scale at the summer workshop on Robustness, sponsored by the Institute for Mathematics and Its Applications, University of Minnesota, Minneapolis.

Stephen Rathbun and Robert Parker won first and second prize awards, respectively, in a competition for Best Student Statistics Paper Presentation sponsored by the Iowa chapter of the American Statistical Association at its spring 1990 meeting with the Iowa section of the Mathematics Association of America, held in Ames. Titles of the winning papers appear on p. 20. For a second year, an ISU statistics team won the annual Data Analysis Competition sponsored by the ASA chapter and open to teams of graduate students in Iowa. The winning team members were Phil Iversen, Robert Parker, Morgan Wang, and Alan Zimmermann. Contestants were given, for analysis and interpretation, a real data set arising from a flawed fractional factorial experiment to identify causal factors related to unacceptably high levels of a gas (environmentally safe but noxious-smelling) used in core molding in a foundry. The goal was to salvage the experiment and prepare written and oral presentations of the results, including recommendations to management.

■ Editorial Activities

William Q. Meeker, Jr., continued as editor of *Technometrics*, with Denise Riker as editorial assistant. Stephen Vardeman continued as an associate editor. Meeker is also on the editorial board of *Selected Tables in Mathematical Statistics* and on January 1, 1990, began serving as a co-editor of that publication.

Yasuo Amemiya continued as associate editor of *The American Statistician*.

Krishna Athreya is an associate editor of *Probability Theory and Related Fields* and serves on the editorial board of *Statistics & Probability Letters*.

Noel Cressie is on the editorial board of *Chemometrics and Intelligent Laboratory Systems*.

H. A. David is a member of the editorial board for the *Journal of the Indian Society of Agricultural Statistics*.

Wayne Fuller continued as associate editor of *Survey Methodology*.

Oscar Kempthorne is an associate editor of the *Journal of Statistical Planning and Inference* and a member of its executive committee. He is also on the editorial advisory board of the *Journal of Statistical Computation and Simulation*.

William J. Kennedy remains on the international editorial board of *Communications in Statistics—*

Simulation and Computation and is co-editor of its Algorithm section.

Edward Pollak is an associate editor of *Biometrics* and continues to serve on the editorial board of *Mathematical Biosciences*.

Mack Shelley continued as co-editor of the international newsletter, *Agricultural Bioethics Forum*.

Christopher Skinner is an associate editor of *Biometrika*.

W. Robert Stephenson became a member of the editorial board for *Selected Tables in Mathematical Statistics*.

Leroy Wolins is a member of the board of editors for *Educational and Psychological Measurement*.

■ Papers Presented, Lectures, and Seminars

At the 1989 joint statistical meetings of the American Statistical Association, the Institute of Mathematical Statistics, and the Biometric Society (ENAR and WNAR) in Washington, D.C., August 6-10:

AMEMIYA, Yasuo: "A modification of the usual estimators for the multivariate errors-in-variables and factor analysis models";

Andrews, Douglas M., and Herbert A. DAVID: "Nonparametric analysis of unbalanced paired-comparison or ranked data";

Biele, Jonathan, and Noel CRESSIE: "Minimum risk schemes in sequential sampling";

Zimmerman, Dale L., and Noel A. C. CRESSIE: "Improved estimation of the kriging variance";

DAVID, H. A.: "The ASA archives at Iowa State University";

Gotway, Carol A., and Noel A. C. CRESSIE: "Improved prediction with the generalized linear model";

GROENEVELD, Richard A., and Barry C. Arnold: "Sequential sampling estimation for finite populations of $N = nr$ objects";

Guo, Renkuan, and Herbert T. DAVID: "Component assessment using system data—an asymptotic Bayes treatment of nonidentifiability";

HINZ, Paul N., and Ann M. Weltevreden: "Variance component estimation using Winsorized data";

Hulting, Frederick L. (Iowa State University and General Motors Research Laboratories) and David A. HARVILLE: "Bayesian and non-Bayesian procedures for small-area estimation: relationships and computational aspects";

KENNEDY, William J., Jr.: "Computers in statistical education";

KOEHLER, Kenneth J., and Paul G. McGovern (University of Minnesota): "Bootstrap estimation for correlated survival data";

Lin, Chiou-Hua, and Shashikala SUKHATME: "The power of precedence tests";

Lin, Tsung-Hua (Iowa State University and The Upjohn Company) and David A. HARVILLE: "Some alternatives to Wald's confidence interval and test";

Lu, C. Joseph, and William Q. MEEKER: "Using degradation measures to assess reliability";

MEEDEN, Glen D.: "The admissibility of the linear interpolation

estimator of the population total";

MEEKER, William Q., Jr., and Luis A. Escobar: "Influence diagnostics for censored regression data";

Nanayakkara, Nuwan, and Noel CRESSIE: "Combining two unbiased estimators of a common mean";

POLLAK, Edward: "The effective population size of an age-structured population with a sex-linked locus";

Rathbun, Stephen L., and Noel A. C. CRESSIE: "A model for a spatial birth process";

Eltinge, Elizabeth M., and Carl W. ROBERTS: "Analyzing textbooks using linguistic content analysis";

SHELLEY, Mack C. II: "Time series perspectives on federal budgetary aggregates";

STRAHAN, Robert F.: "Simple in-class psychology experiments to aid statistics teaching";

STUFKEN, John: "Concepts of balance in block designs";

Sullivan, Gary R., and Wayne A. FULLER: "The use of measurement error to avoid disclosure";

Symanowski, James T.: "A bivariate logistic model with applications to ordered categorical data."

Vander Wiel, Scott A., and William Q. MEEKER: "Accuracy of approximate confidence bounds using censored regression data from accelerated life tests";

VARDEMAN, Stephen B.: Discussant, Session on Economic and Statistical Issues in Quality Improvement;

VARDEMAN, Stephen B., and Karen Jensen: "Better $\bar{X}$ and R charts for rounded data."

At the joint meeting of the Biometric Society (ENAR), Institute of Mathematical Statistics, and four sections of the American Statistical Association, in Baltimore, Maryland, April 1-4, 1990:

Beam, Craig A. (Duke University Medical Center): "The extension of ROC curve methodology to the evaluation of discriminant functions and the selection of discriminant function variables";

CRESSIE, Noel: "Mapping disease incidence";

Gotway, Carol A. (Sandia National Laboratories): "Minimax prediction in spatial problems";

Meeter, Carol A. (Merck Company, Inc.): "Optimum accelerated life tests with non-constant σ";

SUKHATME, Shashikala: "Stratification of ROC studies," by Sukhatme and Craig A. Beam (Duke University Medical Center);

WIEAND, Sam: "Introduction to North Central cancer treatment group metastatic colo-rectal cancer clinical trial"; also discussant for ENAR session on Bayesian Analysis of Cancer Clinical Trials;

"Adjusting the logrank test for a balanced treatment allocation," by Terry Therneau, David Gilbertson, and Wieand.

At the joint meeting of the Iowa sections of the Mathematics Association of America and the American Statistical Association, April 6-7, in Ames, Iowa:

ATHREYA, Krishna: The mathematics of bootstrap";

Parker, Robert: "Adjusting the census";

Rathbun, Stephen: "A space-time survival point process for a longleaf pine forest."

At other locations:

AMEMIYA, Yasuo: "Instrumental variable estimation for the nonlinear functional relationship model," seminar, Department of Statistics and Actuarial Science, University of Iowa, October 19.

ATHREYA, Krishna: "Branching processes and Lyaponov exponents," at the University of Sheffield, IMS symposium, August 16-19, 1989, in Sheffield, England.

"Bootstrapping Markov chains: Countable case," colloquium, Department of Statistics, University of Georgia, October 30, 1989, and colloquium, Department of Mathematics, University of Maryland, College Park, April 5, 1990.

"Probability measures on function spaces," graduate student colloquium, Department of Mathematics, Iowa State University, April 18.

"Bootstrapping Markov chains: Countable case," by Athreya and Cheng-Der Fuh, at the Institute of Mathematical Statistics meeting at Michigan State University, East Lansing, May 16.

Carriquiry, A. L.: "Bayesian prediction as applied to an unbalanced mixed linear model," by Carriquiry and D. A. HARVILLE. VII EIPES (Winter School on Probability and Statistics), Centro Interamericano de Enseñanza de Estadística, Santiago, Chile, July 27, 1989.

"Classical and Bayesian prediction from unbalanced mixed linear models," seminar, Department of Mathematics, University of Rome "La Sapienza," Rome, Italy, October 18.

"Prediccion clasica y Bayesiana en modelos lineales mixtos," seminar, Centro de Matematicas, Montevideo, Uruguay, December 29.

"Methods for assessing health risk in food," by Carriquiry, H. H. Jensen, S. M. Nusser, and S. R. Johnson, at The Economics of Food Safety Workshop, sponsored by the University of Connecticut, Alexandria, Virginia, June 4, 1990.

CRESSIE, Noel A. C.: "Analysis, modeling, inference, and design for spatial data," at the Gordon Research Conference on Statistics in Chemistry and Chemical Engineering, New Hampton, New Hampshire, August 2.

"Weighted smoothing of estimated undercount," at the 1990 Annual Research Conference of the U.S. Bureau of the Census, March 19, in Washington, D.C.

"Spatial mapping of regional variables," seminar, Department of Statistics, University of Adelaide, Adelaide, Australia, April 9.

DAVID, H. A.: "Some properties of order statistics filters," at the 1990 SPIE/SPSP Symposium sponsored by the International Society for Optical Engineering and the Society for Imaging Science and Technology, February 15, Santa Clara, California.

"Nonparametric methods of ranking from paired comparisons," by David and Douglas M. Andrews (Wittenberg University), at the 1990 AMS-IMS-SIAM Summer Research Conference on Probability Models and Statistical Analysis for Ranking Data, June 11, Amherst, Massachusetts.

FULLER, Wayne A.: "Prediction with the components of variance model," at the 47th session of the International Statistical Institute, Paris, France, August 30, 1989; also discussant for the session on Estimation and Analysis of Panel Survey Data, August 31.

"Analysis of repeated surveys," keynote address at the symposium, Analysis of Data in Time, sponsored by Statistics Canada, Ottawa, October 23.

"Nonlinear estimation for time series," seminar, Department of Statistics, University of Wisconsin-Madison, May 2, 1990.

"Introduction to estimation for measurement error models," at the Summer Research Conference in Statistics, Mobile, Alabama, June 14.

HARVILLE, David A. and **Daniel R. Jeske** (Iowa State University and AT&T Bell Laboratories): "Mean squared error of estimation or prediction under a general linear model," at the annual meeting of the Statistical Society of Canada, in St. John's, Newfoundland, June 6, 1990.

HINZ, Paul: "Use of multivariate analysis in variable selection problems," Animal Ecology Seminar, Iowa State University, September 29, 1989.

"Graduate study in statistics at Iowa State," lecture for two classes in mathematical statistics, Luther College, December 1.

ISAACSON, Dean L.: "Statistics as an independent unit," on October 28 at the annual meeting of the Department Chairs' Colloquium, hosted by the Board on Mathematical Sciences, National Research Council, in Crystal City, Virginia.

KOEHLER, Kenneth J.: "A multivariate logistic distribution with applications to the analysis of ordered categorical data," seminar, Department of Biostatistics and Epidemeology, University of South Florida, November 14.

"Constructing multivariate distributions with specific univariate marginal distributions," seminar, Department of Mathematics, National University of Singapore, January 18, 1990.

"Statistical methods for correlated survival data," seminar, the Upjohn Corporation, Kalamazoo, Michigan, April 12.

"Constructing multivariate distributions with specific univariate margins with applications to multivariate logistic regression," at the Southwest Michigan ASA chapter meeting, at Western Michigan University, April 12.

LAHIRI, Soumendra N.: "Second order optimality of stationary bootstrap," at the 214th meeting of the Institute of Mathematical Statistics, May 15, 1990, in East Lansing, Michigan.

LORENZ, Frederick O.: "Psychological stress: Measurement and consequences," by Lorenz, Rand D. Conger, and Paul Lasley, and "A note on response quality and the timing of the return of a mail questionnaire," by Willis Goudy, Xiaodong Yang, Ge Xiao Jim, and Lorenz at the Rural Sociological Society meetings, Seattle, Washington, August 7, 1989.

"Economic distress and marital quality: An illustration of method variance problems in causal modeling," by Rand D. Conger, Lorenz, Katherine J. Conger, Shirley Huck, Ronald L. Simons, Les B. Whitbeck, Janet N. Melby, and Glen Elder, Jr., at the 51st annual conference of the National Council of Family Relations, New Orleans, Louisiana, November 5.

Discussant and presider, session on Quantitative Methodology, Midwest Sociological Society meetings, Chicago, Illinois, April 12, 1990.

MEEKER, William Q., Jr.: "Optimum accelerated life tests with nonconstant σ," seminar at Bellcore, Inc., Morristown, New Jersey, and at AT&T Bell Laboratories, Murray Hill, New Jersey, on July 25 and 26, 1989, respectively.

Discussant for session on statistical graphics, Gordon Research Conference on Statistics in Chemistry and Chemical Engineering, New Hampton, New Hampshire, August 4.

"Design and analysis of accelerated life tests," at the Oakland University Quality and Productivity Improvement Conference, November 8, Rochester, Michigan.

"Influence analysis with censored regression data," seminar for the Department of Statistics, North Carolina State University, January 12, 1990, and for the Department of Statistics and Actuarial Science, University of Waterloo, Ontario, Canada, February 8.

Nusser, Sarah M.: Estimating the distribution of usual intakes," by Nusser, Helen H. Jensen, **Wayne A. FULLER,** and Stanley R. Johnson, at the American Institute of Nutrition winter meeting, Charleston, South Carolina, December 10, 1989.

"A transformation approach to estimating usual intake distributions," by Nusser, **Alicia L. Carriquiry,** Helen H. Jensen, and **Wayne A. FULLER,** at the Conference on Applied Statistics in Agriculture, Kansas State University, April 1990.

ROBERTS, Carl W.: "Quantifying the content of verbatim text," by Roberts and Albert Baker—seminar for the Linguistics Program, Iowa State University, May 10, 1990.

SACKS, Jerome M.: Lecture on statistical aspects of flow cytometry, at an Iowa State University Flow Cytometry Workshop, July 1989.

"Plot size determination," seminar for the National Soil Tilth Laboratory, Iowa State University, July.

"Baseline information," seminar for the National Animal Disease Center, Ames, Iowa, November.

SENGUPTA, Debapriya: "On shrinkage towards an arbitrary estimator," seminar, Department of Statistics, University of Wisconsin-Madison, October 25.

SHELLEY, Mack C. II: "Dealignment, realignment, and the 1988 vote: Evidence from Senate elections," by Shelley and Steven G. Koven, at the 1989 annual meeting of the American Political Science Association, September 1, 1989, in Atlanta, Georgia; also presented as a Political Science Colloquium, Iowa

Centerfold: Preparation of the ISU statistics historical display for the American Statistical Association Sesquicentennial was primarily the work of Theodore Bailey and Jauvanta Walker. Assistance was provided by the university Media Graphics department. Some of the photographs were also used in the ASA video presentation on the history of statistics. Photos in the panel on p. 22, reading from L to R, in tiers:

(a) Henry A. Wallace
(b) Gertrude Cox
(c) A. E. Brandt in the Mathematics Statistical Services Section
(d) Experimental plots at the ISU agronomy farm
(e) Sir Ronald A. Fisher
(f) Stat Lab faculty and graduate students
(g) George Snedecor and William Cochran
(h) Service Building, now called Snedecor Hall, home of the Statistical Laboratory
(i) Mu Sigma Rho insignia design
(j) Paul Homeyer, Oscar Kempthorne, Ray Jessen, and Snedecor—key faculty in the new Department of Statistics
(k) An area probability sampling map from the national Master Sample of Agriculture
(l) Greenhouse experiment reported on in a journal publication by C. A. Black and Oscar Kempthorne
(m) George Snedecor teaching his new introductory statistics course in the quonset
(n) Program for the International Conference on Quantitative Genetics
(o) Brochure for the Stat Lab 50th anniversary conference
**(p) Statistics faculty at ISU in 1989**

IOWA STATE UNIVERSITY

DATELINE

1913 G.W. Snedecor arrives at ISU
1924 H.A. Wallace seminars, to agricultural research workers
1925 Publication of 'Correlation and Machine Calculation' (by H.A. Wallace and G.W. Snedecor)
1927 Mathematics Statistical Services Section created (with Snedecor and A.E. Brandt in charge)
1931 R.A. Fisher visiting professor, summer. Fisher's first visit to the U.S.
1931 First M.S. degree in statistics at ISU, to Gertrude M. Cox (awarded through Department of Mathematics)
1933 Statistical Laboratory organized, directed by Professor Snedecor; Gertrude Cox and Mary Clem join staff
1935 Statistical Section of Iowa Agricultural Experiment Station established
 Extensive development of sampling initiated
1936 R.A. Fisher visiting professor. ISU first American university to award Fisher a D.Sc.
1936 A.E. Brandt co-authors paper with J.V. Atanasoff
1937 *Statistical Methods* by G.W. Snedecor published
1938 Cooperative agreement with USDA; rapid expansion of Statistical Laboratory
1939 Rapid growth in graduate program in statistics stimulated by William G. Cochran
1940 First Ph.D in statistics at ISU, to Holly C. Fryer
1943 Master Sample of Agriculture project begins
1947 Formation of the Department of Statistics
1950 T. A. Bancroft director/head of statistical center
1952 The Design and Analysis of Experiments by O. Kempthorne published
1952 Biostatistics Conference, June, July
1957 First mainframe computer in Statistics (IBM 650)
1961 Numerical Analysis Section of Statistical Laboratory created
1968 Mu Sigma Rho Fraternity founded at ISU
1972 H. A. David director/head of statistical center (through June 1984, succeeded by D. Isaacson)
1976 International Conference on Quantitative Genetics
1983 Conference marking the 50th anniversary of the Statistical Laboratory
1989 Conference in honor of Oscar Kempthorne

Master Sample of Agriculture

INTERNATIONAL CONFERENCE ON QUANTITATIVE GENETICS

50 Years ISU Stat Lab
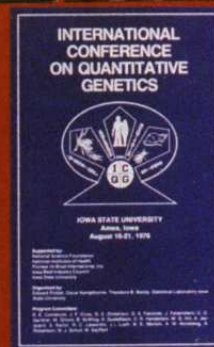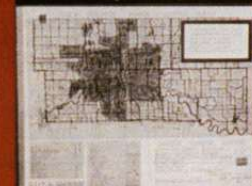
STATISTICAL CENTER

TEACHING
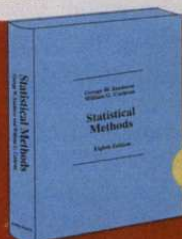
ISU Statistics Graduates
including joint majors

- 363 B.S.
- 549 M.S.
- 299 Ph.D.

Statistics Majors
Fall 1988

- 50 undergraduate
- 120 graduate

Students Graded in Statistics Courses
Academic year 1988-89

- 4,652 students
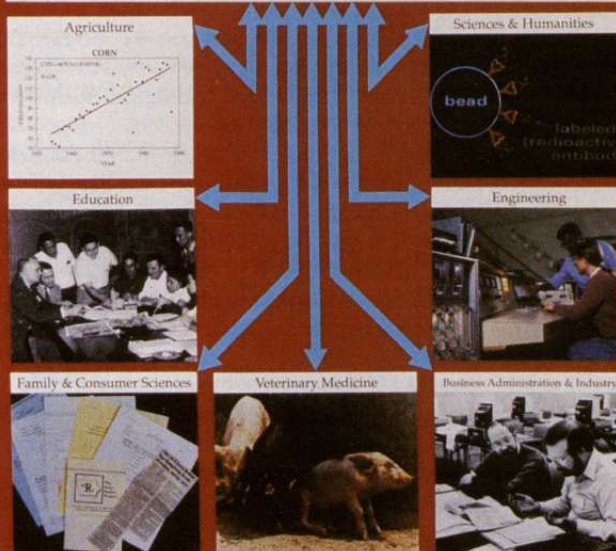
8th Edition Fall 1989

RESEARCH

CURRENT MAJOR AREAS

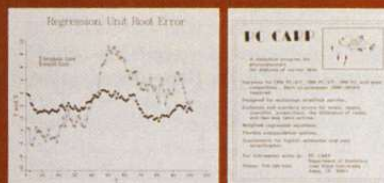|	
Components of variance models	Operations research
Contingency tables	Order statistics
Econometric statistics	Probability
Engineering statistics	Reliability
Experimental design	Robustness
Genetic statistics	Spatial statistics
Linear models	Statistical computing
Mathematical programming	Statistical quality control
Measurement error models	Stochastic processes
Multivariate analysis	Survey design
Nonlinear estimation	Survey sampling
Nonparametric statistics	Time series
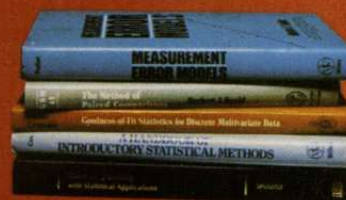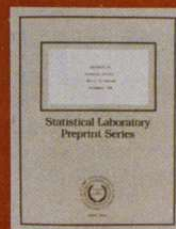
CONSULTING

CENTRAL TO THE UNIVERSITY'S MISSION

- Services to researchers
- Joint research
- Teaching ideas
- Ideas for research in statistics

Agriculture

Sciences & Humanities

Education

Engineering

Family & Consumer Sciences

Veterinary Medicine

Business Administration & Industry

PROJECTS

Joint Research and Survey Activities
with Universities, Hospitals, State agencies, Federal agencies (NASS, NAHMS, HNIS, Census Bureau, SCS)

Regression, Unit Root Error

PC CARP

Statistical Numerical Analysis & Data Processing
Graphics Illustrating Section Projects

Distribution and Proportional Extent of Vertisol Soils in the United States

State University, April 19, 1990.

"University and state government response to biotechnology," at the GTE Lectureship Program on Science, Technology, and Human Values Conference on Biotechnology and Ethics: Social Change and Human Values, at the University of Missouri-Columbia, December 7; also roundtable discussant on "Important social values surrounding biotechnology," December 6.

"Tiananmen Square and perceptions of political realities in China: A content analysis of media coverage," by Liangfu Wu, Xia Li, Shelley, and Ellen B. Pirro, at the annual meeting of the Midwest Political Science Association, April 5, 1990, in Chicago, Illinois.

SKINNER, Christopher: "Disclosure avoidance for census microdata in Great Britain," at the U.S. Bureau of the Census Annual Research Conference, Washington, D.C., March 19, 1990

"Logistic modelling of gross flow rates with measurement error," seminar at the U.S. Bureau of Labor Statistics, Washington, D.C., May 18.

STEPHENSON, W. Robert: "Teaching statistics: Which come first, the formulae or the data?"—seminar, Department of Statistics, University of Newcastle, New South Wales, Australia, October 11, 1989.

"Statistical consulting with industry," seminar, Department of Mathematics, National University of Singapore, Republic of Singapore, February 9, 1990.

"Data: What, where, why, how to collect," at the annual general meeting of the Hunter Valley Chapter of the Australian Society for Operations Research Incorporated, Newcastle, New South Wales, Australia, March 21.

"Graphical analysis of factorial experiments," seminar, Department of Statistics, University of Newcastle, May 2.

"Experimental design: A tool for process and product improvement," seminar for BHP Wire Products Technical Staff, Newcastle, New South Wales, Australia, June 6.

STUFKEN, John: "Variance balanced and pairwise balanced block designs," seminar, Department of Mathematics and Statistics, University of Guelph, Ontario, Canada, July 20, 1989.

"Group divisible treatment designs for comparing test treatments with a standard treatment," seminar, Department of Mathematics, Statistics, and Computer Science, University of Illinois at Chicago, February 23, 1990.

SUKHATME, Shashikala B.: "The choice of precedence tests," seminar for the Indian Statistical Institute, Bangalore Center, Bangalore, India, and for the Department of Statistics, Karnatak University, Mysore, on January 8 and 10, respectively.

"The best precedence test in life testing experiments," special lecture under the University Grants Commission Programme, Department of Studies in Statistics, University of Mysore, Mysore, India, January 9.

"ROC curves with random number of cases," seminar, School of Public Health and Department of Biostatistics, University of Pittsburgh, February 9.

Sullivan, Gary (Lilly Research Laboratories): "The use of measurement error to avoid disclosure," by Sullivan and **Wayne A. FULLER,** at The Institute of Management Sciences/ Operations Research Society of America 1990 Annual Spring Meeting, May 9, 1990, in Las Vegas, Nevada.

VARDEMAN, Stephen B.: "Design and analysis of experiments," a review session for the American Society for Quality Control certified Quality Engineer Examination, given in Marshalltown, Iowa, November 27, 1989, for the society's Central Iowa Section.

■ Other Meetings

Noel Cressie and Mervyn Marasinghe attended selected sessions of the workshop on Robustness, Diagnostics, Computing, and Graphics in Statistics sponsored by the Institute for Mathematics and Its Applications, University of Minnesota, and held July 10-September 1, 1989. Cressie was a member of the workshop's organizing committee.

Mack C. Shelley II was an invited participant at the Sixth Political Methodology Conference, University of Minnesota, July 13-15, 1989.

Krishna Athreya, Debapriya Sengupta, Soumendra Lahiri, Patrick Homblé, and Che-Ping Lee attended the 11th Midwest Probability Colloquium held at Northwestern University on October 20-21, 1989.

Shashikula Sukhatme attended The Way Up VII: Improving the Campus Climate for Women, a statewide conference for women in higher education administration, November 2-3, 1989, in Des Moines, Iowa.

Jerome M. Sacks attended the 45th annual conference of Applied Statistics, held in Atlantic City, New Jersey, in December.

Wayne A. Fuller participated in the National Research Council Workshop on Methodological Approaches to the Preparation of Small-area Estimates, held in Washington, D.C., January 24-26, 1990.

Krishna Athreya attended the 213th meeting of the Institute of Mathematical Statistics held on April 1-4 in Baltimore, Maryland.

Bud Meador attended the SAS Users Group International 15th Annual Conference on April 1-4, in Nashville, Tennessee.

As a branch delegate, Jauvanta Walker attended the biennial meeting of the National League of American Pen Women, Inc., on April 21-24, in Kansas City, Missouri.

David Cox, Paul Hinz, and Jerome M. Sacks attended the Kansas State University Conference on Applied Statistics in Agriculture held April 29-May 1 in Manhattan, Kansas.

Soumendra Lahiri attended the 22nd Symposium on the Interface of Computing Science and Statistics, held May 17-20, 1990, at Michigan State University and co-sponsored by the Society for Industrial and Applied Mathematics.

Theodore B. Bailey attended the Sewall Wright Centennial Symposium, held June 7-9, in Madison, Wisconsin.

Mack C. Shelley II was an invited participant in a meeting with the National Advisory Task Force on Positive Guidance concerning the Final Report of the Task Force, in Washington, D.C., June 8.

Kui-Jang Wang attended the 1990 International Statistical Symposium: New Developments in Statistical Theory and Applications on June 28-30 in Taipei, Taiwan.

Publications and Dissertation Abstracts

In the Statistical Laboratory preprint series, 27 titles (#89-13 to 89-39) were added during the last half of 1989 and 10 more (#90-1 to 90-10) in the first half of 1990. Copies of the most recent set of abstracts are available on request. Any preprint may be requested by number directly from the author. A new set of preprint abstracts will be released in fall 1990.

In the listing of publications below, names in boldface type indicate authors from the ISU statistical center, with students' last names shown in boldface caps and lower case letters and faculty surnames boldfaced in all capital letters. If the research reported on was done at ISU but the author is now elsewhere, present location is shown in parentheses. If the work was done partly here and partly at a different present location, both institutions are mentioned parenthetically.

■ Books

Anderson, T. W., **Krishna B. ATHREYA,** and Donald L. Iglehart, editors. **Probability, Statistics, and Mathematics: Papers in Honor of Samuel Karlin.** San Diego: Academic Press, Inc. xl + 371 pp. 1989.

This volume consists of 24 papers written by mathematicians, probabilists, statisticians, and economists in honor of Samuel Karlin on the occasion of his 65th birthday. The papers come from three of the five main fields in which Karlin worked: total positivity, mathematical analysis, and approximation theory; probability, statistics, and stochastic processes; and operations research and management sciences. Lists of Karlin's 10 books and 330 papers and his Ph.D. students are also included.

Bardes, Barbara A., **Mack C. SHELLEY, II,** and Steffen W. Schmidt. *American Government and Politics Today: The Essentials,* third edition. St. Paul: West Publishing Company. 1990. xxx + 569 pp.

This is the third edition of an introductory textbook in national political institutions and processes. Extensive use is made of public opinion data, and students are advised how to interpret popular poll results in the light of sampling procedures and other considerations. A new appendix on how to conduct research in government and political science has been added, including suggested reference sources

and procedures for choosing and analyzing a research topic. Results of the 1988 national elections are emphasized throughout the book. Supplemental materials include a student study guide, an instructor's manual with printed test bank, a computerized testing program, a computerized study guide, an extensive library of videotapes, enrichment lectures, transparency acetates, and a handbook, *An Introduction to Critical Thinking in American Politics.*

SNEDECOR, George W., and William G. Cochran. *Statistical Methods,* eighth edition. Ames, Iowa: Iowa State University Press. 1989. xx + 503 pp.

The first edition of this book was published in 1937 with George W. Snedecor as the sole author. Snedecor asked William G. Cochran to do the revisions for the sixth edition, and Cochran was listed as the second author of the sixth and seventh editions. The present edition was prepared by several members of the Department of Statistics at Iowa State University. David F. Cox, who helped complete the remaining authorial work on the seventh edition after Cochran's death, coordinated the work on the eighth edition.

The revisions were guided by the principle that the work should remain the work of its original authors; thus, much of the material remains as previously published. A significant change in this edition occurs in the notation used to describe the operations of multiple regression. Matrix algebra replaces the original summation operators, and a short appendix on matrix algebra is included.

■ Published Research

AMEMIYA, Yasuo. On the convergence of the ordered roots of a sequence of determinantal equations. *Linear Algebra and Its Applications* 127 (1990) 531-542.

Let $\lambda_1(n) \geq \lambda_2(n) \geq \lambda_p(n)$ be the ordered roots of $|\mathbf{A}(n) - \lambda \mathbf{B}(n)| = 0$, where $\mathbf{A}(n)$ is a $p \times p$ real symmetric matrix and $\mathbf{B}(n)$ is a $p \times p$ real symmetric positive definite matrix. Assume that $\mathbf{A}(n) \to \mathbf{A}$ and $\mathbf{B}(n) \to \mathbf{B}$ as $n \to \infty$, where the rank of $\mathbf{B}$ may be less than p. Using a result on the continuity of the zeros of a polynomial, the limiting behavior of p sequences $\{\lambda_j(n)\}_{n=1}^{\infty}$, $j = 1,2, \ldots ,p$, is investigated.

AMEMIYA, Yasuo. A note on the limiting distribution of certain characteristic roots. *Statistics & Probability Letters* 9:5 (1990) 465-470.

Let $\mathbf{A}(n)$ and $\mathbf{B}(n)$ be sequences of $p \times p$ random matrices with a joint limiting distribution as $n \to \infty$. The limiting distribution of the ordered roots of $|\mathbf{A}(n) - \lambda \mathbf{B}(n)| = 0$ is characterized under very general conditions.

AMEMIYA, Yasuo. Two-stage instrumental variable estimators for the nonlinear errors-in-variables model. *Journal of Econometrics* 44:3 (1990) 311-332.

Estimation for the nonlinear functional errors-in-variables model is considered under the assumption that instrumental variables are available. The approximate bias in the ordinary instrumental variable estimator due to the nonlinearity of the relationship is derived. Utilizing the nonlinearity of the relationship, an estimator of the error covariance matrix is introduced. Using the error covariance matrix estimator, two types of two-stage instrumental variable estimators are proposed. The two two-stage estimators do not have the same asymptotic bias due to the nonlinearity. A Monte Carlo experiment also shows the superiority of the two-stage estimators over the ordinary estimator.

ATHREYA, K. B., and A. P. N. Weerasinghe. Exponentiality of the local time at hitting times for reflecting diffusions and an application. Pp. 41-58 in *Probability, Statistics, and Mathematics: Papers in Honor of Samuel Karlin,* edited by T. W. Anderson, Krishna B. Athreya, and Donald L. Iglehart. 1989.

A continuous time analog to a specified sequence of gambling problems—namely, a reflecting Brownian motion reflecting at the origin—is examined. It is shown that the penalty for hitting 0 is exponentially distributed. Then the more general case of reflecting diffusions is considered. Finally the theory is applied to a stochastic control problem.

COX, D. F. Teaching statistical methods to graduate students in colleges of agriculture. Pp. 132-136 in *Applied Statistics in Agriculture*—Proceedings of the Kansas State University Conference on Applied Statistics in Agriculture, held May 1-2, 1989. 1990.

Journal Paper No. J-13559 of the Iowa Agriculture and Home Economics Experiment Station, Project 101.

One method of judging the effectiveness of the teaching of statistical methods is to rate the quality of their use in the research journals of the agricultural sciences. A conclusion that improvement is possible is easily supported by such a review. Basic concepts such as the meaning of replication, the definition of an experimental unit, and the nature of experimental error are misunderstood, and this leads to faulty analyses and incorrect conclusions. Changes in teaching that would improve the product are not specified easily because research on the topic is difficult. Perhaps more emphasis on the basic concepts of experimental science could lead to more complete understanding of the nature of statistical thinking and, consequently, more effective and correct use of the methods available.

Miller, Charles D., John L. Richard, Frederick B. Hembrough, Gary D. Osweiler, and **David F. COX.** In vitro effects of cyclopiazonic acid mycotoxin on turkey papillary muscles. *American Journal of Veterinary Research* 51:5 (1990) 836-838.

An in vitro bioassay system was used to study the effects of cyclopiazonic acid (CPA) mycotoxin on cardiac muscle obtained from turkeys. The data indicate that acute exposure to 6 μg of CPA/ml of modified Krebs-Henseleit solution significantly ($P < 0.05$) decreased five in vitro turkey cardiac muscle performance criteria: maximal weight a muscle could lift; maximal contraction velocity; relaxation velocity; time to peak contraction; and total time for muscle contraction and relaxation. The effect on these five criteria appeared to result from intracellular changes partially associated with calcium availability and were irreversible, suggesting that physiologic changes had developed after acute exposure to CPA.

CRESSIE, Noel, and F. Pesarin. Comment on "Space-time modelling with long-memory dependence: Assessing Ireland's wind resource," by J. Haslett and A. E. Raftery. *Applied Statistics* 38:1 (1989) 31-32.

CRESSIE, Noel. Ergodicity for time series and spatial processes. *Journal of Statistical Computation and Simulation* 32:1-2 (1989) 61-63.

Ergodicity in time and space is discussed. It is pointed out that the usual definition in space is inappropriate for geostatistical problems where data are a finite sampling of a continuous realization of a random spatial process.

CRESSIE, Noel, and Timothy R. C. Read. Spatial data analysis of regional counts. *Biometrical Journal* 31:6 (1989) 699-719.

Counts data from spatially contiguous regions offer a challenge to the statistician from both the data analytic and the statistical modeling points of view. Important applications include epidemiological studies (e.g., cancer mortality over the counties of the United States) and Census Bureau surveys (e.g., undercount over the census blocks of an urban area). It has long been recognized by time-series analysts that data close together in time usually exhibit higher dependence than those far apart. Time-series data analysis relies on methods of data transformation, detrending, and autocorrelation plotting. In this article, the approach is generalized to a spatial setting, through the use of transformations, weighted median polish, and variogram analysis of the median-polish residuals.

CRESSIE, Noel. Geostatistics. *The American Statistician* 43:4 (1989) 197-202.

Most data have a space and time label associated with them; data that are close together are usually more correlated than those that are far apart. Prediction (or forecasting) of a process at a particular label where there is no datum, from observed nearby data, is the subject of this article. One approach, known as geostatistics, is featured, from which linear methods of spatial prediction (kriging) will be considered. Brief reference is made to other linear/nonlinear,

stochastic/deterministic predictors. The (linear) geo-statistical method is applied to piezometric-head data around a potential nuclear-waste repository site.

CRESSIE, Noel. Empirical Bayes estimation of undercount in the decennial census. *Journal of the American Statistical Association* 84:408 (1989) 1033-1044.

On April 1, 1990, the decennial census for the United States will be conducted by the U.S. Bureau of the Census. By December 31, 1990, the bureau is specified by law to submit state population counts for the purpose of reapportionment of the U.S. House of Representatives, and by March 31, 1991, to submit small-area population counts for the purpose of re-districting. Census counts are used in a variety of other ways: for revenue-sharing formulas between different levels of government, for demographic projections, as a base for morbidity and mortality statistics, and so forth. Census undercount is defined simply as the difference between the true count and the census count, expressed as a percentage of the true count. Small-area estimation of this undercount is considered here, using empirical Bayes estimators based on a new and, it is argued, more realistic model than has been used before.

CRESSIE, N., and P. B. Morgan. Design considerations for Neyman-Pearson and Wald hypothesis testing. *Metrika* 36:6 (1989) 317-325.

The Neyman-Pearson Lemma describes a test for two simple hypotheses that, for a given sample size, is most powerful for its level. It is usually implemented by choosing the smallest sample size that achieves a prespecified power for a fixed level. The Lemma does not describe how to select either the level or the power of the test. In the usual decision-theoretic structure there exists a sampling cost function, an initial prior over the hypothesis space and various payoffs to right/wrong hypothesis selections. Then the optimal test is a Bayes decision rule that maximizes the expected payoff net of sampling costs. This paper shows that the Bayes-optimal test and the Neyman-Pearson test can be the same and how the Neyman-Pearson test, with fixed level and power, can be viewed as a Bayes test subject to restrictions on the payoff vector, cost function, and prior distribution.

CRESSIE, Noel, Carol A. Gotway (Sandia National Laboratories), and **Martín O. Grondona** (Instituto Nacional de Tecnologia Agropecuaria, Buenos Aires, Argentina). Spatial prediction from networks. *Chemometrics and Intelligent Laboratory Systems* 7:3 (1990) 251-271.

This article defines a random-field model that can be used for the prediction of pollutants at locations where no data are available, based on data taken from a spatial network of monitoring sites. Acid deposition data collected from the UAPSP network in 1982 and 1983 are analyzed in two stages. Bias-resistant and outlier-resistant techniques are used to determine the spatial dependence; then a spatial model is built that is made up of a quadratic trend surface and the spatially correlated error. Spatial sampling plans and optimal designs for selecting monitoring sites are summarized and discussed. The question of the location of additional sites (and deletion of existing ones) is also addressed.

CRESSIE, Noel. The origins of kriging. *Mathematical Geology* 22:3 (1990) 239-252.

In this article, kriging is equated with spatial optimal linear prediction, where the unknown random-process mean is estimated with the best linear unbiased estimator. This allows early appearances of (spatial) prediction techniques to be assessed in terms of how close they came to kriging.

DAVID, H. A. Some applications of order statistics. *Proceedings of the Thirty-fourth Conference on the Design of Experiments in Army Research Development and Testing.* U.S. Army Research Office. Pp. 1-13. 1989.

This paper focuses on applications of order statistics to (a) estimators that are resistant to outliers, (b) current measures of location and dispersion such as the moving median and the moving range, and (c) some problems in reliability.

BATTESE, George E. (University of New England), **Nancy A. Hasabelnaby** (King Saud University, Riyadh, Saudi Arabia), and **Wayne A. FULLER.** Estimation of livestock inventories using several area- and multiple-frame estimators. *Survey Methodology* 15:1 (1989) 13-27.

Estimation of total numbers of hogs and pigs, sows and gilts, and cattle and calves in a state is studied using data obtained in the June Enumerative Survey conducted by the National Agricultural Statistics Service of the U.S. Department of Agriculture. It is possible to construct six different estimators using the June Enumerative Survey data. Three estimators involve data from area samples, and three estimators combine data from list-frame and area-frame surveys. A rotation sampling scheme is used for the area frame portion of the enumerative survey. Covariances among the estimators for different years are estimated using data from the five years 1982 through 1986.

A composite estimator is proposed, obtained by a generalized least-squares regression of the vector of different yearly estimators on an appropriate set of dummy variables. The composite estimator is designed to yield estimates for livestock inventories that are "at the same level" as the official estimates made by the U.S. Department of Agriculture.

Arnold, B. C., and **Richard A. GROENEVELD.** Sequential sampling estimation for finite populations of $N = nr$ objects. *The Biometrical Journal* 32:2 (1990) 143-153.

Random sampling from a finite population of size $N = nr$ (r known) is considered. The statistic observed is $T^k_{rn\ell}$, the number of observations required until the kth set of size ℓ from the n sets of r is obtained. An asymptotically unbiased estimator of n is obtained together with its approximate variance. Recommendations are made for choices of r and ℓ, based on the large sample expectation of $T^k_{rn\ell}$. An application in archaeology to the estimation of the number of individuals originally present based on multiple bone counts is considered.

Hasabelnaby, Nancy A. (King Saud University), James H. Ware, and **Wayne A. FULLER.** Indoor air pollution and pulmonary performance: Investigating errors in exposure assessment. *Statistics in Medicine.* 8:9 (1989) 1109-1126.

We use pulmonary function measurements on pre-adolescent children and indoor air pollution measurements in the homes of these children to illustrate estimation techniques for linear regression models containing independent variables measured with error. In our data set, replicate measures of indoor air pollutant concentrations provide one method of estimating measurement error variances. Surrogate information in the form of number of cigarettes smoked is also available for the pollutant of interest. Several estimation procedures are presented, and we combine two estimators, one based on surrogate information and one based on replication information, using generalized least squares.

HINZ, Paul N., and Mario R. Pareja. A combined analysis of experiments when treatments differ among experiments. Pp. 186-193 in *Applied Statistics in Agriculture—Proceedings of the 1989 Kansas State University Conference on Applied Statistics in Agriculture.* 1990.

Journal Paper No. J-13574 of the Iowa Agriculture and Home Economics Experiment Station, Project 101.

This paper discusses a method used for a combined analysis of experiments when the treatments represent levels of a quantitative factor but differ among experiments. The method is illustrated on data from a series of experiments designed to study the relationship of grain yield of soybeans as affected by the density of the weed species velvetleaf.

KEMPTHORNE, Oscar. The fate worse than death and other curiosities and stupidities. *The American Statistician* 43:3 (1989) 133-134.

This is an editor's invited column concerning a pet peeve of the author's, that estimation of a parameter θ, which is stated in the model to belong to a set Θ, must always yield a result that is in Θ. Several illustrations are given of poor statistical thinking and silly results obtained by statisticians that may be passed on to unsuspecting beginning students.

KEMPTHORNE, Oscar. Discussion of the paper, "The Non-orthogonal Design of Experiments," by R. Mead. *Journal of the Royal Statistical Society, Series A,* 153:Pt. 2 (1990) 191-192.

Kim, S. H. (Kyung Sung University, Pusan, Korea), and **H. A. DAVID.** On the dependence structure of order statistics and concomitants of order statistics. *Journal of Statistical Planning and Inference* 24:3 (1990) 363-368.

Let (X_i, Y_i), $i = 1, \ldots, n$, be n independent identically distributed pairs of rv's. If the X_i are ordered, one obtains both the order statistics $X_{1:n} \leq \cdots \leq X_{n:n}$ and their concomitants $Y_{[1:n]}, \ldots, Y_{[n:n]}$, where $Y_{[r:n]}$, $r = 1, \ldots, n$, are the Y_i paired with $X_{r:n}$. Some results of Tukey (1958) on the dependence structure of the $X_{i:n}$ are reviewed and extended. Conditions are given for the $Y_{[i:n]}$ to be associated or to be multivariate totally positive of order 2 (MTP_2). It is also shown that the covariance of two order statistics can be negative if the X_i are sufficiently negatively dependent.

KOEHLER, Kenneth J., and **Paul G. McGovern** (University of Minnesota). An application of the LFP survival model to smoking cessation data. *Statistics in Medicine* 9:4 (1990) 409-421.

We use a limited failure population (LFP) model based on the Weibull distribution to model the times from initial abstinence to return to smoking for subjects enrolled in programs to help them stop smoking. The model contains a third parameter that corresponds to the proportion of subjects who permanently abstain from smoking. The data are subject to both right and interval censoring. Furthermore, subjects receive treatment in groups, and individuals in the same group may provide correlated outcomes. Use of a maximum likelihood estimation procedure that assumes independent outcomes provides reasonable parameter estimates, but the corresponding standard errors tend to be too small, which results in tests with inflated type I error levels and confidence intervals that tend to be too narrow. We use a bootstrap procedure to obtain more reasonable values for the standard errors and to construct confidence intervals that more nearly achieve the stated coverage probabilities.

Davis, Susan E., Erwin E. Klaas, and **Kenneth J. KOEHLER.** Diurnal time-activity budgets and habitat use of Lesser Snow Geese *Anser caerulescens* in the middle Missouri River valley during winter and spring. *Wildfowl* 40 (1989) 45-54.

Journal Paper No. J-13122 of the Iowa Agriculture and Home Economics Experiment Station and Welder Wildlife Foundation Contribution No. 338.

Diurnal time activity and habitat use of wintering and spring-migrating Lesser Snow Geese were studied in the middle Missouri River valley during 1983 and 1984. Geese spent the majority of daylight hours sleeping and loafing. During winter and spring migration, geese spent 17.5 percent and 24.0 percent, respectively, of a 12-hour day feeding. Geese primarily fed in corn stubble fields; they also fed on winter wheat and bromegrass. The availability of waste corn in the middle Missouri River valley presumably influences the winter distribution of Snow Geese.

Liu, Jingyu, and **H. A. DAVID.** Quantiles of sums and expected values of ordered sums. *Australian Journal of Statistics* 31:3 (1989) 469-474.

Watson and Gordon [*Australian Journal of Statistics* 28 (1986) 192-199] investigated the relationship between the quantiles of a sum of independent continuous random variables and the sum of the individual quantiles. In this note some further results are obtained. Also corresponding relationships are developed for the expected values of the order statistics of a sum, and for the sum of the expected values of the individual order statistics.

Keith, Pat M., and **Frederick O. LORENZ.** Financial strain and health of unmarried older people. *The Gerontologist* 29:5 (1989) 684-691.

In a study of 1,782 older unmarried persons, we found no evidence that financial strain contributed to poor health. This conclusion was a result of an analysis of the 1969 and 1979 waves of the Longitudinal Retirement History Study conducted by the U.S. Bureau of the Census for the Social Security Administration. Multiple indicators of health and financial strain were used to estimate true score and error variances.

Whitbeck, Les B., Ronald L. Simons, Rand D. Conger, and **Fred O. LORENZ.** Value socialization and peer group affiliation among early adolescents. *Journal of Early Adolescence* 9:4 (1989) 436-453.

This study examined parental influence on the values of early adolescents and the influence of adolescents' values on their choice of friends. The degree to which early adolescents identified with their parents and the parents' endorsement of two measures of conventional values were found to predict adolescents' endorsement of conventional values. In turn, adolescents who endorsed values oriented toward altruism were less likely to report association with friends who had been involved in deviant behavior. Endorsing values oriented toward success and affluence did not reduce adolescents' reports of friendships with peers who had been involved in deviant activities. The results suggest the importance of considering types of values when investigating value influence on adolescent behavior. They also suggest that values indirectly affect adolescent behavior by influencing peer group affiliation.

Boik, Robert J., and **Mervyn MARASINGHE.** Analysis of nonadditive multiway classifications. *Journal of the American Statistical Association* 84:408 (1989) 1059-1064.

The problems of testing additivity and estimating σ^2 in unreplicated multiway classifications are considered. To model nonadditivity and jointly estimate σ^2, the interaction parameter space must be restricted; otherwise the model is saturated. The parameterization we use is a multiway extension of the two-way multiplicative interaction model of Mandel (1971) and Johnson and Graybill (1972). For exam-ple, in a three-way classification, we model interaction as $\theta_{ijk} = \lambda \delta_{1i} \delta_{2j} \delta_{3k}$. This structure is a special case of the k-mode principal components model, which has received considerable attention in the psychometric literature (Kapteyn, Neudecker, and Wansbeek 1986). We construct an exact test of $\lambda = 0$ and propose an estimator of σ_2 that can be used when interaction has been detected. Our test is an approximation to the likelihood ratio test (LRT) of H_0: $\lambda = 0$. The proposed test has essentially the same power as the LRT but is easier to compute, and the exact null distribution of the test statistic is known. Selected percentiles of the null distribution are given for three-way classifications. For large $|\lambda/\sigma|$, a transformation of the test statistic is shown to be approximately distributed as a noncentral F and can be used to compute the power of the test. The test and estimator are illustrated on a data set having three rows, three columns, and four layers.

MEEDEN, Glen (University of Minnesota). Admissible contour credible sets. *Statistics & Decisions* 8:1 (1990) 1-10.

Some examples of inadmissible highest posterior density credible set procedures are given. It is suggested that posterior contour credible sets should be used instead.

MEEDEN, G. (University of Minnesota), M. Ghosh, C. Srinivasan, and **S. VARDEMAN.** The admissibility of the Kaplan-Meier and other maximum likelihood estimators in the presence of censoring. *The Annals of Statistics* 17:4 (1989) 1509-1531.

For the nonparametric estimation of a survival function when censoring is present, the Kaplan-Meier estimator is often used. The admissibility of this estimator and other related maximum likelihood estimators is demonstrated. This is done by reducing the problem to one involving just the multinomial distribution and then using the stepwise Bayes technique to prove admissibility.

Peterka, Peter B., and **W. Robert STEPHENSON.** Nested designs: A tool for process engineers. *Chemical Engineering Progress* 86:4 (1990) 12-15.

No matter which quality philosophy is considered, there are always two types of variation involved in process monitoring. The first is the natural or inherent variation of the process, sometimes called "common cause" variation. The second is variation due to "special" or assignable causes, which can be reduced or eliminated if the special causes acting on the process can be identified and corrected. Shewhart control charts play an important role in identifying when a special cause exists. While Shewhart control charts are used to signal special causes, process capability studies involving nested designs quantify common cause variability. Nested designs can be invaluable to process engineers in the study of a process capability by identifying the major sources of common cause or random variability. This article dis-

cusses nested designs and their use in examining the factors that contribute to common cause variation.

ROBERTS, Carl W. Other than counting words: A linguistic approach to content analysis. *Social Forces* 68:1 (1989) 147-177.

A linguistic technique for the content analysis of texts and transcripts is described and illustrated. The technique produces a quantitative description of texts that represents both the interrelations among words and their classification into meaningful categories. The face validity of the description is demonstrated with a computer-aided "translation" of coded data back into text. The advantages of linguistic content analysis over qualitative and computer-aided approaches to content analysis are discussed. Also discussed are problems of linguistic ambiguity and of the computer automation of the technique.

Semyonov, Moshe, and **Carl W. ROBERTS.** Ascription and achievement: Trends in occupational mobility in the United States, 1952-1984. Pp. 107-128 in *Research in Social Stratification and Mobility,* Vol. 8, edited by Arne L. Kalleberg. JAI Press, Inc. (Greenwich, Connecticut). 1989.

Intergenerational mobility has traditionally been considered a characteristic of the stratification system, and changes in mobility have been viewed as indicating shifts in the opportunity structure of society. Here, applying a series of log-linear models to data from nine national surveys (administered between 1952 and 1984 at four-year intervals), it is demonstrated that the role of ascription has decreased in the U.S. mobility regime. In particular, there has been a decrease in the odds that father and son have the same occupational status. There is no strong evidence of trends in the odds that persons with particular educations attain higher or lower status jobs. However, it does appear that education has come to play a more dominant role in the mobility process due to a general upgrading of the U.S. occupational structure from 1952 to 1984. Evidence is provided that mobility (measured as uniform association) is greatest among college graduates and least among high school graduates without college degrees. As a consequence, the post-Second World War increase in the proportion of college-educated Americans has resulted in a shift to greater universalism in the U.S. occupational marketplace.

Brogden, Kim A., Louis Chedid, Randall C. Cutlip, Howard D. Lehmkuhl, and **Jerome SACKS.** Effect of muramyl dipeptide on immunogenicity of *Corynebacterium pseudotuberculosis* whole-cell vaccines in mice and lambs. *American Journal of Veterinary Research* 51:2 (1990) 200-202.

Efficacy of whole cells (WC) of *Corynebacterium pseudotuberculosis* vaccines with and without muramyl depeptide (MDP) was determined from the survival of mice and lesions in lambs after IV injection. In mice, protection was related to the concentra-

tion of WC in the vaccine. At high WC concentrations, protection could only be moderately increased to 82.3% with high concentrations of MDP or increased to 90% protection with low concentrations of MDP. In lambs, high prechallenge antibody titers were observed after vaccination with WC. Protection and vaccination site abscesses in lambs were related to the concentration of WC and MDP. Pulmonary or vaccination site abscesses were not observed in 4 of 4 lambs vaccinated with 1 mg of WC + 50 µg of MDP.

Pirtle, Eugene C., **Jerome M. SACKS,** Victor F. Nettles, and Edward A. Rollor, III. Prevalence and transmission of pseudorabies virus in an isolated population of feral swine. *Journal of Wildlife Diseases* 25:4 (1989) 605-607.

The purpose of this study was to determine the prevalence and transmission spread of pseudorabies virus (PRV) in a closed, isolated (insular) population of feral swine not exposed to PRV-infected domestic swine. Six hundred sixty-one feral swine (*Sus scrofa*) from Ossabaw Island, Georgia (USA) were captured and bled, and their sera were tested for PRV antibody during a six-year period. Prevalence of seroconversion in females was somewhat higher than in males (10% versus 7%), but the difference was not statistically significant. Adults had a significantly higher prevalence than juveniles (29% versus 1%). An important finding in this study was that seroconversion occurred primarily in the adult feral swine.

Thurston, J. R., N. F. Cheville, R. B. Rimler, and **J. SACKS.** Serum complement activity and serum enzymes in rats after a subcutaneous injection of toxin prepared from *Pasteurella multocida* type D. *Veterinary Immunology and Immunopathology* 23:4 (1989) 385-388.

Toxin produced by *Pasteurella multocida* type D was investigated for its effect on serum complement and serum biochemistry in rats. Rats were given a sublethal single subcutaneous injection of D toxin equivalent to 0.2 µg/kg of body weight. Serum obtained 1, 3, 5, and 7 days post-treatment was tested for complement activity, total bilirubin, aspartate aminotransferase, alanine aminotransferase, and alkaline phosphatase. Serum complement titers were significantly elevated ($P < 0.05$) at all times after injection of toxin compared to rats injected with diluent and tested at the same intervals. Bilirubin was decreased but both control and D toxin-treated rats had low concentrations of bilirubin in their sera. The other biochemical constituents measured had no consistent pattern that would indicate liver damage in the rats.

Williams, P. P., **J. M. SACKS,** P. C. Yang, E. C. Pirtle, G. A. Ericson, and G. W. Beran. Immunological surveillance of a pseudorabies quarantined herd using SPF-gilts and their progeny as sentinels. *Viral Immunology* 2:3 (1989) 185-193.

This report compares immune responses of vaccinated and control SPF (specific pathogen free) pure-

bred, second generation, gilts and evaluates them and their progeny as potential sentinels in a PRV (pseudorabies virus) quarantined herd. It also compares various serological assays used to monitor humoral responses and tests the gilts and offspring for lymphocyte stimulation responses to a T-cell mitogen and PRV.

The gilts and their progeny were monitored weekly for PRV shedding, lymphocyte stimulation responses, and PRV humoral antibodies. Pre- and post-PRV vaccination, post-herd exposure, and farrowing-to-finishing time intervals were targeted. Results indicated that second generation SPF-Chester White pure-bred gilts and their progeny appear to have been useful PRV sentinels, based on PRV status. The gilts detected PRV in the herd housing quarters and their progeny detected PRV within the farrow-to-finish quarters. A strategy for using SPF-progeny in further surveillance testing is proposed.

SHELLEY, Kathy. Evaluation of presentation graphics for the agricultural sciences. Pp. 125-131 in *Applied Statistics in Agriculture*—Proceedings of the Kansas State University Conference on Applied Statistics in Agriculture, held May 1-2, 1989. 1989.

Professional-looking text and graphic slides enable an audience to comprehend the main ideas of a presentation more quickly. With the advent of easy-to-use graphic software packages and the affordability of personal computer hardware to run this software, researchers may now prepare their own slides or transparencies. This paper describes basic graphic software design and offers criteria for selection of an appropriate software package for scientific research presentations. Comparisons between two prototype graphics packages, Harvard Graphics and SAS*/Graph, are made on the basis of the following selection criteria: (1) basic software design, (2) available hardware, (3) output device drivers, (4) available statistical graphics, and (5) data import/export facilities. Graphic style is also addressed here with sample graphs illustrating a current popular theory of visual discrimination.

SHELLEY, Mack C. II, Brian J. Reichel, William F. Woodman, and Paul Lasley. Perceptions of the role of university research in biotechnology: Town, gown, and industry. Pp. 262-275 in *Agricultural Bioethics: Implications of Agricultural Biotechnology*, edited by Steven M. Gendel, D. Michael Warner, and Faye Yates. Iowa State University Press, Ames, Iowa. 1990.

Descriptive statistical evaluations are presented for attitudinal differences regarding the proper role of land-grant universities in biotechnology research among the following respondent groups: biotechnology research faculty, nonbiotechnology faculty, graduate students, university administrators, biotechnology company executives, and farm operators. Consequences for economic development resulting from a university research emphasis are examined, together with consequences for university

research agendas of an emphasis on biotechnology. Differences between farm operators' views and those held by other sets of respondents generally are sharpest.

Reichel, Brian J., Paul Lasley, William F. Woodman, and **Mack C. SHELLEY II.** Economic development and biotechnology: Public policy response to the farm crisis in Iowa. *Agriculture and Human Values* 5:3 (1988) 15-25.

In periods of social crisis, policymakers become particularly vulnerable to interest groups mobilizing to compete for scarce funds. At this point, legislators are no longer able to address the specific needs of their primary constituency directly, but rather are forced to do so in pretext only. New, unfamiliar technologies provide ample ammunition for astute interest groups to take advantage of times of economic turmoil and maneuver for policy support through dramatic campaigns of "salesmanship." By publicizing a crisis situation, dramatizing it effectively, and advertising an innovation as the solution to the crisis, legislators may be persuaded to give priority to interest group pressures above and beyond those of the local constituency.

Iowa's attempt to address the farm crisis through economic development strategies relying on biotechnology is examined in this paper. The results of extensive surveys of legislators and farmers are examined, and the consequences for state policy of using biotechnology under the auspices of economic development are discussed.

Woodman, William F., Brian J. Reichel, and **Mack C. SHELLEY.** University-industry relationships in biotechnology: Convergence and divergence in goals and expectations. Pp. 64-75 in *Agricultural Bioethics: Implications of Agricultural Biotechnology*, edited by Steven M. Gendel, A. David Kline, D. Michael Warner, and Faye Yates. Iowa State University Press, Ames, Iowa. 1990.

National and local university respondents' views of the advantages and drawbacks to cooperative research arrangements between universities and biotechnology corporations are examined in this article. There is a strong consensus between university and industry respondents on the need to orient university activities toward the marketplace. Differences are found between academic and corporate attitudes (and among university respondent groups) regarding such issues as patent rights, the embargoing of marketable research results, and the anticipated role of biotechnology in resolving farm surpluses, benefitting larger farm operations rather than family farmers, and making farms more dependent on large corporations.

Koven, Steven G., and **Mack C. SHELLEY II.** Public policy effects on net urban migration. *Policy Studies Journal* 17:4 (1989) 705-718.

Population migrations within the United States between 1970 and 1980 produced major changes in

the relative sizes of cities, states, and regions. This study explores some correlates of migration for all cities in the United States with populations greater than 250,000 in 1970. A number of service, public policy, ecological, and economic variables were investigated in order to determine their relevance to recent aggregate migration trends. Public policy variables displayed stronger associations with migration than did the other independent variables considered.

SPOSITO, V. A. Some properties of L_p-estimators. Chapter 2 in *Robust Regression: Analysis and Application,* edited by K. D. Lawrence and J. L. Arthur. Marcel Dekker (New York). 1989. Pp. 23-58.

Various generalized properties of L_p-estimators, $(p \leq 1)$, are underscored. Efficient computational procedures are developed that are based on some of these properties. Furthermore, some of these properties are shown to be useful in verifying whether any median-polish solution is also an L_1 solution, i.e., a solution that minimizes the sum of absolute deviations.

STEPHENSON, W. Robert, Frederick L. Hulting, and Karen Moore. Posterior probabilities for identifying active effects in unreplicated experiments. *Journal of Quality Technology* 21:3 (1989) 202-212.

A FORTRAN program is presented for the calculation and plotting of posterior probabilities from a Bayesian analysis of unreplicated factorial and fractional factorial designs. For small experiments (15 effects or fewer), the calculations produce exact analytical results. For larger experiments numerical integration is used to calculate the probabilities. The numerical integration, while more efficient for larger experiments, produces resulting probabilities that are only approximate.

STEPHENSON, W. Robert. Mu Sigma Rho ($\mu\sigma\rho$): The national statistical honor fraternity. *Stats* 1:2 (1989) 17-18.

The origins, growth, and plans for the future of Mu Sigma Rho are examined.

STEPHENSON, W. Robert, and Carol J. Lancaster. Mu Sigma Rho: Local chapter activities. *Stats* 1:3 (1990) 21-22.

The kinds of activities that the various local chapters of Mu Sigma Rho, the national statistical honor fraternity, sponsor are discussed.

Hedayat, A., **J. STUFKEN,** and I. N. Landgev. The possible support sizes for BIB designs with v = 8 and k = 4. *Journal of Combinatorial Theory,* Series A, 51:2 (1989) 258-267.

Hedayat and Hwang [*Journal of Combinatorial Theory,* Series A, 36:2 (1984) 163-173] studied the support sizes for BIB designs with v = 8 and k = 4.

They established the existence or nonexistence for all possible support sizes, with the exceptions of 15, 16, 17, and 19. We show that there are no such BIB designs with support sizes 15 and 16, while there are designs with support sizes 17 and 19. These latter designs require at least 42 blocks. In addition, we provide an answer to their question on self-complementary designs.

Hedayat, A., and **J. STUFKEN.** A relation between pairwise balanced and variance balanced block designs. *Journal of the American Statistical Association* 84:407 (1989) 753-755.

We show that the problems of constructing pairwise balanced block designs and variance balanced block designs are equivalent. This provides incentive to study only the direct construction for the simplest of these designs—namely, pairwise balanced designs.

Hedayat, A. S., and **J. STUFKEN.** On the maximum number of factors in two construction methods for orthogonal arrays. Pp. 33-40 in *Statistical Data Analysis and Inference* (Invited Papers presented at the International Conference on Recent Developments in Statistical Data Analysis and Inference in Honor of C. R. Rao, Neuchâtel, Switzerland, August 21-24, 1989), edited by Y. Dodge. North-Holland, Amsterdam. 1989.

An important problem in studying orthogonal arrays is the determination of the maximum number of factors that can be accommodated in such an array. A slightly easier and more tractable problem is to determine the maximum number of factors that can be accommodated in an orthogonal array if consideration is restricted to arrays that can be constructed through a particular method. This paper describes two such methods of construction and shows that the maximum numbers of factors under these two methods are the same.

Hedayat, A., Bing-Ying Lin, and **J. STUFKEN.** The construction of ΠPS sampling designs through a method of emptying boxes. *The Annals of Statistics* 17:4 (1989) 1886-1905.

We present a simple but universal technique for the construction of ΠPS sampling designs. A tool that is used in the construction consists of playing a game in which objects are removed from N boxes, n at a time, and at most one from each box at a time. Necessary and sufficient conditions on N, n, and the contents of the boxes are established such that all boxes can be emptied by this process.

It is shown that every ΠPS design can be derived from such a game. Sampling designs with additional properties are obtained through additional restrictions on emptying the boxes. Various rigorous methods are presented, complemented by numerous suggestions. The emphasis is on controlling sample selection probabilities and inequalities for the first- and second-order inclusion probabilities. The method is very adaptive to computer use.

WIEAND, Sam, Mitchell H. Gail, Barry R. James, and Kang L. James. A family of nonparametric statistics for comparing diagnostic markers with paired or unpaired data. *Biometrika* 76:3 (1989) 585-592.

In this paper we study a broad class of non-parametric statistics for comparing two diagnostic markers. One can compare the sensitivities of those diagnostic markers over restricted ranges of specificity by selecting an appropriate statistic from that class. As special cases, one can compare the entire area under the receiver-operator curve (Hanley and McNeil, 1982), or one can compare the sensitivities at a fixed common specificity. Usually we would recommend a comparison based on an average of sensitivities over a restricted high level of specificities. Test procedures and confidence intervals are based on asymptotic normality. These procedures are applicable for paired data, in which both diagnostic markers are performed on each subject, and for unpaired data. The procedures may be used to compare two real functions of multiple diagnostic markers as well as to compare individual markers.

Podratz, K. C., and **H. S. WIEAND.** Carcinoma of the vulva: prognostic factors and sites at risk for recurrence. Pp. 277-284 in *Advances in Gynecology and Obstetrics, Vol. 3—Gynecological Cancer,* Proceedings of the XIIth World Congress of Gynecology and Obstetrics, Rio de Janeiro, October 1988. P. Belfort, J. A. Pinotti, and T. K. A. B. Eskes, editors. 1989.

■ Book Reviews, Etcetera

HARVILLE, David A. Comment on Kempthorne (1989)—Letter to the editor. *The American Statistician* 44:2 (1990) 188.

HARVILLE, David A. Comment on Puntamen and Styan (1989)—Letter to the editor. *The American Statistician* 44:2 (1990) 192.

KEMPTHORNE, Oscar. *Linear Models for Unbalanced Data,* by Shayle R. Searle. Series in Probability and Mathematical Statistics. 536 pp. Wiley, 1987. $49.95. Reviewed in *American Scientist* 77 (1989) 404-405.

KEMPTHORNE, Oscar. Comment on "The equality of the ordinary least squares estimator and the best linear unbiased estimator" by Simo Puntanen and George P. H. Styan. *The American Statistician* 43:3 (1989) 161-162.

KEMPTHORNE, Oscar. Reply to Letters to the Editor on Kempthorne (1989). *The American Statistician* 44:2 (1990) 189-190.

MEEKER, William Q., Jr. *Parameter Estimation in Reliability and Life Span Models,* by A. C. Cohen

and B. J. Whitten. Marcel Dekker, Inc., New York, 1988. xv + 394 pp. Reviewed in *Journal of Official Statistics* 6:2 (1990) 214-215.

MEEKER, W. Q., Jr. *Statistical Methods in Accelerated Life Testing,* by R. Viertl. Vandenhoeek & Ruprecht, Göttingen, 1988, VII + 134 pp., DM 145,—. Reviewed in *Metrika* 37:5 (1990) 319-320.

STEPHENSON, W. Robert, and Oscar KEMPTHORNE. *Introduction to Contemporary Statistical Methods,* 2nd edition, by Lambert H. Koopmans. Boston: Duxbury Press, 1987. xiv + 683 pp. $38 (solutions manual, restricted); workbook (with diskette), $15. Reviewed in *Journal of the American Statistical Association* 84:407 (1989) 836-837.

WIEAND, H. S. "Determining sample sizes for clinical trials," by S. Ellenberg. Article reviewed in *Oncology No. 8, 3* (1989) 48-49.

■ Thesis Abstracts

Andrews, Douglas Martin. Nonparametric analysis of unbalanced paired-comparison or ranked data. Ph.D. thesis, Iowa State University Library. August 1989.

Suppose we have t objects $C_1, \ldots, C_t$, and that objects C_i and C_j are judged pairwise in n_{ij} independent comparisons, for $i,j = 1, \ldots, t$; $i \neq j$. In the simplest of such "paired-comparison" experiments, all pairs of objects are compared an equal number of times. It is often inconvenient or impractical to carry out such a design: some pairs of objects might be compared more often than others, and some pairs might not be compared at all. Most of the available methods for analysis of *unbalanced* paired-comparison data are parametric, in the sense that a (paired-comparison) linear model generates, for each pair of objects, the "preference probability" π_{ij} with which C_i is preferred to C_j.

The few existing nonparametric approaches are critically examined. H. A. David (1987) proposes a simple method of scoring objects from unbalanced paired-comparison data that takes into account differences in the strength of the competition encountered by each object as well as possible differences in the number of comparisons on each pair of objects. Statistical properties of the proposed scores are developed for the general unstructured case and for special cases of partial balance, such as when objects are arranged in a group divisible design. The asymptotic distribution of these scores leads to several approximate tests of hypotheses, including a test for equality of the objects.

The approach is then extended to unbalanced ranked data. It is shown that the previous non-parametric rank approaches fail to account adequately for the aspects of unbalanced data of concern in this dissertation.

Davis, Paula Marie Lasack. Evaluation and prediction of maize response to early-season injury from stalk borer. Ph.D. thesis, Iowa State University Library. May 1990.

The effects of stalk borer (*Papaipema nebris* (Guenee) (Lepidoptera: Noctuidae)) injury, imposed at corn-leaf stages 1 through 7, on visible injury, stalk elongation, and grain yield were evaluated in a three-year study. Regression models were developed to predict plot yield and individual plant yield. Models for individual plant yield were combined with injury profiles to predict grain yield as a function of percentage of plants injured and corn development stage. Economic injury levels and economic thresholds were determined, and a management program was presented.

In a second study, degree-day models were used to time insecticide applications (permethrin) to egg hatch and larval movement. Although applications at egg hatch significantly reduced stalk borer density in grass terraces by 54-85 percent, applications timed with movement were more effective in reducing severe damage to corn.

Finally, a management model, SBMGMT, was developed to simulate the stalk borer/corn agroecosystem. The model predicts stalk borer phenology, corn development, and grain yield for various management strategies.

Fuh, Cheng-Der. The bootstrap method for Markov chains. Ph.D. thesis, Iowa State University Library. August 1989.

Let $\{X_n; n \geq 0\}$ be a homogeneous ergodic Markov chain with transition probability matrix P. The problem of estimating P and the distribution of the hitting time T_Δ of a state Δ arises in several areas of applied probability. Kulperger and Prakasa Rao [*Sankhyā*, 1990] have investigated the application of the bootstrap method to this problem in the finite state space case. This thesis considers the countable state space case.

Suppose $\underline{x} = (x_0, x_1, \ldots, x_n)$ is a realization of the Markov chain. Let $\hat{P}_n$ be the maximum likelihood estimator of P. The bootstrap method for estimating the sampling distribution H_n of $\sqrt{n}(\hat{P}_n - P)$ can be described as follows:

1) With $\hat{P}_n$ as its transition probability, generate a bootstrap sample $\underline{x}^* = (x_0^*, x_1^*, \ldots, x_{N_n}^*)$. Let $\hat{P}_n^*$ be the bootstrap maximum likelihood estimator of $\hat{P}_n$ based on $\underline{x}^*$.

2) Approximate the sampling distribution H_n by the conditional distribution $H_n^* \sqrt{N_n}(\hat{P}_n^* - \hat{P}_n)$ given $\underline{x}$.

To justify this method, we need to show that H_n^* is close to H_n asymptotically. It is known that
$$\sqrt{n}(\hat{P}_n - P) \rightarrow N(\underline{0}, \Sigma p) \text{ in distribution,}$$
where Σp is the variance covariance matrix. Thus, the bootstrap method will be justified if we show that H_n^* also goes to $N(\underline{0}, \Sigma p)$ in distribution.

In this paper, a central limit theorem for a double array of countable state space Markov chains is proved and then used to justify the above bootstrap

method. A central limit theorem for a double array of Harris chains is also established.

Funo, Eiichiro. Proving admissibility using the stepwise Bayes technique: With applications to maximum likelihood estimation. Ph.D. thesis, Iowa State University Library. August 1989.

The stepwise Bayes technique is a simple but versatile method for proving admissibility of estimators under a strictly convex loss function like squared error loss. For example, when X ~ Binomial (n, θ), it is easy to prove that under squared error loss the MLE of θ is admissible using the stepwise Bayes technique. Similarly, the admissibility of the joint MLE can also be proven in cases of $\underline{X}$ ~ Multinomial and independent Binomial random variables.

Furthermore, those results can be extended. Let $\underline{X}$ ~ Multinomial $(n, \underline{p})$ where $\underline{p} \, \varepsilon \, \Xi = \{(p_0, p_1, \ldots, p_k): 0 \leq p_i \leq 1 \text{ for each } i = 0, 1, \ldots, k \text{ and } \Sigma_{i=1}^k p_i\}$, and $\underline{p} = \underline{\phi}(\underline{\theta}) = (\phi_0(\underline{\theta}), \phi_1(\underline{\theta}), \ldots, \phi_k(\underline{\theta}))'$ where $\underline{\theta} \, \varepsilon \, \Theta = \{(\theta_{10}, \theta_{11}, \ldots, \theta_{1s_1}; \theta_{20}, \theta_{21}, \ldots, \theta_{2s_2}; \ldots; \theta_{r1}, \theta_{r2}, \ldots, \theta_{rs_r}): 0 \leq \theta_{ij} \leq 1 \text{ for any } i, j \text{ and } \Sigma_{j=1}^{s_i} = 1 \text{ for each } i = 1, 2, \ldots, r\}$. Assume $\underline{\phi}: \Theta \rightarrow \equiv$ is an onto map and each $\phi_i(\underline{\theta})$ is a monomial of $\theta_{10}, \theta_{11}, \ldots, \theta_{1s_1}; \theta_{21}, \theta_{22}, \ldots, \theta_{2s_2}; \ldots; \theta_{r1}, \theta_{r2}, \ldots, \theta_{rs_r}$. Then, the stepwise Bayes technique can be used to show that the MLE of $\underline{\theta}$ is admissible under squared error loss. This result is useful for proving the admissibility of maximum likelihood estimators in many areas of statistics, for example, missing data analysis, censored data analysis, log-linear models and finite population sampling problems.

In contrast to the above admissibility theorem, in binomial or multinomial problems when the parameter space is restricted or truncated to a subset of the natural parameter space, the MLE may be inadmissible under squared error loss. A quite general condition for the inadmissibility of maximum likelihood estimators in such cases can be established using the stepwise Bayes technique and the complete class theorem of Brown.

Gotway, Carol Anne. Inference from spatial processes. Ph.D. thesis, Iowa State University Library. August 1989.

Spatial statistics considers problems where the locations of the data, as well as the data themselves, are thought to be important components of their statistical study. In particular, correlation between random variables at nearby locations might be used to improve inference techniques. This gives rise to a wide variety of difficult but fascinating statistical problems. This dissertation considers spatial statistical inference in the areas of estimation, hypothesis testing, and prediction.

In the first section, a fundamental relationship between prediction and estimation is exploited to obtain biased predictors with smaller risk than the usual best linear unbiased (kriging) predictor. Assuming a general covariance structure, several such predictors are derived and their properties are discussed. Simultaneous multiple prediction is empha-

sized, and applications to spatial statistics are featured.

In the second section, methods of inference using correlated data (with emphasis on testing equality of means in a one-way analysis of variance) are summarized and compared, and the consequences of overlooked spatial correlation are illustrated. The idea of a spatial analysis of variance is used to exploit intratreatment correlation in order to obtain valid tests of significance.

Grondona, Martín Oscar. Estimation and design with correlated observations. Ph.D. thesis, Iowa State University Library. August 1989.

Several problems related to estimation, analysis, and design with correlated observations are addressed. Under a one-dimensional covariance structure, asymptotic expressions of the bias of OLS residuals-based estimators for the covariance function and the variogram are presented. An estimator for the covariance function based on recursive residuals is introduced and compared with the classical OLS residuals-based estimator. A spatial approach to the analysis of experiments, where spatial dependence is assumed, is compared to the traditional one based on uncorrelated observations. The efficiency of incomplete block designs under second-order autoregressive error processes is studied and conditions for the universal optimality of balanced incomplete block designs are derived. Finally, results on the efficiency of first-order nearest-neighbor balanced designs are presented, and its robustness against misspecification of a first-order autoregressive error process is discussed.

Hulting, Frederick Landis. Some Bayesian and non-Bayesian procedures for the analysis of comparative experiments and for small-area estimation: Computational aspects, frequentist properties, and relationships. Ph.D. thesis, Iowa State University Library. August 1989.

Let $\mathbf{y}$ represent an $n \times 1$ observable random vector that follows the mixed-effects linear model $\mathbf{y} = \mathbf{X}\beta + \mathbf{Zs} + \mathbf{e}$. Here $\mathbf{X}$ and $\mathbf{Z}$ are given matrices, β is a vector of unknown parameters, and $\mathbf{s}$ and $\mathbf{e}$ are statistically independent random vectors that have multivariate normal distributions with mean vectors equal to $\mathbf{0}$ and covariance matrices of $\sigma_e^2\mathbf{I}$ and $\sigma_s^2\mathbf{I}$, respectively. The problem considered is that of the prediction of the realization of a random variable of the form $w = \lambda'\beta + \delta's$. Many inference problems, including the estimation of a treatment contrast and the estimation of a small-area mean, can be regarded as special cases of this problem.

We consider both traditional (frequentist) and Bayesian approaches to the point and interval prediction of w. In applying the Bayesian approach, we suppose that the prior distribution of w is of a certain form, and derive the corresponding posterior distribution. We consider various characteristics of the posterior distribution, including the posterior mean and the HPD credible set. We show how, by taking advantage of various representations for frequentist predictors, the normally severe computational requirements of the Bayesian approach can be reduced.

We present the results of a Monte Carlo study of the frequentist properties of both the traditional and the Bayesian predictors as applied to inference about treatment contrasts and small-area means. The results suggest that the Bayesian approach produces point and interval predictors whose overall performance compares favorably with that of the frequentist predictors, and that there are applications where the Bayesian predictors should be used in preference to the frequentist predictors.

Lin, Chiou-Hua. Powers of two-sample rank tests under Lehman alternatives. Ph.D. thesis, Iowa State University Library. May 1990.

Let $X_1,\ldots,X_m$ and $Y_1,\ldots,Y_n$ be two independent samples from two continuous distributions F and G. For testing the hypothesis H_0: F = G, with no additional assumption on F and G, rank tests are used as they are easy to use and distribution-free under H_0. However, the problem of finding the distribution of the ranks of the Xs and Ys in the pooled sample is difficult in general when F $\neq$ G. A generalized Hoeffding type theorem is given and used to obtain the distribution of the ranks under a variety of alternatives. Hence the small sample powers of the most frequently used rank tests for two-sample location and scale problems are obtained.

The best precedence test (BPT) is derived for testing H_0 when two types of items are on test. The test has maximum power in the class of precedence tests at a given alternative $F = 1 - (1 - G)^\lambda$ for some $\lambda > 1$, and it saves considerable time on test. We compare the power of the BPT with other tests and also obtain the average number of failures for the BPT.

The distribution of the ranks under each of three truncation models is obtained in a simple form. The ordering of the values of the probability function of the ranks is used to search for locally most powerful tests. The powers of the generalized Wilcoxon test and the logrank test under the random censoring model are obtained.

Sullivan, Gary Robert. The use of added error to avoid disclosure in microdata releases. Ph.D. thesis, Iowa State University Library. December 1989.

In this research, we concentrate on the data perturbation technique of masking each data vector by adding a random error vector. After describing the general procedure, we consider the approach an intruder might use in attempting to determine an individual's confidential attributes. It is shown that the conditional expected value of the attributes given the masked data and the public data is the best predictor of the unknown attributes.

We investigate the effect of the covariance structure of the error vectors on the success of the intruder. It is demonstated that, if the variance of the added error is fixed at a fraction of the variance of the

original variables, then the optimal correlation structure of the errors with respect to confidentiality protection is the correlation structure of the original variables.

We present a masking algorithm designed to preserve the moments and univariate distribution functions of masked variables, while providing disclosure protection. The degree of protection is a function of the variance of the added error. A computer program that implements the algorithm is outlined. The procedure is designed so that the covariance structure of the masked data is similar to that of the original data. Results of masking example data files with the computer program are summarized.

Symanowski, James Thomas. Multivariate distributions with applications to logistic regression models for correlated categorical responses. Ph.D. thesis, Iowa State University Library. August 1989.

A number of models for ordered categorical responses have appeared in the statistical literature over the past few decades. Many of these models are based on a latent variable approach in which the underlying random variable follows a continuous probability distribution. The exact value of the underlying random variable is not observed; rather, it is only known that the response occurred in one of several mutually exclusive categories. Such models are referred to as logit, or logistic regression models when an underlying logistic distribution is used.

Statistical analyses with logistic regression models are straightforward when the categorical responses are assumed to be independent. Relaxation of the independence assumption allows for inclusion of a wide variety of practical applications, but appropriate models have not been thoroughly developed. Most of the research on correlated categorical responses has been confined to the development of conditional and mixed models.

An alternative approach taken in this dissertation is a multivariate latent variable approach. In particular, correlated categorical responses will be considered to have arisen from the categorization of an underlying multivariate logistic random variable. This approach is a multivariate extension of the usual univariate logistic regression model; in fact, it provides an logistic regression model for each univariate margin. A major advantage of this approach is that the model parameters can be interpreted with respect to the influence of the regression variables on the univariate marginal distribution of each single response. Conditional and mixed models, on the other hand, permit only conditional interpretations of parameters.

Included in the first paper is a specification of a new bivariate logistic distribution. This distribution is applied to the analysis of bivariate ordered categorical responses. A listing of the computer program developed for this analysis is given in Appendix C. In the second paper a bivariate logistic regression model is developed and illustrated and is based on the aforementioned bivariate logistic distribution. A computer listing for this model is found in Appendix D. The third paper includes a generalization of one of Gumbel's bivariate logistic distributions. A new multivariate uniform distribution is derived in the fourth paper and is used to specify a multivariate logistic distribution. It is shown that the pairwise correlations can range between zero and one and are, in general, not equal. The asymptotic normality of maximum likelihood estimators for product multinomial models is established in Appendix A. Finally, a simple expression for the Fisher information matrix arising from a product multinomial likelihood function is derived in Appendix B.

Zakaria, Rahmat Syahni. The monotonicity of component importance measures in linear consecutive-$\underline{k}$-out-of-$\underline{n}$ systems. Ph.D. thesis, Iowa State University Library. August 1989.

The monotone behavior of component importance measures in linear consecutive-$\underline{k}$-out-of-$\underline{n}$ systems is studied through the formulation of a number of importance measures for these systems, when all components are assumed to be independently and equally reliable.

Several types of component importance measures are considered. For $\underline{n} > 2\underline{k}$, only the Deegan-Packel and Vesely-Fussel measures are "monotone," whereas the Birnbaum and Barlow-Proschan measures are "nonmonotone" for the entire domain of component reliability $\underline{p}$, when $\underline{n}$ is in the range $[2\underline{k} + 1, 3\underline{k} + 1]$. For $\underline{n} > 3\underline{k} + 1$, the Birnbaum measure is "nonmonotone" for certain $\underline{p}$ and $\underline{k}$, and the Barlow-Proschan measure is "nonmonotone" when $\underline{n}$ is sufficiently large.

The STAT-er Clatter was originally formed by Douglas Andrews, who completed his Ph.D. in the 1989 summer term. The predominantly brass instrumental group continues under Phil Iversen's guidance, adding special musical touches to ISU Statistical Laboratory events: from L to R, Iversen, Dawn Dubois, Alice Cramer, Ann Russey, Rob Parker, Todd Borchart, and Scott Vander Wiel.

Department of Statistics

The Department of Statistics offers courses leading to the degrees Bachelor of Science, Master of Science, and Doctor of Philosophy with major in statistics. These degrees are conferred by the College of Sciences and Humanities and by the Graduate College. A Master of Science degree in operations research is offered jointly with the Department of Industrial and Manufacturing Systems Engineering.

Undergraduates in statistics may choose double majors if they wish. Joint majors are not frequent at the M.S. level but a Ph.D. student may choose a co-major in order to add depth in an area of application.

M.S. candidates may choose either the thesis or the nonthesis option. The latter requires a written examination and completion of a creative component representing at least two credits of independent work. The M.S. thesis (representing about six credits of work) is expected to be independent original work and publishable. In comparison, creative components need not include original research, although some do and have been published. The purpose of the creative component is to give a student the opportunity to do independent study under a major professor in an area of mutual interest.

Some students use the creative component as a stepping stone to a Ph.D. thesis topic. Others use it as an opportunity to work through an applied statistics problem from beginning to end. For some students, independent study involves working on a consulting project or exploring opportunities opened by internships or using computers for statistical computing in an innovative way not covered in general coursework. In some instances, the data to be analyzed come from jobs previously held by the students or are specially collected in their home countries.

The written examination for the nonthesis M.S. program is now given each year before the start of the spring and summer sessions, not in June and October as in the past. Part 1 of the two-part exam covers methods (Stat 500 and 511); Part 2 covers theory (Stat 542-543). Thirty students took the full test May 31, 1990; three others took only one of the two parts as a repeated examination.

The Ph.D. written prelim in statistics is given in October and late March to early April. This examination is now based only on the material in six core courses—Stat 500, 511, 542, 543, 642, and 643. Therefore students can take the test earlier in their careers than in previous years when it covered more material. The exam consists of eight in-class questions, given over two days. These include two questions each from Stat 642 and 643, one question from Stat 511, and three methods questions that are based on material at the 500, 511, 542, and 543 level. The preliminary oral examination includes questions on courses listed on the Program of Study.

A written examination for students minoring in statistics at the Ph.D. level is given in mid-January and June, at roughly the same time as the M.S. examination for majors. A Ph.D. minor in statistics requires at least two courses in methods, including Stat 401; Stat 447; and a minimum of four statistics courses and 12 semester credits. The written minor examination includes at least three questions from Stat 401, at least two from Stat 447, and at least one question from another statistics course.

A statistics minor at the M.S. level requires a minimum of three courses in statistics at the 400 level or above, including Stat 401 and 447, and a course grade of at least a B in both Stat 401 and 447. However, it does not require a written exam.

Several changes and additions to the regular teaching program were made in 1989-90. During the fall semester, William Q. Meeker taught Stat 328, Applied Business Statistics, and, at the same time, the course was videotaped for use in the off-campus M.B.A. program at five locations throughout the state. David F. Cox taught Stat 593X, a workshop on statistical methods for students in the Master of Agriculture degree program. The one-credit course was given on campus on Saturday mornings in November and December.

During the spring semester, Yasuo Amemiya taught Stat 447, Statistical Theory for Research Workers, on campus and as a professional outreach course through Business and Engineering Extension. A videotape of the course was prepared and sent to Cedar Rapids, Iowa, for a class at Rockwell International/Collins. Amemiya also met with the offcampus students several times in Cedar Rapids.

Mack Shelley taught Stat 401, Research Methods for Research Workers, at the university's Urbandale Center May 22-July 5 for the off-campus M.P.A. program.

During most of the year, Krishna Athreya held a weekly seminar (jointly with W. Kliemann and A. Weerasinghe of the Department of Mathematics) for faculty and advanced graduate students on probability theory. Athreya, S. Lahiri, and D. Sengupta held a weekly seminar on mathematical statistics in the Department of Statistics.

Kenneth J. Koehler's course Stat 557, Statistical Methods for Counts and Proportions, formerly an experimental course, has been moved from summer to become a regular fall offering, starting in 1990.

Teaching assistants continued to serve the Department of Statistics very well in the classroom, as shown by teacher evaluations made by their students. The number of teaching assistants lecturing and having primary responsibility for their classes has increased markedly. In the fall of 1976, there were seven such assistants, while in the fall of 1989, there were 16. This increase is a reflection of the growth in the service component of the statistics program. In addi-

tion, other teaching assistants helped with laboratory sections and paper-grading.

The number of students in the graduate program has also increased in recent years. From 1985-86 to 1989-90 it has risen from 121 to 163. About 56 percent of students enrolled in the graduate major program come from countries other than the U.S. About 34 percent come from other states, and the remainder from Iowa. At present, there is considerable interest among incoming students in the industrial statistics/quality control area. As the number of applications for admission to the program increases, we are able to be more selective. More information is given in the departmental brochure, "Iowa State University—Graduate Program in Statistics," which is available upon request.

Course offerings for the 1989-90 academic year and the 1990 summer session, with primary catalog listing in statistics, are listed below. A few courses with primary listing in mathematics or industrial and manufacturing systems engineering may also be taken for statistics credit at the undergraduate or graduate level.

■ 1989-90 Course Offerings in Statistics

Courses for Undergraduate Students Only

100	Orientation in Statistics and Biometry	R	F		Hotchkiss
101	Principles of Statistics	4	F,S,SS Carley Coffin Dombroski	Dunnigan Mundfrom Russey	
104	Introduction to Statistics	3	F,S,SS C. P. Cox Gregory Hotchkiss	Pollak Sukhatme	
105	Introduction to Statistics for Engineers	2	F,S Amemiya Isaacson	Sukhatme	
201	Applied Regression Analysis for Business	2	F	Carley	
227	Introduction to Business Statistics	5	F,S,SS Andersen Chowdhury Gregory Griffiths Hofer	McKeown Olin Parker Rossi	
231	Probability and Statistical Inference for Engineers	4	F,S Croos Homblé	Lahiri Sukhatme	
300	Cooperative Education	R	F		Hotchkiss
305	Engineering Statistics	3	F,S Peterka Sanger Vardeman		
328	Applied Business Statistics	3	F,S Groeneveld	Meeker	
328X	Applied Business Statistics	3	F		Meeker

333	Probability and Statistics for Electrical and Computer Engineers	3	F,S		McDonald
341	Introduction to Theory of Probability and Statistics	3	F Athreya	Groeneveld	
342	Introduction to Theory of Probability and Statistics	3	S		Groeneveld

Courses for Graduate Minors and Undergraduates

401	Statistical Methods for Research Workers	4	F,S,SS Bailey C. P. Cox D. F. Cox Hickman Homblé Hotchkiss	Kennedy Lorenz Roberts Sanger Shelley Strahan	
402	Statistical Design and the Analysis of Experiments	3	F,S Hinz & D. F. Cox Hotchkiss	Marasinghe Strahan	
404	Statistics for the Social Sciences	3	F		Roberts
405	Applied Econometric Statistics	3	S		Skinner
407	Methods of Multivariate Analysis	2	F		Hinz
421	Survey Sampling Techniques	3	S		Hickman
432	Applied Probability Models	3	F		Groeneveld
436	Genetic Statistics for Research Workers	3	F		Bailey
447	Statistical Theory for Research Workers	4	S,SS		Amemiya
451	Applied Time Series	3	S		Meeker
480	Statistical Application of Digital Computers	3	F		Marasinghe
481	Computer Processing of Statistical Data	3	S		Marasinghe
490	Independent Study	var	F,S Hotchkiss	Wolins	

Courses Primarily for Graduate Students, Major or Minor

500	Statistical Methods	4	F		Koehler
501	Multivariate Statistical Methods	3	S		Koehler
511	Theory and Application of Linear Models	3	S		Harville
512	Design of Experiments	3	F		Stufken
521	Theory of Sample Surveys I	3	S		Sengupta
522	Theory of Sample Surveys II	3	F		Sengupta

533	Reliability	3	S	H. T. David & Meeker
536	Genetic Statistics I	2	F	Pollak
538	Econometric Statistics	3	F	Amemiya
539	Game Theory	3	F	H. T. David
540	Operations Research Methods and Economic Analysis	3	S	Sposito
542	Theory of Probability and Statistics	3	F	Lahiri
543	Theory of Probability and Statistics	3	S	H. A. David
544	Bayesian Decision Theory	3	SS	Cressie
579	Introduction to Computer Hardware and Software Systems for Statistical Computing	1	F	Kennedy
580	Statistical Computing	3	F	Kennedy & Marasinghe
590B	Special Topics: Methods	Var	F,S,SS	H. T. David Sposito Shelley
593X	Workshop on Statistical Methods	1	F	D. F. Cox
599	Creative Component	Var	F,S,SS	Koehler Amemiya Lorenz Cressie Marasinghe H. A. David Meeker H. T. David Sacks Fuller Sposito Harville Stufken Hinz Vardeman Kennedy

Courses for Graduate Students, Major or Minor

606	Spatial Statistics	3	S	Cressie
611	Advanced Linear Model Theory	3	F	Harville
612	Advanced Design of Experiments	3	S	Stufken
642	Advanced Probability Theory	3	S	Sengupta
643	Theory of Estimation and Testing of Hypotheses	3	F	Cressie
645	Order Statistics	3	F	H. A. David
651	Time Series	3	S	Fuller
680	Advanced Statistical Computing	3	S	Kennedy
699	Research	Var	F,S,SS	Amemiya Marasinghe Cressie Meeden H. A. David Meeker H. T. David Pollak Fuller Shelley Harville Stufken Kennedy Sukhatme Koehler Vardeman Lahiri

Graduate Students

Barbara Dombroski received a Women in Science and Engineering Graduate Student Award for her first year of study.

Graduate College Teaching Excellence Awards went to Douglas Andrews in August, Dan Mundfrom in December, and Scott Andersen and Ann Russey in May. These awards recognize outstanding contributions in the teaching of undergraduate students while working toward a degree. A Graduate College Research Excellence Award was given to Martín Grondona in August in recognition of outstanding research accomplishments in a graduate program. The departmental Dan Mowrey Consulting Excellence Awards were presented to Mary Anne Dellva and James Robison-Cox in the spring.

During the year, 33 M.S. degrees in statistics and 11 Ph.D. degrees, including three for joint majors, were awarded. Names of graduate degree recipients, with names of major professors, time of graduation, and employment or educational decisions, are given below. An asterisk signifies that the student has chosen to remain at Iowa State to work toward a doctorate in statistics.

M.S. Recipients

Maria Theresa Tumada Agatep (Spring 1990; Yasuo Amemiya) returned to the Economics Department, College of Human Sciences, St. Louis University, Baguio City, Philippines, where she is currently an associate professor.

Scott W. Andersen (Spring 1990; William Q. Meeker, Jr.) is joining Eli Lilly's Clinton Laboratories in Indiana, as statistician in its Process Variation Group.

Linda Maria Brands (Fall 1989; William Q. Meeker, Jr.) has been working as statistician-statistical consultant in the Nutrasweet Company, Mount Prospect, Illinois.

Chao-Yin Chen (Summer 1989; Yasuo Amemiya) is continuing graduate study at ISU toward an M.S. degree in economics.

Ching-Ju Diane Chen (Spring 1990; Kenneth J. Koehler) is now married and living in Victorville, California.

Shih-Neng Chen (Summer 1989; Yasuo Amemiya) is continuing graduate study at ISU toward a doctorate in economics.

Jia-Chyi Chiu (Spring 1990; John Stufken).

Tae-Kyoung Cho (Spring 1990; John Stufken) is continuing graduate study toward a Ph.D. in statistics at Oklahoma State University.

Jeffrey D. Hofer (Spring 1990; Paul N. Hinz) is working as an associate statistician in the Quality Assurance/Quality Control Manufacturing Area, Lilly Research Laboratories, in Indianapolis, Indiana.

Bojein Kuo (Summer 1989; Edward Pollak) is continuing graduate study toward a Ph.D. in biostatistics.

John Peter Lagus (Spring 1990; Paul N. Hinz) is a research fellow in biostatistics, Division of Biostatistics, School of Public Health, University of Minnesota, Minneapolis.

*Yung-Seop Lee (Spring 1990; William J. Kennedy).

I-Ming Liu (Summer 1989; W. Robert Stephenson) is continuing graduate study toward a Ph.D. in statistics at Florida State University.

Cynthia Renee Long (Summer 1989; William Q. Meeker, Jr.) is working on a Ph.D. program in biostatistics at the University of Iowa.

Jae P. McKeown (Spring 1990; Kenneth J. Koehler) is a corporate statistician with the Packing Corporation of America, Skokie, Illinois.

Carol Anne Meeter (Summer 1989; William Q. Meeker, Jr.) is a statistician with Merck & Co., Inc., Rahway, New Jersey, in its clinical biostatistics department.

***Kwan Soo Park** (Summer 1989; Yasuo Amemiya).

Robert Lewis Parker (Spring 1990; Noel A. C. Cressie) has enrolled for Ph.D. studies in statistics at the University of New Mexico, Albuquerque.

Peter Brian Peterka (Fall 1989; Stephen B. Vardeman) is an advanced statistician, Statistical Consulting, 3M Information Systems and Data Processing, 3M Center, St. Paul, Minnesota.

Amanda Anne Prestwor (Summer 1989; Stephen Vardeman) has been working in the Glass Division, Ford Motor Company, Tulsa, Oklahoma.

***Muhamad Sabran** (Fall 1989; Edward Pollak).

Astini Salihima (Fall 1989; Donald K. Hotchkiss) is working toward a doctorate in statistics at Oklahoma State University.

Mary Elizabeth Sayler (Summer 1989; William Q. Meeker, Jr.) is an associate statistician in Lilly Research Laboratories, Lilly Corporate Sector, Indianapolis, Indiana.

Theresa Lynn Scheetz (Spring 1990; Jerome Sacks) has accepted a position as instructor in the Department of Mathematics and Statistics, Winona State University.

Chii-Jyh Shyu (Spring 1990; Mervyn G. Marasinghe) is continuing studies at Iowa State University during the summer term before returning to Taipei, Taiwan.

David Darrel Steenhard (Fall 1989; William Q. Meeker, Jr.) is a statistician with AT&T in Bedminster, New Jersey.

Pei-Ying Sun (Spring 1990; Yasuo Amemiya) returned to Taipei, Taiwan, and accepted a government position in the Executive Yuan Directorate-General of Budgets, Accounting, and Statistics.

Wendy Jeanne Swanson (Summer 1989; Kenneth J. Koehler) is a computing consultant with William M. Mercer, Inc., a benefits consulting firm in Minneapolis, Minnesota.

Teresa Ann Takle (Summer 1989; W. Robert Stephenson) is employed as a statistician at Rosemount Inc., Eden Prairie, Minnesota.

Ibrahim O. Talib (Spring 1990; Kenneth J. Koehler) has returned to Riyadh, Saudi Arabia, as trainer in the Planning Department, Institute of Public Administration, Kingdom of Saudi Arabia.

***Muhammad Arif Tiro** (Fall 1989; H. A. David).

Ching-Ching Yang (Summer 1989; H. A. David) is working toward a doctorate in statistics at the University of Wisconsin.

***Yunn-Hwu Yu** (Fall 1989; Paul N. Hinz).

Ph.D. Recipients

Douglas Martin Andrews (Summer 1989; H. A. David) is an assistant professor in the Department of Mathematics and Computer Science, Wittenberg University, Springfield, Ohio.

Paula Marie Lasack Davis (Spring 1990; joint majors in entomology and statistics; Larry P. Pedigo and Paul N. Hinz) has joined the Department of Entomology, Cornell University, as an assistant professor.

Cheng-Der Fuh (Summer 1989; joint majors in mathematics and statistics (probability); Krishna Athreya and Dean Isaacson) returned to Taiwan to be a research associate professor in the Institute of Statistical Science, Academia Sinica, in Taipei.

Eiichiro Ed Funo (Summer 1989; Glen Meeden) returned to Japan and accepted a position to teach in the Department of Economics, Kanto Gakuin University, in Yokohama.

Carol Anne Gotway (Summer 1989; Noel A. C. Cressie) worked as a research assistant in Fontaineblau, France, at the Centre de Geostatistique, Ecole Nationale Superieure des Mines de Paris, for five months; then in February she joined Sandia National Laboratories, Albuquerque, New Mexico, as statistician.

Martín Oscar Grondona (Summer 1989; Noel A. C. Cressie) returned to the Instituto Nacional de Tecnologia Agropecuaria (INTA), Castelar, Buenos Aires, Argentina, as statistical consultant. During the spring quarter 1990, he taught in the Department of Statistics, University of California-Riverside, as visiting assistant professor.

Frederick Landis Hulting (Summer 1989; David A. Harville) is a senior research scientist, Mathematics Department, General Motors Research Laboratories, Warren, Michigan.

Chiou-Hua Lin (Spring 1990; Shashikala Sukhatme) returned to Taichung, Taiwan, to take a position as associate professor in the Department of Statistics, Tunghai University.

Gary Robert Sullivan (Fall 1989; Wayne A. Fuller) is working as a statistician in the Lilly Research Laboratories, Lilly Corporate Sector, Indianapolis, Indiana.

James Thomas Symanowski (Summer 1989; Kenneth J. Koehler) accepted a position as senior statistician in the Scientific Information Services Department, Lilly Research Laboratories, Greenfield, Indiana.

Rahmat Syahni Zakaria (Summer 1989; joint majors in statistics and industrial engineering; Herbert T. David and Way Kuo) returned to Indonesia to a position as lecturer in the Department of Statistics, Faculty of Agriculture, Universitas Andalas, in Padang.

M.S. Candidates

Agatep, Maria Theresa	Dombroski, Barbara
Ahmad, Mahmood	Drinkwater, Karen
Akbar, Aminul (operations research)	Dubois, Dawn
	Garcia, Cathalina
Al-Shiha, Abdoullah	Gilloon, Peter
Al-Zaid, Munther Ali A.	Gregory, Shelly
Andersen, Scott W.	Griffiths, Richard
Becker, Lori	Han, Seung-Ho
Borchert, Todd	Hassanain, Khalif M. A.
Brands, Linda M.	Helterbrand, Jeffrey
Chen, Chao-Yin	Hofer, Jeffrey D.
Chen, Ching-Ju Diane	Holman, Susan L.
Chen, Kehang	Howard, Sarah F.
Chen, Shih-Neng	Hwang, Taekyu
Chen, Yi-Ju	Iversen, Philip W.
Cheng, Man-Lai Alice	Kang, Shin-Soo
Chiu, Jia-Chyi	Kao, Yu-Ling
Cho, Jihwan	Karabulut, Ihsan
Cho, Tae-Kyoung	Kelly, Georgene
Chowdury, Risana	Ko, Seoung-Gon
Chung, Ching-Yi	Kreisberg, Mark S.
Cramer, Alice M.	Kuo, Bojein
Dellva, Mary Anne	Lagus, John P.
Djamal (operations research)	Lee, Kye-Don

Lee, Ming-Yu
Lee, Shu-Hua
Li, Chia-Lin
Lin, Kuo-Chin
Liu, I-Ming
Long, Cynthia
Luk, Stella Chueck-Wah
Lyan, Dze-Hwei
Ma, Chuan-Chuan
McKeown, Jae P.
Meeter, Carol A.
Milbrath, Rochelle L.
Misambo, Barnabas
Moreno G., Carlos
Nininahazwe, Yvon
Olin, Bryan D.
Park, Sangun
Parker, Robert L.
Pepper, Dwayne
Peterka, Peter B.
Prestwar, Amanda
Putranto, Beta
Reese, John T.
Remadi, Sallem
Riddell, Jennifer K.
Roback, Paul J.
Ross, Philip H.
Rushing, Leroy N.
Russey, Ann C.

Salihima, Astini
Scheetz, Theresa
Sheu, Ru-Shuo
Shyu, Chii-Jyh
Sly, Diane S.
Smith, Blake A.
Soumare, Harouna
Steenhard, David
Suharno
Sun, Pei-Ying
Swanson, Wendy J.
Takle, Teresa A.
Talib, Ibrahim
Tiro, Muhammad
Walczak, Daniel E.
Wall, Steven J.
Wang, Wei
Weaver, Amy Hewitt
Wellman, Mark (operations research)
Whitney, Christine M.
Worth, Barbara J.
Wouhib, Abera
Yalçin, Ilker
Yang, Ching-Ching
Yansaneh, Ibrahim
Yen, Shu-Yuan
Yen, Yung-Li

Ph.D. Candidates

Adam, Abdoulaye
Al-Mahmoud, Ahmad M. A.
Andrews, Douglas M.
Jonathan Biele
Brescia, Victor P. (joint statistics-economics)
Bryan, Mark F. (in absentia)
Carley, Michael R. (joint statistics-economics)
Chakak, Abderrahmane
Coffin, Marie A.
Cranford, B. Keith (in absentia)
Croos, Joseph H. R.
Davis, Paula Lasack (joint entomology-statistics)
Dunnigan, Gerri M.
Freire, Clarice A.
Fuh, Cheng-Der (joint mathematics-statistics)
Funo, Eiichiro
Garrigoux, Christian (joint statistics-industrial engineering)
Gotway, Carol A.
Grondona, Martín O.
Han, Geun-Shik
Homblé, Patrick R.
Huang, Mu-Yeh (joint statistics-industrial engineering)
Hulting, Frederick L.
Lee, Yung-Seop
Lei, Ding-Hwa Dean
Lemke, Klaus (joint statistics-industrial engineering)
Li, Seung-Chun
Lin, Chiou-Hua
Liu, Jingyu
Loughin, Thomas M.
Lu, Chi-hsien Joseph
McDonald, David G. (joint statistics-meteorology)

Medak, Frederick M.
Mundfrom, Daniel (joint statistics-professional studies in education)
Navvabpour, Hamid
Nusser, Sarah
Park, Chongsun
Park, Heon Jin
Park, Kwan Soo
Rana, Abdul Wajid
Rathbun, Stephen L.
Robison-Cox, James F.
Sabran, Muhamad
Sanger, Todd M.
Sarkar, Sahadeb
Shin, Dongwan
Sriplung, Kai-One (joint economics-statistics)
Sullivan, Gary R.
Symanowski, James T.
Takahashi, Hiroshi (joint animal science-statistics)
Tollefson, Margot
Vander Wiel, Scott
Ver Hoef, Jay (joint botany-statistics)
Vidyashankar, Anand (joint mathematics-statistics)
Wang, Chung-Ching Morgan
Wang, Kui-Jang William
Wilmarth, Steven
Yoo, Seongmo
Yu, Yunn-Hwu
Zakaria, Rahmat S. (joint statistics-industrial engineering)
Zimmermann, Alan G.

Cooperative internships were held by the following graduate students during the year: Brian

Lindstrom, at Weyerhaeuser, Tacoma, Washington, for 12 months through summer 1990; Pamela Marsh, at Weyerhaeuser, Hot Springs, Arkansas, through December 1989; Michael Marcketti, through December 1989 at PMI; Susan Holman and Sarah Howard, at Mayo Clinic, Rochester, Minnesota, summer 1990; Rochelle Milbrath, at Dow Chemical in Midland, Michigan, and Todd Sanger, mainly at Dow Europe, in Zurich, Switzerland, summer 1990.

Scott Vander Wiel, who had been a full-time contract consultant with General Electric Corporate Research & Development, Schenectady, New York, through summer 1989, worked for GE half-time during fall semester while continuing graduate study at Iowa State. Dan Mundfrom received a summer 1990 appointment as mathematician to work for the National Security Agency, U.S. Department of Defense, at Fort Meade, Maryland.

■ Mu Sigma Rho

The 19th annual Mu Sigma Rho lecture was presented by Ronald S. Brookmeyer, professor of biostatistics at The Johns Hopkins University. His lecture, entitled "A Statistical History of the AIDS Epidemic," considered statistical issues involved in estimating the incubation period of AIDS (HIV infection) and estimating the number of individuals infected with the AIDS virus.

Dr. Brookmeyer is a recognized leader in the field of AIDS research. He is principal investigator on a National Cancer Institute grant for Statistical Methods in AIDS Research, and in 1985 he was an invited lecturer at the Institute of Health, National Center for Preventive Medicine in Beijing, China. He has published over 40 research papers and has presented numerous invited papers at professional meetings. His visit on April 17-19 was co-sponsored by the Iowa STAT-ers, the ISU Department of Statistics, eight other departments, the Graduate College, the Student Health Center, the Student Counseling Service, and, from the community, McFarland Clinic.

Eighteen new members were initiated into the honor society at the annual banquet, which preceded the lecture on April 17. The students were recognized for their scholarly achievements in statistics course-
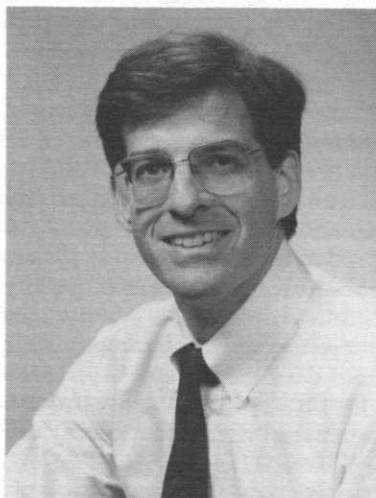
Mu Sigma Rho lecturer
Ronald Brookmeyer.

work. Officers for 1989-90 for the Iowa Alpha Chapter of Mu Sigma Rho were Scott Vander Wiel, president; Todd Sanger, vice president; and Barbara Worth, secretary/treasurer. Yasuo Amemiya served as faculty advisor.

■ B. V. Sukhatme Memorial Lecture

The 7th B. V. Sukhatme Memorial Lecture was presented by Mary E. Thompson on April 25, 1990. She spoke on the topic "Estimating Functions and Sampling." Thompson received her doctorate at the University of Illinois in 1969, then joined the Department of Statistics and Actuarial Science, University of Waterloo, in Ontario, Canada, where she became a full professor in 1980. She is a fellow of the American Statistical Association and a member of the International Statistical Institute.

■ Iowa STAT-ers

The Iowa STAT-ers, the Department of Statistics graduate student club, concluded another successful campaign featuring social and intellectual enrichment opportunities. This active group of 70 students has commanded recognition both among graduate departments at Iowa State University and from outside statistics departments for its varied menu of activities and its participation level.

For instance, vice-president Scott Vander Wiel coordinated a weekly Iowa STAT-er seminar series that included talks by ISU faculty members and students and talks by others from business and academia (see inside back cover). Jeff Helterbrand organized a weekly reading group where students met informally to discuss statistical issues and concepts not covered in course work.

John Lagus and Blake Smith organized several social functions providing opportunities for interaction outside the hallways of Snedecor, as well as glimpses into different cultures and different backgrounds of classmates. This year's highlights included the Moment Generating Function (a semi-formal gathering), the Winter Party (with skits and music), the Culture Party (with the theme of children from around the world), and an interdepartmental picnic with students from the departments of Statistics, Psychology, and Professional Studies in Education.

Additional outlets for STAT-er students were provided by two music groups coordinated by Phil Iversen, the STAT-er Clatter and the newly formed Stat Family Singers. These groups were featured in the spring at the second annual STAT-er recital. The STAT-er Clatter musicians also performed at the Meeden farewell dinner and the Wolins farewell dinner. Both groups appeared at the Holiday Open House and the Winter Party. Yet another outlet explored by STAT-ers was the intramural sports scene, where, in particular, the STAT-ers once again displayed their broomball prominence.

Funds were raised for STAT-er activities through the sale of sweatshirts, boxer shorts, can coolers, and birthday calendars.

Officers for the year were Jeff Hofer, president; Scott Vander Wiel, vice president; Phil Iversen, treasurer; and Ann Russey, secretary. Todd Sanger was the student representative at statistics faculty meetings. Ann Russey was editor of the STAT-er Chatter newsletter. The social committee included John Lagus and Blake Smith; Joseph Croos was international student representative. Amy Weaver and Alan Zimmermann were members of the ISU Graduate Student Senate, while Todd Sanger was GSS treasurer. Noel Cressie served as faculty adviser to the Iowa STAT-ers.

■ Snedecor and Bancroft Awards

The 1990 George W. Snedecor Award was presented to Scott Vander Wiel as the most outstanding Ph.D. candidate in the Department of Statistics among students completing the doctoral preliminary examination during 1989. The award honors the founder and first director of the Statistical Laboratory. Vander Wiel received a bachelor's degree in industrial engineering at Iowa State in 1985 and a master's in statistics here in 1987. He has held internships with Process Management Institute and General Electric Company. He is a research assistant and vice president of Iowa STAT-ers.

The T. A. Bancroft award recognizes achievements in statistics by students who completed Ph.D. prelim examinations in the past calendar year and who have a joint major in statistics and another area or a declared minor in statistics. The 1990 award was given to Johann Detilleux, a research assistant in animal breeding. The award honors Theodore A. Bancroft, director of the Statistical Laboratory and head of the Department of Statistics from 1950 to 1972. Detilleux completed a D.V.M. degree in 1982, at the Université de Liège, and a tropical medicine specialty in 1983, and worked as a veterinarian in Cameroon, Belgium, and France. She completed a master's here in animal breeding in 1989.

■ Undergraduates

The undergraduate program for majors in statistics at ISU is of high quality. However, unlike the crowded service teaching and graduate programs, it has room for more students. In an effort to help with recruiting, we are introducing a freshman scholarship, to be funded by the Department of Statistics and Eli Lilly & Company. We also plan to send a brochure to all high school mathematics divisions in Iowa in order to increase the number of first-year ISU statistics majors.

Undergraduate students received a number of recognitions during the academic year. On April 17, 1990, at the annual banquet of the Mu Sigma Rho statistics honorary, Lynne A. Carber, Chadd J. Crouse, Linda M. Hornberger, and Ramona I. Wright were initiated as members. On April 24, at the Scholarship Recognition Dinner, Anita Hinkeldey was recognized as the highest-ranked graduating senior in statistics. On Saturday, May 5, at a ceremony during Veishea, Greg Pieper received a Laura Vernon Scholarship. This scholarship is awarded by the Sciences and Humanities Council and the Statistics Club to an

undergraduate major who has demonstrated high scholastic achievement and has participated in departmental, university, and community activities. In June, Steven Stockdale, a biometry major, was selected to receive a Lane-Wells Scholarship for the 1990-91 school year.

Fifteen students received B.S. degrees in statistics during the period July 1, 1989, to June 30, 1990. One of these had a joint major program, as indicated below. Names of the degree recipients follow, with employment or study plans, where definite. An asterisk indicates that the student is continuing in the graduate program in statistics at ISU.

Joel David Brown (Spring 1990).

Susan Kay Heineman (Spring 1990) is a statistical analyst with the Principal Financial Group, Des Moines, Iowa.

*Anita Marie Hinkeldey (Spring 1990, with distinction).

Dale Allen Huntley (Spring 1990).

Julia Elizabeth Klein (Spring 1990) has accepted a position as mathematical statistician in the U.S. Bureau of the Census, Washington, D.C.

Ay Bing Liu (Fall 1989) returned to Johore Bahru, West Malaysia.

Christine Pieper Lundahl (Summer 1989) is a personnel management specialist with the Iowa Department of Personnel, Des Moines, Iowa.

Shalini Manjanatha (Spring 1990) is remaining in Ames while her husband completes graduate study.

Sarimah Binti Md. Yusoff (Fall 1989) returned to Klang, Selangor, Malaysia.

Cho-Kwong Ng (Fall 1989, computer science and statistics, with distinction) returned to Kowloon, Hong Kong.

Annette Marie Pippert (Spring 1990), now Annette Pippert-VanLent, has accepted a position as junior statistician with the Garst Seed Company, Slater, Iowa.

Suzelina Binti Sarif (Spring 1990) returned to Kuala, Trengganu, Malaysia.

Joseph C. Surber (Spring 1990) is a junior statistician in the A. C. Nielsen Company, Northbrook, Illinois.

Edward Martin Tometich (Spring 1990) has accepted a position as mathematical statistician in the U.S. Bureau of the Census, Washington, D.C.

Esther Louise Woods (Spring 1990) is a supply management officer in the Iowa Army National Guard.

William Rudolph, who graduated in May 1989 in statistics and mathematics, has taken a position as an actuarial trainee with Crum & Forster Corporation, a division of Xerox, in Morristown, New Jersey. Max Schneff, a May 1989 statistics graduate, is employed as a statistical research analyst for the State of Iowa; he works in the Criminal and Juvenile Justice Planning and Statistical Analysis Center in Des Moines.

Four continuing undergraduate students have 1990 summer internships involving statistics. Linda Hornberger is working for the Center for Agricultural and Rural Development (CARD) at Iowa State in the Summer Internship for Women Program in Science and Engineering. Daniel Parks is working as a statistical intern for the IBM Corporation in Rochester, Minnesota. Greg Pieper is working for the Department of Human Rights, State of Iowa, in Ames as a statistical intern, as he did in the summer of 1989. Michael Tott is working for the Lincoln National Life Insurance Company, Fort Wayne, Indiana, in its summer actuarial program.

In addition, Anita Hinkeldey, a spring graduate, is working in the William F. Taylor Summer Internship Program at the Mayo Clinic, Rochester, Minnesota. Matt Gerdis worked as a statistical intern with Weyerhaeuser, Inc., in Hot Springs, Arkansas, from January to June 1990.

■ Statistics Club

The Statistics Club was established to promote interest in the field of statistics among undergraduates. The club sponsored a number of events—social, academic, and career-related— throughout the year and continued its monthly newsletter.

The first meeting, in September, was the annual pizza and beverage party at the Pizza Pit in Ames, with enjoyable conversations about summer experiences. Then at the first business meeting of the club, on October 11, members discussed at length their experiences in statistics-related jobs or foreign study.

Anita Hinkeldey described her eight-month experience in 1989 with the Weyerhaeuser company, Hot Springs, Arkansas. She discussed a number of research projects in forestry in which she participated, and she emphasized the importance of having or obtaining a knowledge of PC/SAS*. Greg Pieper talked about his experience working as a statistical intern in summer 1989 for the Department of Human Rights, State of Iowa, in Ames. He was responsible for data collection, entry, and analysis on several projects. Julia Klein contrasted university life at Iowa State with that at the University of Hamburg, Germany, where she spent the 1988-89 academic year. She mainly studied the German language and German literature, but also took courses in economic statistics and statistics.

On November 28, Leon Burmeister, a B.S., M.S., and Ph.D. graduate of the ISU Department of Statistics, gave a talk on environmental issues in Iowa. He discussed cancer rates for various types of cancer in the nation and in Iowa. He is currently a professor in the Department of Preventative Medicine and Environmental Health in the College of Medicine, University of Iowa.

On February 1, Julie Hunsinger-Wiese, a 1988 B.S. graduate in statistics at Iowa State, talked about "Being an Actuary." She spoke about her experience working as an actuary with the Lincoln National Life Company, Fort Wayne, Indiana, since summer 1988. The talk was well attended, and one of our undergraduate majors subsequently obtained a position in the company's 1990 summer actuarial program.

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On March 22, Shail Butani from the Bureau of Labor Statistics, U.S. Department of Labor, talked about the nature of statistical work done by the bureau. She also showed a video tape about the B.L.S. and living in Washington, D.C. On April 23, Jeffrey Larson-Keller, a 1987 B.S. graduate in statistics from Iowa State, discussed his past 2½-years' experience as a data analyst at the Mayo Clinic, Rochester, Minnesota. He described the clinic's statistical unit and, in some detail, one medical project upon which he had worked. Elections were held, with ballots due on May 1, 1990. The officers for next year will be:

president: Lynne Carber
vice president: Matt Gerdis
secretary/treasurer: Laura Roeder

Richard A. Groeneveld served as faculty adviser for the 1989-90 year.

■ Seminars

The series of regular weekly noncredit seminars offered by the Statistical Laboratory and the Department of Statistics throughout the 1989-90 year was planned by Edward Pollak, Debapriya Sengupta, and Dean Isaacson.

Statistical Laboratory Seminars

Summer 1989

July 5   Bayesian and non-Bayesian procedures for small-area estimation: Relationships and frequentist properties. Frederick L. Hulting

12   The use of added error to avoid disclosure. Gary R. Sullivan

Fall 1989

August 30   Statistics outside Snedecor Hall. Dean L. Isaacson

September 6   On performance of outlier tests. Sushama M. Bendre, ISU and Department of Statistics, University of Bombay, India

13   Buehler bounds for a certain system performance measure. Herbert T. David

15   Nonparametric empirical Bayes estimation with $O(n^{-1/2})$ rate of a truncation parameter. Somnath Datta, Department of Statistics, University of Georgia

27   Generalized means of the lognormal distribution. Arnold M. Faden, Department of Economics, Iowa State University

October 4   Mean squared error of estimation or prediction under a general linear model. David A. Harville

11   Bayes optimal designs for comparing new treatments with a standard treatment. Dibyen Majumdar, Department of Mathematics, Statistics, and Computer Science, University of Illinois at Chicago

18   Some generalized results on order statistics from independent and nonidentically distributed variables. N. Balakrishnan, Department of Mathematics and Statistics, McMaster University, Ontario, Canada

25   A unified analysis of multiparameter hierarchical models in the common exponential families. Carl N. Morris, Statistical Sciences Center, Department of Mathematics, University of Texas-Austin

30   (co-sponsored by the ISU Center for Nondestructive Evaluation) Fracture mechanics, nondestructive evaluation and statistics: Applications in gas turbine engines. Charles Annis, Pratt & Whitney, West Palm Beach, Florida

November 8   Morphometrics: A civilised version of craniometry. Subhash Lele, Department of Biostatistics, The Johns Hopkins University

15   Minimum risk schemes in sequential sampling. Jonathan Biele

29   Regression quantiles and the bootstrap: A natural setting to investigate the problem of smoothing the bootstrap. Probal Chaudhuri, Department of Statistics, University of Wisconsin-Madison

December 13   On the stability of stochastic difference equations. Patrick Homblé

Spring 1990

January 24   The effective population size of an age-structured population with a sex-linked locus. Edward Pollak

31   Optimum accelerated life tests with nonconstant σ. William Q. Meeker, Jr.

February 8   Multivariate analyses of agricultural crop processing in the ancient Near East. Miriam Chernoff, formerly with the Biostatistics Unit, Psychiatry Department, Massachusetts General Hospital, Boston, Massachusetts

14   Image algebra: A synopsis. Jennifer Davidson, Department of Electrical Engineering and Computer Engineering, Iowa State University

21   Using fuel to control a process to a goal. Ananda Weerasinghe, Department of Mathematics

22   Estimation and prediction in mixed linear models. Alicia Carriquiry

28   Regression models and coefficient ratios. Christopher J. Skinner, Department of Social Statistics, University of Southampton, U.K., and Iowa State University

March 21   Parameter estimation for spatial inhomogeneous Poisson point processes. Stephen Rathbun

April 4   A martingale difference specification test on the residuals of time series. Melvin J. Hinich, Department of Government, University of Texas

11   An overview of knowledge representation and inference. Mervyn G. Marasinghe

18   Statistical problems in AIDS research. Ron Brookmeyer, Department of Biostatistics, Johns Hopkins University

23   Edgeworth expansions and the bootstrap. R. N. Bhattacharya, Department of Mathematics, Indiana University

May 2   (Co-sponsored by Department of Industrial and Manufacturing Systems Engineering) Identifiability problems linked with the aircraft air conditioner data. Harold Ascher, Naval Research Laboratory, Washington, D.C.

9   Powers of two-sample tests under Lehmann alternatives. Chiou-Hua Lin

May 14   Failure time analyses for data collected from independent groups of correlated individuals. Sarah Nusser

Summer 1990

June 27   The distributions of certain record statistics from a random number of observations. H. N. Nagaraja, Department of Statistics, The Ohio State University, Columbus

Special Lectures and Seminars

Iowa STAT-ers Seminar Series

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