Statistical Laboratory

established 1933

Annual Report
July 1, 1990 to June 30, 1991

$$\sigma^2 \quad \mu \quad \Omega \quad \chi^2 \quad \Sigma \quad \beta$$

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Contents

THE STATISTICAL LABORATORY
Iowa State University
1990-91 Annual Report

A Year of Self Scrutiny and Reviews

The ISU statistical center, including the Statistical Laboratory, the Department of Statistics in the College of Liberal Arts and Sciences, and the Statistics Department of the Iowa Agriculture and Home Economics Experiment Station, went through a self-study and an external review during the year.

The process started in the summer of 1990 with the preparation of a self-study document. Since the department had been actively working on planning over several years, much of the needed data had already been collected. However, it took several subcommittees and many months to produce the final 221-page document. This report describes where we have been and where we are as a statistical unit. The review team used this document and many interviews to establish recommendations on where we should go from here.

The review team visiting Statistics on March 25-26 consisted of David S. Moore, chair, from Purdue; Stephen Fienberg, Carnegie-Mellon University; Graham Kalton, University of Michigan; Jerald F. Lawless, University of Waterloo; Ingram Olkin, Stanford University; and Daniel L. Solomon, North Carolina State University. Their report was submitted on April 17. Although the review team felt that many parts of our program were strong, they naturally identified areas where we need to improve. Some of these recommendations will be reviewed in this annual report since they will be our goals for the near future.

In the area of faculty, "the Department is understaffed relative to the unusual volume and variety of responsibilities it carries." This has been a concern of ours for several years. We searched to fill six faculty positions in 1990-91, with five being replacements due to resignations and retirements. Unfortunately, three searches were frozen because of the university's budgetary freeze on hiring. Therefore, we remain understaffed, especially in the areas of survey sampling and statistical methods. Searches will resume as soon as the freeze is lifted.

In the area of statistical computing, the recommendation was for "immediate provision of modern networked workstations for all faculty, including the electrical refurbishing of parts of Snedecor Hall required to support better computing facilities." Fortunately this need is being addressed by Project Vincent™ 1991 (see p. 39). Nineteen new workstations were awarded to Statistics and will be installed in July 1991. Fourteen of the machines will be assigned to research sections or individual faculty members. The remaining five machines will be placed in 203 Snedecor for use by statistics students. We finally have a new computing room for students that will contain six workstations and four PCs. Although the new workstations do not satisfy all of our computing needs, they certainly allow us to move forward in an area in which we had fallen behind.

In the area of research, the review team recommended "a rebuilding of strength in core statistics and in new areas of statistical methodology, leading to greater visibility in the statistical research literature." This has been a continuous goal of the department. Progress is apt to follow the addition of new faculty since they will bring new research areas to our program and allow current faculty members more time for research.

It was encouraging to learn that most of the suggestions contained in the external review report had been stated in the department's 1988 strategic plan. These include meeting some specific needs in what was considered by the review team "a generally satisfactory

An external review team visited the Stat Lab in March to review the ISU statistical center. Shown from L to R are Graham Kalton, David Moore, Jerald Lawless, Stephen Fienberg, Ingram Olkin, and Daniel Solomon.

New faculty member Derrick Rollins (L) meets with the outside review team. He holds a joint appointment in statistics and chemical engineering and has research interests in gross error detection for chemical processes and minimum variance process control.

teaching mission." We are not being asked to change directions, but are being urged to move faster. We look forward to improving in the areas recommended for particular attention by the committee while also improving the quality of those areas that they found strong at this time.

A second review of our program was conducted on February 8 for the National Research Council. Faculty members representing the council visited departments in the mathematical sciences to determine what makes a graduate program strong. The results of these visits will be summarized in a report by the faculty who made the reviews. The review team sent to Iowa State consisted of Patricia Langenberg, Department of Epidemiology and Preventive Medicine, the University of Maryland, and Peter Glynn, Department of Operations Research, Stanford. Langenberg received her B.S. degree in statistics and mathematics here a number of years ago.

The 1990-91 year has seen changes in the top level of university administration but continuity in its sense of ISU's mission as a land grant institution. Following President Gordon Eaton's resignation, Provost Milton Glick served as interim president for seven months until a new president, Martin Jischke from the University of Missouri-Rolla, took office.

Administrative changes will be continuing next year. David Bright has resigned as dean of the College of Liberal Arts and Sciences as of June 30, 1991. While a replacement is sought, David Glenn-Lewin will become interim dean; he has been associate dean. The office of the vice provost for research and advanced studies and dean of the Graduate College will still provide administrative direction for the Statistical Laboratory but Patricia Swan will also serve as interim provost, beginning in August when Milton Glick takes a position as senior vice president and provost at Arizona State University.

Personnel

Derrick Rollins has been appointed assistant professor of statistics and chemical engineering, effective August 21, 1990. He received master's degrees in chemical engineering and in statistics at Ohio State and completed a doctorate in chemical engineering there in 1990. He has nearly seven years' experience as a process engineer with E. I. Du Pont. Another new joint appointment with engineering has been made effective July 1991 (see the end of this section). These two positions recognize the strengthening and expanding relations between statistics and engineering at Iowa State.

Debapriya Sengupta was on leave from June 30 through December 1990 to be a visiting lecturer at the Indian Statistical Institute, Calcutta. He resigned from ISU effective December 31. Stephen J. Haslett, who had been in New Zealand on leave since October 1988, also resigned effective December 31. He is remaining at Victoria University of Wellington, as research statistician and lecturer in the Institute of Statistics and Operations Research.

Alicia Carriquiry was appointed assistant professor of statistics, effective August 21, 1990, to teach courses in statistical methods and work with the Center for Agricultural and Rural Development and the Survey Section of the Statistical Laboratory on joint projects. She had been a postdoctoral associate with the ISU Center for Agricultural and Rural Development since January 15, 1990, providing statistical expertise for projects in which both the center and the Survey Section were involved.

Klaus Hinkelmann (Ph.D. ISU 11/63) spent the fall semester at ISU as visiting professor of statistics, primarily to work with Oscar Kempthorne on a two-volume revision of Kempthorne's book *The Design of Experiments*. Hinkelmann was on leave from Virginia Polytechnic Institute and State University, where he is professor and head of the Department of Statistics.

Ismail Oğuz came here in September as a visiting scholar for the academic year, for study and research. He had been a research assistant in the Department of Animal Science, University of Ege, Bornova-Izmir, Turkey, and returned to his university June 24, 1991.

Noel A. C. Cressie is on faculty improvement leave for the 1991 year, spending the spring semester as Visiting Fellow, Centre for Mathematics and Its Applications, Australian National University, Canberra, Australia. He made short visits to Perth and Sydney to discuss research with colleagues. He will be spending

the fall semester at the Department of Statistics, Stanford University.

Patrick Homblé resigned as temporary instructor in August 1990 to become an assistant professor of statistics at the University of Georgia. Daniel Mundfrom, upon completion of his doctorate in statistics and education here, was appointed temporary instructor in the Department of Statistics for summer 1991. (See also p. 42.)

Paul Kvam is working during the months of June and July 1991 as a postdoctoral research associate on H. A. David's Army Research Office contractual project. Since completing his Ph.D. studies at the University of California, Davis, last December, Kvam has been a postgraduate researcher there in the Department of Epidemiology and Preventive Medicine.

Jerome Sacks received a USDA Agricultural Research Service award for superior performance in 1990.

The College of Liberal Arts and Sciences chose Wayne A. Fuller to receive its 1991 Award for Excellence in Research. An award plaque was presented to him "in recognition of excellence in education" on May 8 at a representative assembly meeting.

Donald K. Hotchkiss began early retirement at the end of the fall semester but agreed to continue teaching during the spring on a temporary basis. A retirement reception to honor him was held on May 9 in the Memorial Union Campanile Room. He has been on the statistics faculty for 30 years.

Roy A. Hickman chose early retirement as of May 20 but is continuing supervision of the Statistical Laboratory Survey Section on a temporary basis until a replacement is found. Dorothy Edwards, who has worked for ISU 23 years, including 12 years in the Survey Section, also chose early retirement effective June 30. A retirement dinner was given at the Starlite Village Motel.

Looking toward next year: Mark S. Kaiser has accepted a position as assistant professor to fill a position formerly held by Donald Hotchkiss. He received his doctorate in statistics at the University of Missouri- Columbia and has worked for the U.S. Fish and Wildlife Service as a mathematical statistician at the National Fisheries Contaminant Research Center in Columbia since 1984. He has also taught at the University of Missouri-Columbia as visiting assistant professor in the Department of Statistics this year.

Peter Sherman has accepted a joint appointment as assistant professor in the departments of Statistics and Aerospace Engineering and Engineering Mechanics. He has been on the faculty of the School of Mechanical Engineering, Purdue University, since 1984 when he completed his doctorate in mechanical engineering at the University of Wisconsin-Madison.

Also F. Jay Breidt, Department of Statistics, Colorado State University, has accepted an assistant professorship. He is completing a Ph.D. degree at Colorado State.

Carl Roberts will be on faculty improvement leave for the period September 1, 1991-August 31, 1992 to write a book on a theory of cognition. He has been awarded a foreign travel grant and will be doing independent research in the Netherlands in the Hague.

Statistical Laboratory Staff—Fiscal Year 1990-91 under the administrative direction of:

Gordon P. Eaton, Ph.D.—president of the university (until October 31, 1990)

Milton Glick, Ph.D.—interim president (November 1, 1990-May 31, 1991)

Martin C. Jischke, Ph.D.—president (June 1, 1991 on)

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

David F. Bright, Ph.D.—dean, College of Liberal Arts and Sciences; director, Liberal Arts and Sciences Research Institute (until June 30, 1991)

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

C. Philip Cox, professor emeritus

David F. Cox

Noel A. C. Cressie

Herbert A. David, Distinguished Professor in Liberal Arts and Sciences

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

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

Richard A. Groeneveld

David A. Harville

Roy D. Hickman, professor emeritus

Klaus Hinkelmann, visiting

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

Donald K. Hotchkiss, professor emeritus

David V. Huntsberger, professor emeritus

Dean L. Isaacson

Oscar Kempthorne, emeritus Distinguished Professor in Liberal Arts and Sciences

William J. Kennedy

Kenneth J. Koehler

William Q. Meeker, Jr.

Edward Pollak, joint appointment with Department of Genetics

Jerome M. Sacks, USDA collaborator

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

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 Systems Engineering

H. Samuel Wieand, Mayo Clinic collaborator

Leroy Wolins, professor emeritus

Associate Professors

Yasuo Amemiya

Frederick O. Lorenz, joint appointment with Department of Sociology

Mervyn G. Marasinghe

Carl W. Roberts, joint appointment with Department of Sociology

W. Robert Stephenson

Shashikala Sukhatme

Temporary Associate Professor

Stephen J. Haslett (on leave)

Assistant Professors

Harold D. Baker

Alicia Carriquiry, joint appointment with Center for Agricultural and Rural Development

Derrick Rollins, joint appointment with Department of Chemical Engineering

John Stufken

Temporary Assistant Professors

Soumendra N. Lahiri

Debapriya Sengupta (on leave)

Temporary Instructors

Patrick Homblé

Daniel Mundfrom

Resident Collaborator

Dean Thompson, USDA Soil Conservation Service

Visiting Research Scholars

Byoung Jin Ahn

Ismail Oğuz

Postdoctoral Research Associate

Paul H. Kvam

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. Cooperative internships are listed on p. 41.

Baiching An

Jeffrey Andersen

Christine Ashman

Todd Borchert

Man-Lai Alice Cheng

Risana Chowdhury

Marie A. Coffin

Alice Cramer

Joseph H. R. Croos

Rohit S. Deo

Kevin W. Dodd (Corning scholar)

Barbara Dombroski

Karen Drinkwater

Dawn DuBois

Thomas Fischer

Jun-ichiro Fukuchi

Heidi Geheb (Procter & Gamble scholar)

Mary L. Gessner

Shelly L. Gregory

Richard R. Griffiths

Michael Hartfield (Shell scholar)

Jeffrey Helterbrand

Anita M. Hinkeldey (Eli Lilly scholar)

Sarah F. Howard

Philip W. Iversen

Georgene Kelly

Thomas Kirchoff (Dow scholar)

Ding-Hwa Dean Lei

Klaus W. Lemke

Brian Lindstrom

Chih-Yao Liu

Jingyu Liu

Thomas M. Loughin

Todd Manke (Shell scholar)

Steven Mattics

Jose-Luis Mazas (Corning scholar)

David G. McDonald

Elizabeth McMichael (Shell scholar)

Frederick M. Medak (Shell fellow)

Richard C. Meyer

Rochelle L. Milbrath

Peter Müller (DAAD scholar)

Hamid Navvabpour

Christopher C. Novak (Eli Lilly scholar)

Eric L. Novak

Bryan D. Olin

Savas Papadopoulos

Heon Jin Park

Elizabeth M. S. Paterno

Lisanne R. Raymos (Shell scholar)

Sallem Remadi

Paul J. Roback

James Robison-Cox

Shonda D. Roelfs (Corning scholar)

Philip H. Ross

Leroy N. Rushing, Jr.

Todd M. Sanger (National Science Foundation fellow)

Sahadeb Sarkar

Laura Schillmoeller (Corning scholar)

Dongwan Shin

Diane S. Sly

Michael H. Smith

Kai-One Sriplung

Gerald Städtler (DAAD scholar)

Julia Stein (DAAD scholar)

Margot Tollefson

Daniel E. Walczak

Chung-Ching Morgan Wang

Kui-Jang Wang

Ouhong Wang

Paul F. Wenz (Corning scholar)

Ibrahim Yansaneh

Seongmo Yoo

Yunn-Hwu Yu

Alan G. Zimmermann

Supported Graduate Students

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

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

Gregorio Atuncar—Federal University of Minas Gerais/CAPES

Victor P. Brescia—ISU Center for Agricultural and Rural Development

Brad Bushman—Department of Psychology, ISU

Abderrahmane Chakak—Fulbright

Djamal—Government of the Republic of Indonesia

Gerri M. Dunnigan—ISU Center for Nondestructive

Don Hotchkiss wiith his wife, Dorothy, at a retirement reception held in his honor in the Memorial Union Campanile Room. Future plans include traveling, fishing, and sampling the southern climates during the winter season.

Harouna Soumare—USAID-Senegal
Hiroshi Takahashi—Department of Animal Science, ISU
Dilek Tali—Central Bank of the Republic of Turkey
Muhammad Tiro—MUCIA-AID-Indonesia
Scott Vander Wiel (Shell fellow)—ISU Center for Nondestructive Evaluation and General Electric
Jay Ver Hoef—Department of Botany, ISU
Anand Vidyashankar—Department of Mathematics, ISU
Michael Wallendorf—U.S. Department of Agriculture and Department of Entomology, ISU
Mark Wellman—Department of Industrial and Manufacturing Systems Engineering, ISU
Christine M. Whitney—Iowa Quality Coalition
Steven Wilmarth—Maytag Company
Barbara J. Worth—College of Veterinary Medicine, ISU
Abera Wouhib—UN FAO
Peitsang Wu—Department of Industrial and Manufacturing Systems Engineering, ISU
Ilker Yalçin—Hacettepe University, Turkey

Self-Supporting Graduate Students

Lori Becker (on leave)
Jonathan Biele
Mark F. Bryan
Sherry L. Bushaw
Michael R. Carley
Chun-Fu Chen
Kehang Chen
Yi-Ju Chen
Jihwan Cho
Li-Fang Chuang
Ching-Yi Chung
B. Keith Cranford
Jianying Peng Ding
Clarice A. Freire
Peter K. Gilloon
Geun-Shik Han
Shawkat Hassan
Khalifa M. A. Hassanain
Hui-Lin Hu
Hui-Yi Huang
Taekyu Hwang
Hyum-Hee Joo
Shin-Soo Kang
Yu-Ling Kao
Dae-Lyong Kim

Sahmyeong Kim
Seoung-Gon Ko
Kye-Don Lee
Shu-Hua Lee
Young Jae Li
Kuo-Chin Lin
Yi-Te Lin
Abdolhassan Lotfizadeh
Chueck-Wah Stella Luk
Dze-Hwei Lyan
Chuan-Chuan Ma
Sang-Heon Oh
Margarita Paterno
Jean E. Pelkey
Stephen L. Rathbun
Daniel L. Rose
Ru-Shuo Sheu
Chungyeol Shin
Suharno
Steven J. Wall
Lie-Ling Wu
Shu-Yuan Yen
Yung-Li Yen
Namkyu Yu

Evaluation
Ann Dyer—Engineering Research Institute, ISU
Birol Emir—Government of Turkey
Gilenio Borges Fernandes—EMBRAPA/EPABA, Brazil
Cathalina M. Garcia—USAID and University of Costa Rica
Christian Garrigoux—Monterrey Institute of Technology, Mexico, and ISU Center for Nondestructive Evaluation
Marjorie A. Green—Maytag Company
William H. Harter, Jr.—U.S. Department of Agriculture
Susan L. Holman—College of Business Administration, ISU
Mu-Yeh Huang—Department of Industrial and Manufacturing Systems Engineering, ISU
Ihsan Karabulut—Gazi University, Turkey
Mark S. Kreisberg—ISU Center for Nondestructive Evaluation
Yung-Seop Lee—Department of Textiles and Clothing, ISU
Seung-Chun Li—Department of Sociology, ISU
Chi-hsien Joseph Lu—ISU Center for Nondestructive Evaluation
Carlos Moreno G.—USAID/FES
Yvon Nininahazwe—USAID-Burundi
Sarah Nusser—ISU Center for Agricultural and Rural Development
Beta Putranto—MUCIA-AID-Indonesia
Abdul Wajid Rana—USAID-Pakistan
John T. Reese—Soil Tilth Laboratory, ISU
Jennifer Riddell—Department of Child Development, ISU
Jason W. Rupe—Department of Industrial and Manufacturing Systems Engineering, ISU
Ann C. Russey—College of Family and Consumer Sciences, ISU
Muhamad Sabran—Government of Indonesia

Professional and Scientific Staff

Dianne G. Anderson, research associate, Survey Section
Richard Dorsch, programming consultant, Survey Section
Mary Genalo, research associate, Survey Section
Masoud Kazemi, research associate, Survey Section, beginning November 1, 1990
Edith Landin, administrative assistant
Marie Loughin, research associate, Survey Section, beginning September 16, 1990
Bud Meador, supervisor, Statistical Data Processing Services

Deborah Reed-Margetan, programmer-analyst, Survey Section
Janet L. Schultz, programmer, Survey Section
Kathleen Shelley, supervisor, 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, until May 10
Darlene Wicks, clerk typist, Statistical Computing Section

Survey Section Staff

Glenda Ashley, key entry operator
Kathryn Bottorff, field interviewer
Jean Carey, field interviewer
Dorothy Edwards, statistical clerk
Sharon Erbach, field interviewer
Kathryn Goodwin, field interviewer
Vimlesh Gupta, key entry operator
Nancy Heathman, account clerk
Marlys Huff, field interviewer
Marcia Luze, field interviewer
Helen Nelson, secretary
Kathie Reinertson, data technician
Jasmine Seagrave, data technician
Judy Shafer, clerk typist
Susan E. Verkade, data technician
Karon White, key entry operator

Dorothy Edwards, shown with Roy Hickman, was feted by the Survey Section with a cake on her last day at work.

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, D. K. Hotchkiss, and Kenneth J. Koehler, who were assisted this year by graduate students Thomas Loughin, Anita Hinkeldey, Barbara Worth, and Paul Wenz during fall and spring semesters and Diane Sly for the summer only. (Worth 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. Examples of the year's activities follow.

An important area of research at ISU is energy efficiency/energy conservation. Many experiments in energy-related projects involve researchers from more than one academic department. In the conduct of such experiments, special statistical problems can develop, most of which arise from failure to clearly and specifically identify the objectives and goals of the research before the experiments are started. One interdisciplinary study this past year, in which Ted Bailey collaborated in the design, analysis, and interpretation, was concerned with the effect of various storage conditions for high moisture corn. If high moisture corn could be stored without the costly procedure of drying for storage, considerable energy savings could be achieved. Results from this research suggest that grain deterioration during aerated storage can be suppressed under certain conditions, thereby resulting in important energy conservation.

Other areas of study, such as biotechnology, are characterized by the great diversity of interests and research abilities of the cooperating scientists. It is a challenge to satisfy all those interests in a given investigation and realize the opportunities for shared input in planning, execution, analysis, and interpretation. The old adage that the statistical methods used are at least as important as any of the other methods in the

research becomes an understatement when cross-disciplinary projects are contemplated.

A second example of interdisciplinary research in which Bailey was involved this past year was a study of biodegradability of plastic films. The films must retain all the physical properties expected by the consumer and then, when placed in the appropriate environment, degrade more rapidly than conventional disposable plastics. The data, a multi-factor data set with repeated measures and missing values, contained a large number of response variables. Other statistical problems presented in the analysis and interpretation of the results involved identification of useful models relative to goals and objectives (not previously stated with sufficient specificity). Contrasts of treatment means, and interactions among contrasts, were estimated and interpreted to draw inferences about specific questions of interest.

It should be noted that the graduate students associated with the experiment station statistical consulting unit contribute with good spirit in providing help to the clients we see. They deserve much credit for the quantity and quality of the work accomplished this year.

Paul Wenz analyzed data from two species of nematodes collected in the Adirondack Mountains. The purpose of the study was to discover if characteristics such as their length differed depending on the elevation from which they were collected. Also studied was whether the host tree species influenced these characteristics. Tom Loughin helped a graduate student from the Horticulture Department analyze data from an experiment on methods of extending storage time of strawberries. The treatments were a factorial combination of 2 temperatures and 9 mixtures of oxygen and carbon dioxide. Anita Hinkeldey analyzed data from a survey on the quality of corn from central Iowa grain elevators. Measurements were made on protein and oil content over a three-year period. The analysis evaluated differences among elevators and years. An unweighted means analysis was used because the numbers of samples were not equal among elevators and years.

Barbara Worth helped a graduate student from the College of Veterinary Medicine analyze data from a study of injuries to the knee joint of dog hind legs. When an injury occurs, the diagnosis of the extent of damage is always uncertain. The study was being conducted to compare three new methods and one standard method of externally assessing damage. Surgery was done on the dogs and the actual amount of damage determined so that the effectiveness of the four methods could be evaluated.

Carl Mize, Department of Forestry, hosted Tom Loughin, Karen Drinkwater, Diane Sly, Barbara Worth, and Paul Hinz on a tour of two field experiments. One experiment is located in the flood plain of the Skunk River near the Ames Waste Treatment Plant. This experiment is intended to determine the effect of sewage sludge applications on growth of hybrid poplar trees. The intent is to provide wood that can be used as fuel for the Ames electrical power station. The purpose of the second experiment was to determine the effec-

tiveness of several different types of tree plantings for reducing erosion and enhancing water quality. This experiment is located along Bear Creek on the Risdal Farm near Story City, Iowa.

Karen Drinkwater and Paul Hinz traveled with Jim Lux, Department of Agronomy, to observe a field experiment near Stratford, Iowa. The study area has been invaded by woolly cupgrass, a grass species native to East Asia and of increasing importance as a weed species in Iowa fields. The experiment was designed to test the effectiveness of 3 herbicides, 4 rates of application, and 2 incorporation methods for controlling the species. This experiment has continued for six consecutive years in the same area.

Kenneth Koehler helped a faculty member in animal science develop methods for modeling herd and sire effects on calving ease and survival. These methods used PC CARP programs for fitting logistic regression models to complex survey data. Koehler is working on the development of models for changes in immunity levels in cows during pregnancy and immediately after calving, for researchers in animal science and the National Animal Disease Center. This research may provide information for breeding cows to reduce high infection rates that occur near calving time.

Koehler is also working on models for insect egg hatch times and larval development times. Another project involves the development of models for predicting the times of dew formation and dew evaporation that will be used as part of a larger model for management of high value crops. For a study of duckling development Koehler provided assistance in fitting growth models.

▨ Center for Agricultural and Rural Development

Alicia Carriquiry consulted with the ISU Center for Agricultural and Rural Development (CARD) and the U.S. Human Nutrition Information Service on estimation of usual intake distributions, assessment of dietary status of populations, and development of appropriate software. She consulted with CARD and the Environmental Protection Agency on the use of meta-models in environmental economic research. She also advised on estimation of the concentration of pesticides in the surface and groundwater and in the air, and on modeling the fate and transport of pesticides used in agriculture.

▨ Statistical Computing Section

The Statistical Computing Section provides 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 developing 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 features a 100-megabits-per-second fiber-distributed data interface to augment the interbuilding ethernet service now available. Project Vincent™ also includes a major infusion of high-performance UNIX™-based RISC workstations.

A DEC 5000 workstation and two DEC 2100 workstations were installed in the Statistical Computing Section during the summer 1990. Seven additional workstations of various sizes have been installed in the Statistical Laboratory and the Department of Statistics during the academic year. These machines significantly increase the amount of computing support available for research in statistics. Mervyn Marasinghe, Heidi Geheb, and William J. Kennedy offered two-hour workshop sessions on Project Vincent™ to statistics faculty, staff, and graduate students in the spring.

For the purposes of consulting and provision of programming support, the Statistical Computing Section is organized into two groups, supervised by Bud Meador and Kathy Shelley. The three research assistants in Meador's group this year were Phil Iversen, Klaus Lemke, and Dan Walczak. Shelley's group consisted of Dean Lei, Rochelle Milbrath, Alice Cheng, and Diane Sly. Some of the projects on which these groups participated are the following.

Phil Iversen continued to work on the State Forest Nursery Project. This was his primary responsibility. In addition to writing programs, making modifications to the nursery's computer software, etc., that kept the nursery's day-to-day operation on an even keel, Iversen handled the logistics of computer equipment changes and upgrades. The primary benefit of the equipment changes was that they permitted access to different printers from various personal computers. Iversen was also one of the leaders in using the Project Vincent™ workstations and helped in orienting others to the software and procedures relative to the workstations.

Klaus Lemke provided service to the ISU Center for Industrial Research and Service (CIRAS), using the dBASE IV and PC/SAS* software to support its record keeping and data analysis applications. He also handled the recurring requirement of student scheduling for the College of Veterinary Medicine.

Dan Walczak handled several interesting assignments. Two of his projects were (1) developing a hydraulic conductivity SAS* program for a soil scientist and (2) preparing a SASGRAPH synopsis of faculty evaluations for a member of the Department of Industrial Education and Technology.

The programming for (1) was a rigorous process involving the conversion of a FORTRAN program to SAS*, followed by numerous additional computations and graphics applications. The program uses a sequence of formulas to compute the theoretical hydraulic conductivity of various soil samples, and then the theoretical results are compared to actual field samples. The work for (2) was a more straightforward SAS* programming application, which involved a "visual" comparison of standard 25-question student course evaluation forms rating one faculty member to those rating the next one. This was facilitated using histo-

grams in SAS*/GRAPH, with the average numerical response for a given question (on a scale from 1 to 5) appearing as one histobar. Walczak also took care of some recurring projects, such as the Iowa Corn Yield Test Report.

Consulting work done by Kathy Shelley's group included four major projects and a variety of short-term applications. The major projects were report writing and forecasting for Iowa family foster care; summary statistics and classification analysis for herbicides; report generation and graph modifications for the Iowa Small Business Development Centers (SBDC); and database management, graphics, and table generation for the Ruan Trucking Corporation. Short-term work included projects from various academic disciplines, such as education, business—transportation, animal ecology, and soybean breeding, the Parks Library, and a few projects from Iowa Methodist Hospital, Des Moines.

Dean Lei prepared a herbicide database using dBASE III and developed a design for data analysis. He created a user-friendly dBASE data entry system for entering survey information for the Midwest Transportation Institute, and then wrote several reporting programs. Lei was also involved with creating a database that will be used to analyze psychological differences between white collar criminals and a control group.

Rochelle Milbrath did extensive work involving graphics. These projects included creating a new system for the SBDC Iowa Client Activity Map, involving the integration of PC/SAS* and Harvard Graphics, testing various software for the new Computation Center film recorder, and designing graphs for nesting patterns of a specific bird species. She also worked on a physical fitness study for nurses and a statistical study demonstrating the effectiveness of using helmets while riding motorized two-wheeled vehicles. These last two projects were done for researchers at Iowa Methodist Hospital. Paul Hinz is the statistical consultant for the Iowa Methodist research.

Kenneth Koehler and Kathy Shelley are constructing a data base and developing maintenance cost models for an Iowa-based transportation company. (Also see p. 12.)

Alice Cheng made effective use of macros and report writing skills for Ruan Trucking, SBDC, and projects in the College of Education. She also helped with projects from Iowa Methodist.

Diane Sly generated reports involving foster care in Iowa for the state Department of Human Services. She developed an alternative method for forecasting foster case loads in Iowa with the assistance of Mack Shelley. The models involved have saved the State of Iowa a large amount of money through more accurate forecasts.

Several members of the section were involved in providing assistance to the university community by tuning statistical software in the Project Vincent™ workstations. In particular, SAS* needed to have many defaults changed to make the software more palatable to users. Many modifications were made to the X-Windows interface to make the software more user friendly. Similar tuning was done on the S-PLUS statis-

tical package. Work will continue in this area as more machines become available on campus.

Faculty members of the section also provided assistance on some external projects. These included the following.

V. A. Sposito, with J. Hoekstra, ISU Computation Center, conducted a large study for the center comparing the efficiency of various optimization software. These included IBM's recent release of Optimization Subroutine Library (OSL) and IBM's MPSX/370E. Both systems use the same MPS format input files. The subroutines considered in this study were OSL's primal/dual procedures and OSL's interior barrier procedure. For linear programming models with over 600 variables, OSL's simplex and interior-point methods consistently required less CPU time than MPSX/370E. Overall, the interior-point procedure proved to be the most efficient. User's Reference Memo No. 189 (see p. 33) is available at the ISU Computation Center.

In January 1991, V. A. Sposito presented several on-campus short courses discussing the use of SAS*/OR on Project Vincent™ workstations. These sessions addressed how one can convert standard MPS linear programming format files to SAS* files and how to solve such problems using SAS*'s linear programming software on DEC workstations.

A sequential linear goal programming model was developed by Sposito for the Department of Forestry to determine the optimal land allocation among agricultural and forest production activities, and the best management strategies for the nation's forest production activities, and range ecosystems under several alternative policies. This large-scaled linear programming model consisted of four goals involving national production cost, soil erosion, wildlife habitats, and certain environmental factors. The data used for certain requirements in the model were obtained with the assistance of the ISU Center for Agricultural and Rural Development (CARD).

William J. Kennedy worked with a researcher from the Iowa Department of Transportation to develop a model for predicting useful life of bridge components. A Markov chain-based predictor was central in the resulting model.

■ 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 has worked on a number of projects covering a broad range of subject areas during the past year. Ongoing projects include two longitudinal studies of rural Iowa families. The final year of data collection on a three-wave study funded by the National Institute of Mental Health has been completed. The study was designed to assess differences between farm and nonfarm adolescents as they make the transition from elementary to secondary school. Economic hardships and their possible impact upon children's coping and adjustment patterns are being evaluated. Survey Section staff completed interviews with 94 percent of the original 398 families. Both parents, a target adolescent, and a sibling were interviewed in person during each of the three years. Coding and data entry have been completed, and analysis is underway.

The second 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. During this third wave of the four-year study, section staff recontacted the original families, trained the field staff, and will complete data entry.

Two health-related studies conducted for the Department of Preventive Medicine and Environmental Health at the University of Iowa continue. The first, a study of the epidemiology of cleft lip and/or cleft palate in children, includes 300 case families and 300 control families. Mothers and fathers are being interviewed by telephone about their health and genetic histories. Information about the mothers' pregnancies and delivery experiences is also being collected. The Survey Section is conducting all interviews.

The first stage of interviewing has been completed on a project for the Institute for Agricultural Medicine and Occupational Health being funded by the National Cancer Institute. The project will attempt to evaluate the assessment methods of pesticide exposure in Iowa farmers. Staff interviewers completed interviews with 200 families and 70 spouses. An additional 50 farmers and proxy operators will be interviewed this summer after they have been observed and tested while applying pesticides. The study will evaluate differences between questionnaire data and other types of measurement and differences between proxy versus self reports on questionnaires. Section staff assisted with methodology, questionnaire design, and pretesting and were responsible for interviewer training and data collection.

The second stage of contacts was completed with a sample of 1,066 farmers who had been interviewed by telephone in 1990 about current farming practices and their attitudes toward sustainable agricultural practices. A total of 131 farmers were asked to participate in agronomic testing of their soil, crop, and weed populations on a specific corn field. Staff telephone interviewers elicited participation and collected data about each field. About 80 percent of those agreeing will be recontacted in late fall and asked to participate in a

followup personal interview. Section staff will also conduct these interviews.

Two studies with emphasis on the general economic situation in Iowa were completed for Iowa State University researchers. The first, conducted for the Iowa Department of Human Services by the ISU Department of Human Development and Family Studies, was designed to estimate a standard of need for recipients under the Iowa Aid to Families with Dependent Children program. Of the sample of 1,050 heads of households, 84 percent were interviewed by telephone regarding their income and expenditures. Section staff were responsible for all phases of the survey. The analysis combined the survey data with Consumer Expenditure Survey data and data from a survey of housing costs in Iowa.

The second study, undertaken by a professor in the Department of Textiles and Clothing, involved contacting by telephone 249 businesses that had failed during the past three years. Of the original sample, 82 percent of the businesses were eligible to be interviewed. Of these, 90 percent were interviewed by section staff.

A study of the impact of the Persian Gulf crisis on families of deployed National Guard and Reserve members is currently underway. Professors in the Department of Human Development and Family Studies are undertaking the project with funding from the National Institute of Mental Health. Telephone interviews with "at home" caretakers regarding their emotional distress were conducted prior to the return of the deployed persons. About three months after their return, both the military household members and the "at home" caretakers will be interviewed in person. A control group of guard and reserve families not experiencing deployment will also be interviewed. Survey staff assisted with the methodology and questionnaire design and are responsible for data collection, coding, and data entry.

A snowball sampling scheme is being used to conduct interviews with people involved in projects undertaken by multicommunity economic development organizations in rural Iowa. Board members and those involved in the formation of the organization are also being interviewed. The purpose of the project is to study the formation, evolution, and success of such organizations. Section staff assisted with developing study methods, field forms, and questionnaires and are conducting two stages of telephone and personal interviews with approximately 300 project participants.

Assistance in data processing and analysis was provided to the Iowa Department of Education on a study of alcohol and drug attitudes and behaviors among Iowa youth. The department collected data from a sample of public school students in grades six, eight, ten, and twelve. Data were also collected from school districts on the programs they provide for modifying drug and alcohol abuse. Marie Loughin reformatted the data sets, assisted with data editing, produced summary statistics, and will perform further analysis during the coming year.

Statistical assistance in preparing research proposals was given to a researcher at the Rural Health Center interested in studying young women who

smoke, but are thinking of quitting. Similar assistance was provided to researchers in sociology wishing to do a followup of a nutrition study carried out in 1979, an investigator from the ISU Department of Veterinary Pathology interested in studying llama producers, and faculty in Human Development and Family Studies hoping to conduct a study of family money-management practices as a followup to studies done in 1982 and 1986.

Consultation on using PC CARP for analyzing survey data was provided to a researcher from Cornell University working with data from a national nutritional survey carried out by the National Center for Health Statistics and a statistics graduate student analyzing data from a farm survey. Consultation with a member of the Internal Audits Office encompassed both a discussion of possible procedures for sampling transactions and the use of PC CARP in the analysis.

Personnel from the Department of Preventive Medicine at the University of Iowa utilized the services of the Survey Section to select a sample of counties for a statewide study of rural well water. Advice on sampling procedures was also given to investigators from the ISU Department of Textiles and Clothing for a sample of households from Ames and environs, to a graduate student in Family and Consumer Sciences Education studying home economics programs in community colleges, to a researcher in Human Development and Family Studies looking at problems of aging in Iowa, and to a student in Textiles and Clothing wishing to sample small businesses dealing in apparel and accessories.

Help with questionnaire construction was furnished to the Faculty Senate Committee on Facilities and Educational Resources, a sociology professor studying attitudes and concerns of church members, personnel in the telecommunications office surveying their customers, a Human Development and Family Studies professor assessing the qualifications of preschool applicants for a talented and gifted class at the university, the staff of a hospital evaluating cancer patients' awareness of services offered, a professor in education studying evaluation criteria used by school administrators when hiring secondary teachers, and the administrator of the Women in Science and Engineering program evaluating the effectiveness of a summer internship program for high school students.

A graduate student in English studying the relationship between business persons' evaluations of the quality of a memo and their perceptions of the sex of the memo author was given assistance in designing the sample and in analyzing the data.

A medical group associated with a hospital in southeast Iowa sought help for a study of factors related to low birth weights. Members of the Survey Section devised a sampling plan, helped write a questionnaire, and assisted in training the interviewers. The mothers of all babies born in the hospital with low birth weights are to be interviewed. As a control, a systematic sample of mothers of other babies born during the study period will be selected. Sampling systematically over time enables the investigators to select subjects at the time the birth occurs and interview the mother on the spot.

At the behest of the State Board of Regents, a survey of the Iowa State University faculty was conducted for the purpose of estimating the average number of hours worked per week during the 1990-91 academic year. The data collection is spread over the entire year, a different small sample being selected each week to report their hours worked. This is the fourth time such a survey has been done. The general procedure and the questionnaire were unchanged from the previous round. Survey Section personnel were responsible for designing and selecting the sample, collecting and processing the data, analyzing the data, and writing the summary report.

▇ Industry and Engineering Sciences

The Statistical Laboratory, the Engineering Research Institute, and joint faculty appointments in statistics and industrial and manufacturing systems engineering and in statistics and chemical engineering support statistical consultation with engineering and physical science faculty and graduate students. Consulting with industry is provided through individual contracts with the Department of Statistics and the support of the Iowa Quality Coalition.

Dean Isaacson continued to serve as the Regents' institutions representative on the board of directors of the Iowa Quality Coalition. The coalition supports one statistics graduate student at each of the three Regents' institutions. Christine Whitney was the graduate assistant at Iowa State University for a second year (see below).

Herbert T. David directed a master's thesis in the Department of Industrial and Manufacturing Systems Engineering on parametric "just-in-time" analysis of a production line.

Engineering Research Institute

Herbert T. David, Stephen B. Vardeman, and Ann Dyer provided assistance on a number of engineering research projects. For instance, they worked on a chemical engineering project for which the parameters of a mixture of Weibull-like distributions of particle sizes needed to be identified. They advised a professor of mechanical engineering on a project concerning discriminating between Weibull and log-Normal distributions as descriptors of certain material strength distributions. Advice was given to a student in materials science and engineering on fractional factorial experimentation.

Industrial Consulting

William Q. Meeker, Jr., continued to serve as a consultant to the AT&T Bell Laboratories Quality Technology Center, Holmdel, New Jersey, during summers 1990 and 1991.

Christine Whitney, representing the Iowa Quality Coalition, provided training and consultation to several companies in central and western Iowa, including Coilcraft, Associated Milk Producers, Inc., Cooper Manufacturing, WCI Laundry, and Glacier Vandervell.

Coilcraft, based in Hawarden, Iowa, is a family owned business that originated in Iowa and has expanded to include plants worldwide. Coilcraft manufactures electrical components in the form of wire-wound coils and transformers in many sizes and configurations. Whitney conducted a company-wide employee assessment that highlights employees' views and improvement opportunities at Hawarden. Following the assessment, the plant manager received training in the Deming philosophy through recommended readings and discussions with Whitney.

After this groundwork had been laid, the entire plant was organized for improvement by the hiring of a training coordinator and the development of three teams that were to receive training in the Deming philosophy and statistical process control. These teams worked on various projects in the plant to utilize the training they received. As a result, the training coordinator implemented new training in the Soldering Department, reducing the defect rate from 18-20 percent to "virtually nothing." Teams continue to work on projects and make improvements.

Associated Milk Producers, Inc., is a private label processing and packaging plant located in Mason City, Iowa, where instant nonfat dry milk is processed and packaged for major grocery chains. AMPI has received training in problem-solving techniques and concepts of continual improvement as a necessary prerequisite to statistical training. The North Iowa Area Community College was recommended as a resource for further statistical training, which many employees have now received.

Cooper Manufacturing, originally a manufacturer of lawnmowers, has been specializing in the production of gaskets and metal stampings since 1977 in Marshalltown, Iowa. This organization has approximately 72 employees. Whitney assisted in the development of two of their training courses—Quality Fundamentals and Flowcharting.

Glacier Vandervell in Atlantic, Iowa, is a producer of automobile bushings and bearings. Whitney evaluated Vandervell's training needs through interviews with top management, line supervisors, and the quality coordinator. Vandervell has requested assistance in the development of a course on design of experiments.

Whitney is currently working with Fan Steel-Wellman in Creston, Iowa, providing training to its quality teams.

Where Whitney has provided initial consulting on the industrial application of statistical methods and quality management principles, her industrial contacts have led to the involvement of other Department of Statistics graduate students and staff in several company projects. W. Robert Stephenson, William Q. Meeker, and Stephen B. Vardeman consulted with WCI Laundry on a life data analysis problem. Stephenson and Steve Wilmarth (under an assistantship supported by Maytag Company during spring semester) have worked with Maytag, Newton, Iowa, helping upgrade the company's reliability and life data analysis capabilities. Marjorie Green and Vardeman have worked with Maytag in the area of new product qualification.

▇ Social Sciences and Humanities

Carl Roberts has, as consultant for MetaText, Inc., worked closely in the development of two content analysis

computer-aids—PLCA and MetaText (the latter being currently under development). Both are programs that enable the user to encode both words and their syntactic interrelations prior to statistical analysis. They both make archival data and data from open-ended interviews more accessible to business and academic researchers.

Roberts' other consulting activities included supervision of quantitative analyses performed in dissertations and theses and *ad hoc* consulting on research by students and faculty in the social sciences.

Kenneth Koehler is involved in the analysis of data on perceptions of English pronunciation collected in a study where native English speakers rated nonnative speakers. He assisted in the development of classification models for various projects in industrial psychology, industrial education and technology, professional studies, and the College of Business Administration.

Mack Shelley provided research assistance to faculty, students, and staff in the departments of Political Science, Statistics, Human Development and Family Studies, Professional Studies in Education, Textiles and Clothing, English, Family and Consumer Sciences Education, Psychology, Economics, Community and Regional Planning, Sociology, Industrial Education and Technology, and Freshman Engineering, and the Parks Library.

The topics addressed included the incidence and severity of sexual abuse related to patterns of family interactions and to parental disciplinary practices, household financial management practices, education training, in-home pesticide use in Iowa, research productivity among English department faculty members in the Midwest, hospital facilities, agricultural production and fertilizer use in Indonesia, household food expenditures in Indonesia, demographic and attitudinal predictors of patterns of interaction between adult children and their aging parents, residents' satisfaction with student housing at ISU, parents' and children's peer influences over child sexual behavior, gender differences in word selection from a variety of prose works, a model for allocating salary increases among library faculty and staff, preparation of teachers for working with gifted students in Iowa, injuries in traffic accidents in Iowa, and career choice patterns among college students. One consultee, Gabriel Fadeyi, from Professional Studies in Education, received a fall 1990 Research Excellence Award for his dissertation work.

A variety of statistical methods were applied, including path analysis of survey data, nonparametric and loglinear analysis of contingency tables, factor analysis and reliability assessment of data on hospital facilities, analysis of variance, hierarchical regression analysis, ARIMA-based forecasting, and discriminant analysis. Advice was given at various stages of the research, from the construction of some survey instruments to analysis and interpretation of survey results. Nonsurvey data were supplied by the Iowa Department of Transportation, the Iowa Department of Human Services, public and private hospitals, the government of Indonesia, and the ISU Parks Library.

Robert Strahan assisted students and faculty from the departments of Psychology; Child Development; Industrial Education and Technology; Hotel, Restau-rant, and Institution Management; Physical Education and Leisure Studies; and Art and Design.

Among the studies involved were a meta-analysis of employee attitudes, development of a vocational interests inventory, examination of the psychological phenomenon depersonalization, behavioral analysis of children's attitudes toward their siblings, factor analysis of architectural preferences, examination of factors bearing on desire for a religiously-oriented or secularly-oriented psychological counselor, inventory of students' desire or lack of desire for AIDS-relevant information, evaluation of volleyball instruction, a national survey of attitudes of the elderly toward psychological counseling, a survey of Taiwan teachers' beliefs about how to teach in mathematics, and development of a mathematical model for technology transfer.

■ Other Consulting/Cooperation

Noel Cressie wrote a report to the Special Advisory Panel of the U.S. Department of Commerce setting forth his opinion on whether "Technical Operations Plans," published by the Bureau of the Census on April 9, 1990, and "Final Guidelines for Adjustment," published March 15, 1990, in the *Federal Register,* provide a basis for deciding whether or not to adjust the 1990 census.

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 Sallem Remadi and Bill Harter during 1990-91. Much of the work relates to investigations at the National Animal Disease Center (NADC). In the 1990-91 year, Harter carried out a re-analysis of a repeated-measure data analysis in *Applied Statistics* to obtain simpler expressions of beef weight gain in grazing experiments. Remadi is working on estimating end point titers from a single titer score based on NADC frozen sera data.

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.

Alicia Carriquiry consulted with the Uruguayan Federation of Producers and the UN Food & Agriculture Organization on the design and implementation of a national system of genetic dairy cattle evaluation. Advice was given on installation of software to carry out genetic evaluation of animals at the national level.

Kenneth Koehler and Kathy Shelley initiated a consulting arrangement with the Iowa Heart Center, in Des Moines, Iowa. They will assist in the design and analysis of studies for assessing the effectiveness of various methods for treating cardiovascular deficiencies. Current projects include the design of a new experiment to assess the effectiveness of proposed modifications to percutaneous transluminal coronary angioplasty (PTCA) and the analysis of data from a long-term study of angioplasty procedures for treating blood vessel obstructions in arms and legs.

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 College of Liberal Arts and Sciences, and the Engineering Research Institute.

Mathematical and Statistical Genetics

Project 2588 of the Iowa Agriculture and Home Economics Experiment Station supports research by Edward Pollak on mathematical and statistical genetics. In the 1990-91 year he continued research on age-structured populations. A simple way was found for calculating approximate probabilities that a partially dominant allele survives in dioecious populations when there are Poisson offspring distributions for both males and females.

He also did some work on the calculation of equilibrium probabilities of identity in state of sets of genes in finite populations that are divided into at least two subpopulations of equal size. It was assumed that there is an infinite number of possible neutral alleles. A general procedure was developed for calculating such probabilities when there are two alleles in a sample of four genes, each of which is represented twice. This leads to approximations to steady state variances of some measures of genetic identity and genetic distance.

Muhamad Sabran, working under the direction of E. Pollak, has begun research on population genetic theory for tetrapoloids that reproduce partially by self fertilization.

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 primarily assisted in preparations for the 1992 NRI. Data summaries of the 1982 and 1987 NRIs were produced to assist states in the planning and allocation of resources. The 1992 inventory is designed to esti-mate changes in resource conditions during the last five years. Sample design and selection were completed for each state. The national sample is basically a subsample of approximately 300,000 primary sampling units (PSUs) from the 330,000 PSUs used in the 1982 NRI. Stratification of the sample recognizes the geographic boundaries of county, Major Land Resource Area, and Water Resource Council Hydrologic Unit.

Two types of data are associated with the 1992 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. Data for a set of randomly sampled locations (PSUs) throughout the U.S. provide information, for example, on soil characteristics, land use, and soil erosion. The field work will consist of recording 1992 values, and verifying and updating data collected in 1982 and 1987. The 1992 NRI will employ the use of remote sensing via aerial photography in data collection, instead of on-site field visits.

Section staff assisted in preparing and evaluating training materials for use in remote sensing workshops held at the four SCS National Technical Centers. Preliminary drafts of data collection worksheets were also developed. A linkage system was developed to access soils information from soil interpretations databases for each NRI sample location.

In response to a request by the Secretary of Agriculture, study procedures were developed to estimate the loss of wetlands in the U.S. during the period 1987 to 1991. A subsample of approximately 7,800 PSUs identified as containing wetlands during the 1987 NRI was selected and sent to state SCS offices. After data are collected on these PSUs, estimates of acres in wetlands in 1991 and the change in wetland acres from 1987 to 1991 will be calculated. Procedures for calculating variance estimates will also be developed.

The SCS is cooperating with the Economic Research Service (ERS), USDA, in a study to assess the economic and environmental impact of government policies aimed at reducing agricultural sources of ground water contamination. Study areas in Indiana, Nebraska, Pennsylvania, and Washington have been selected for completion in 1991-1992. Section staff designed and selected samples of PSUs used in the 1987 NRI. These PSUs will be used to identify a sample of about 1,000 farm operators within each study area. Operators will be interviewed regarding their farming practices and chemical use, and the ERS will investigate economic models that interrelated farming activities, ground water quality, soil properties, and farm operators' decision-making processes.

Wayne Fuller initiated work on procedures to "mask" the exact geographic locations of NRI sample sites from non-SCS users of the NRI databases. Such procedures would effectively maintain the confidentiality of these locations and their associated land owners and operators, while allowing meaningful data analyses to be made.

Richard Dorsch is in charge of inventory data processing activities, assisted by Melissa Swanson, Kathie Reinertson, and Sue Verkade. Wayne Fuller

directs the work on sample design and estimation, assisted by Harold Baker and Fred Medak. Other staff members working on inventory projects during the year were Joseph Croos, Dorothy Edwards, and Marie Loughin.

Another important part of the SCS cooperative work is the storage, maintenance, and continuing development of the national soil interpretations databases. These databases are stored on the Iowa State University mainframe computer as part of the SCS cooperative soil survey program for the United States. Harvey Terpstra directs this work, assisted by Deborah Reed-Margetan, Jan Seagrave, Douglas Tschopp, Janet Schultz, Masoud Kazemi, and Todd Borchert. The data entry staff of Glenda Ashley, Vimlesh Gupta, and Karon White also contribute greatly to the data processing effort.

With the addition of 1,000 new records, the soil series interpretation database, which consists of basic soil property and interpretation information for all soil series in the nation, now contains over 33,000 records. With the addition of 250 survey areas, the soil map unit database, which consists of information for each map unit in SCS soil surveys, now contains nearly 3,000 survey areas made up of 250,000 map units. The official soil series description database, which contains a textual description of each soil series in the nation, now contains approximately 14,000 soil descriptions. The soil series classification database contains the official soil classification for over 16,000 soil series.

One of the main uses of these data is to produce computer printed tables that are published in SCS soil survey manuscripts. Downloading portions of these databases to state SCS offices has become a major effort. States in turn download data to SCS county offices. The information then becomes part of an automated system for providing detailed soils information to farmers, planners, and other users. Other current major uses include creation of a national list of hydric soils that determine highly erodible soils, and generating water quality ratings for pesticide leaching and pesticide surface runoff. These data are also distributed to researchers in the government, university, and private sectors.

A recent major programming and data processing effort has been the creation of a data file to be used in determining the eligibility of and level of payments to applicants for the Conservation Reserve Program. This project required that many data elements be reviewed and updated to insure that valid information existed for all cropland areas of the country. More and more, the soils databases are being used to meet the requirements of congressional farm legislation.

Other programming and data processing work undertaken this year included calculating the fine earth soil erosion K factor for all soils in the database, completing work on software for printing and updating soils interpretations for Unix™-based computers, generating map unit soil attribute data to be matched with digitized data for the new state general soil maps, developing an interactive program to aid SCS state offices in entering range site identification,

enhancing the existing water quality pesticide-soil rating program, assisting the SCS national staff in creating SQL queries of the Oracle databases, and providing guidance to remote SCS users.

Section staff made a number of trips in connection with resource inventory and soils database activities. Wayne Fuller and Roy Hickman traveled to Phoenix, Arizona, September 16-21 to attend a pilot course on remote sensing and applications to inventorying natural resources; to Fort Worth, Texas, November 19-20 to discuss remote sensing procedures for the 1992 NRI; and to Washington, D.C., April 2-4 to discuss sample design and data collection procedures for the 1992 NRI. Fuller also traveled to Anchorage, Alaska, August 13-17 to plan for special sample design and inventorying procedures for Alaska in the 1992 NRI; to Washington, D.C., February 5-6 to discuss data protection and confidentiality procedures for NRI data; and to Portland, Oregon, May 13-15 to attend the workshop on data collection procedures and techniques for the 1992 NRI. Hickman traveled to New Brunswick, New Jersey, January 9-11 and to Lincoln, Nebraska, February 13-15 to assist with the SCS training course on applications of remote sensing to inventorying natural resources; and to Lincoln June 3-5 to attend the workshop on data collection procedures and techniques for the 1992 NRI.

Harvey Terpstra and Deborah Reed-Margetan traveled to St. Paul, Minnesota, July 9-12 to attend the SCS National Soils Interpretations and Database Workshop, and to Lincoln, Nebraska, October 31-November 1 with Masoud Kazemi and Douglas Tschopp to discuss programming standards for SCS databases. Kazemi and Tschopp attended a course on Design Decisions put on by McDonnell-Douglas for the Soil Conservation Service in Lincoln November 25-30. Terpstra also went to Portland, Oregon, April 2-5 to attend the Western Region Soil Database Managers Workshop, and, with Kazemi, again to Lincoln May 14-15 to discuss future work on the soils databases. Kazemi traveled to Lincoln February 13-15 and June 17-19 to discuss development of the structure and programming of range site data.

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 1990-1991 year came through Joint Statistical Agreements J.S.A. 90-7 and J.S.A. 91-11. Wayne Fuller is principal investigator. Other personnel working on the project include Joseph Croos, Heon Jin Park, Todd Sanger, Rohit Deo, Margot Tollefson, and Ouhong Wang.

A study of three alternative estimators for the parameters of the autoregressive model was conducted. The three estimators are the ordinary least squares estimator, the symmetric least squares estimator, and the estimator constructed with Pearson correlations. It was demonstrated that the limiting distribution of the estimator based upon Pearson correlations is the same
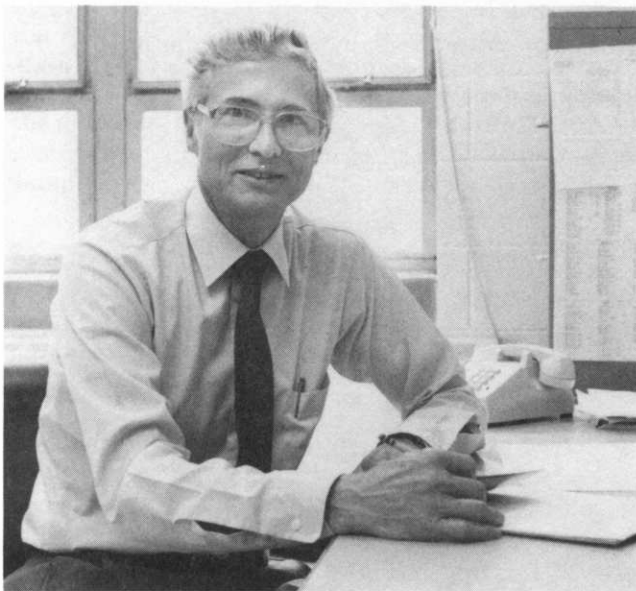
Wayne Fuller was cited for his excellence in research by the College of Liberal Arts and Sciences this spring.

as the limiting distribution of the symmetric estimator. In a Monte Carlo study, the test for a unit root against the alternative of stationarity based upon the ordinary least squares estimator displayed better properties than that based on the symmetric estimator when the model contained no intercept. If the model contains an intercept, the test based on the symmetric estimator has better power properties. The test based on Pearson correlations had properties very similar to those of the symmetric estimator.

Research was conducted on several aspects of the use of masking of microdata for disclosure avoidance. Alternative masking algorithms were developed and evaluated. The algorithms were designed for continuous and for categorical variables. The effects of data masking on nonlinear estimators and on estimates of higher order moments were studied.

Research on estimation for measurement error models concentrated on models for heterogeneous error variances and on robust procedures. Two procedures for models with heterogeneous error variances were studied. One procedure is based upon estimated weights for the observations. The second approach uses a generalized least squares approximation to the maximum likelihood method to estimate the covariance matrix of the true values. Then the estimated covariance matrix is used to estimate the parameter vector.

Robust procedures were developed for the measurement error model with an error in the equation. Conditions under which the robust estimators are consistent were obtained and an expression for the large sample variance was derived. Robust procedures are particularly difficult to design for measurement error models because large errors can occur in any of the variables.

Research was conducted on the estimation of variances for estimates constructed with data from complex surveys in which imputation has been used. Variance expressions were derived with the objective of developing formulas appropriate for routine calculations.

Wayne Fuller visited the Department of Social Statistics, University of Southampton, England, June 24 through July 10, 1991. His research activities centered on measurement error problems. Of particular interest were estimation problems associated with data collected over time in longitudinal surveys.

Estimation for Continuing Surveys

The U.S. Bureau of Labor Statistics supported research on estimation for continuing surveys. The research is directed toward estimation of employment and unemployment statistics with data from the Current Population Survey. Wayne Fuller is principal investigator. Abdoulaye Adam, Ibrahim Yansaneh, Savas Papadopoulos, and Rohit Deo worked on the project. Research has concentrated on the estimation of correlation functions for data collected from the same individuals at two points in time. Procedures for constructing least squares estimates of current level and of change were investigated. The least squares methods were compared with the current method of composite estimation used for the Current Population Survey.

Dietary Intake Estimation

Alicia Carriquiry and Wayne Fuller continued their investigations on methods of estimating usual intake distributions for selected dietary components. Others working on the project are Baiching An and Kevin Dodd. The usual intake of a dietary component for an individual is the long-run average of daily intakes for the individual. The methodology proposed consists of transforming observed daily intakes of a nutrient into normality, and then using a measurement error model and normal theory to predict usual daily intakes in normal space. An adjusted inverse transformation is then applied to the predicted usual intakes in normal space to produce a set of pseudo usual intakes in the original space. 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.

Statistical Computing

William Kennedy and Morgan Wang continued research on self-validating numerical methods and algorithms for approximating probabilities and percentiles in selected distributions. This work was funded by National Science Foundation grant DMS 8907940. The publication listed on p. 34 describes some of the results obtained thus far.

Project reports stemming from contractual work with the university Center for Agricultural and Rural Development (CARD) have been prepared on joint research by V. A. Sposito and others. These concern compromise solutions for economic-environmental decisions in agriculture (see CARD Working Paper 91-WP72, by P. G. Lakshminarayan, J. D. Atwood, Stanley Johnson, and Vince A. Sposito) and a linear program-

ming model of integrated crop, livestock, and forest production (by Joe Colletti, J. Gan, Sposito, and F. S. Hopkins).

Statistical Methods for Survival Data

Kenneth Koehler is the principal investigator for a National Cancer Institute grant project that began May 1, 1991. The 36-month grant supports the development of statistical methods for analyzing survival time and life event history times from data that contain correlated responses.

At Mayo Clinic, H. Samuel Wieand has been investigating methods for using recurrence as a surrogate endpoint for survival in colorectal cancers.

Spatial Statistics

Noel Cressie continued research in spatial prediction and inference for spatial processes, with support from a National Science Foundation grant. Modeling and methodology for space-time point processes received considerable attention. Research was initiated in multivariate spatial prediction and image analysis.

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. An empirical Bayes approach, based on REML estimation of variance-covariance parameters, was taken for prediction of adjustment factors.

Mixed-Effects Linear Models

David Harville carried out research on statistical inference about the variance components in mixed-effects linear models. He also carried out research on statistical prediction, both in the context of mixed-effects linear models and in more general contexts. His research on statistical prediction was supported by the U.S. Office of Naval Research for a five-year period that ended in September 1990.

Probability Theory and Mathematical Statistics

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.

The growth rate of the mean of the maximum of the population size in a multi-type critical branching process was shown to be logarithmic in time, thus extending the single type result.

The rates of decay for the survival probability of a slightly advantageous mutant gene were studied, and necessary and sufficient conditions for the validity of the Haldane-Ewens formula were obtained.

A central limit theorem for double arrays of Harris chains was established (jointly with C. D. Fuh, Academia Sinica, Taipei, Taiwan). Also see p. 18.

Alicia Carriquiry, who received her doctorate here and was profiled in *Stat Lab News* in 1987, is now an assistant professor with a joint appointment in the Department of Statistics and the ISU Center for Agricultural and Rural Development.

Mathematical Modeling of Dendritic Growth

Research on mathematical modeling of dendritic growth by Alicia Carriquiry, working with Wolfgang Kliemann, Department of Mathematics, and Etsuro Uemura, Department of Veterinary Anatomy, is supported through a three-year grant from the National Institutes of Health. Two unified mathematical models for dendritic growth, called the tree-pattern and tree growth branching process models, are to be developed. The quantitative features to be implemented include the geometric branching pattern of dendritic trees, the lengths and diameters of the branches, and the time development of these features. The models will be tested against observations of real dendritic trees.

Order Statistics and Nonparametric Statistics

Concomitants of order statistics, introduced as a class of statistics in David (1973), continue to find fresh applications leading to the need for additional theory. In conjunction with H. N. Nagaraja, Ohio State University, H. A. David, principal investigator under a U.S. Army Research Office contract, is investigating the asymptotic distribution of *ordered* concomitants.

Jim Robison-Cox, research assistant, is studying the behavior of order statistics in the presence of linear trend. Major computations have produced tables of means, variances, and covariances for sample sizes up

to ten in the normal case. With the help of these tables, the robustness against linear trend of various linear statistics can be readily examined.

Paul Kvam is working under the contract during the months of June and July as a postdoctoral research associate. He has new ideas for making ranked-set sampling more efficient.

■ Operating Characteristic Studies

Receiver operating characteristic (ROC) analysis, developed in statistical decision theory, is useful to engineers in "signal detection" and to psychologists in comparison of experiments. In recent years, research workers in medicine have become very concerned with the measurement of "information" in a variety of imaging systems. As a result, ROC analysis has become a very powerful tool for diagnostic research in clinical experiments. Shashikala Sukhatme has shown how nonparametric ROC analysis can be improved by using an appropriate model in case sample sizes are random.

In many clinical experiments it is clear that external factors can affect the performance diagnostic tests as these factors influence the distributions of separator variables. Sukhatme is investigating how concomitant information can be incorporated to improve ROC analysis. She is developing methods for using stratification of cases and/or controls in nonparametric ROC studies.

■ Hybrid Double Sampling Plans

Vincent Shu of Abbott Laboratories, H. T. David, and graduate student Seoung-Gon Ko have begun work on developing double sampling plans, for use in clinical trials, that combine desirable properties of both group sequential plans and Bayes procedures.

■ Sampling Strategies for DOE Waste Site Mapping

Stephan Weeks of the Ames Laboratory, Eric Bartlett of the Department of Mechanical Engineering, H. T. David, statistics graduate student Seoungmo Yoo, and nuclear engineering graduate student Taher Al-Jundi are involved in a pilot study to explore the feasibility of developing adaptive sampling strategies for efficiently mapping certain of the thousands of Department of Energy (DOE) waste sites. Such mappings are intended to identify regions of high concentration of waste materials, which must be identified before waste removal and site clean-up is undertaken. This pilot study is being funded by the Ames Laboratory, U.S. Department of Energy.

■ 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, with Steve Vardeman, Yasuo Amemiya, and graduate students Christian Garrigoux,

Todd Sanger, Mark Kreisburg, C. Joseph Lu, and Scott Vander Wiel participated in research intended to demonstrate the feasibility of incorporating nondestructive evaluation (NDE) inspectability and life cycle NDE inspection cost considerations into the engineering design process. They have been involved with a number of different tasks related to statistical aspects of this large project.

Amemiya and Kreisberg have been developing statistical methods for analyzing and extracting signals from C-scan ultrasonic NDE data. Data arising in an ultrasonic NDE inspection were analyzed, and statistical procedures were developed for detecting areas inspected for flaws in such an inspection.

Vander Wiel and Vardeman have explored methods, based on extensions of classical decision theory, of setting NDE detection thresholds. Garrigoux and Meeker have been developing methods for planning in-service inspections with the goal of minimizing the number of inspections with a constraint of the hazard function, based on a fatigue failure model. Lu and Meeker have been developing statistical methods for analyzing degradation (e.g., fatigue) data and using these data to estimate product reliability. Additional work is being done to compare and assess the tradeoffs between degradation analysis and the more traditional time-to- failure reliability data analysis.

On March 4-6, William Q. Meeker visited the Alcoa Technical Center, Alcoa, Pennsylvania, to discuss technical problems of mutual interest in the area of reliability and nondestructive evaluation.

Yasuo Amemiya and Herbert T. David, along with a graduate student, Gerri Dunnigan, continued to work on a project under the Industry/University Cooperative Research Program of the ISU Center for Nondestructive Evaluation. The project concerns the statistical analysis of nondestructive evaluation data from refinery pipe system monitoring, and the development of new inspection plans.

■ Gross Error Detection

Two first-year M.S. students—one in statistics and one in chemical engineering—are working in the area of gross error detection under the direction of D. K. Rollins. The statistics graduate student, Shonda Roelfs, with support from a university research grant, is concentrating on the bilinear constraints problem, and the engineering student is concentrating on the dynamic extension. Both students are in the process of preparing initial papers for their work, and grant proposals are being written to support their research efforts next spring.

■ Statistical Prediction

Posterior modes are often used as estimators of posterior means. If the posterior distribution is unimodal and approximately symmetric, the posterior mode is a reasonable estimator of the mean. Alicia Carriquiry and Wolfgang Kliemann, Department of Mathematics, are investigating geometric aspects of the joint posterior distribution of fixed and random effects in a mixed linear model. They have shown that these posterior distributions can be at most bimodal,

and give conditions for unimodality. An estimator "closer" to the mean than the mode is formulated for the bimodal posterior case. This research is funded in part by an innovative research grant from the Iowa Agriculture and Home Economics Experiment Station.

Research by Carriquiry and Aziz Bouzaher, Department of Economics, has begun on prediction of multiproduct yields when products are not independent. The yield of corn products in the dry milling industry is largely determined by the physical characteristics of the corn kernel. Product yields comprise a set of nonindependent response variables that, when expressed as percentages of total yield, exhibit a sum-to-one constraint. The objective of the research is to identify and estimate a set of predictive equations to enable dry millers to predict the yields of different dry milling products from knowledge about quality characteristics of corn. This project is partially funded through a one-year grant from the Iowa Corn Production Board.

Liberal Arts and Sciences

Funds from the College of Liberal Arts and Sciences (formerly Sciences and Humanities) helped support research by Krishna Athreya, Soumendra Lahiri, Derrick Rollins, John Stufken, and Shashikala Sukhatme. Some of this work has been described earlier in this section.

Krishna Athreya used Jensen's inequality to develop a measure of nondegeneracy of probability distributions on the real line. This was shown to be additive only in the quadratic case, thus strengthening the role of variance.

For one-dimensional transient diffusions, growth rates of additive functionals were studied by Athreya in joint research with A. Weerasinghe, Department of Mathematics.

Research by John Stufken concerned topics relating to the design of experiments in the 1990-91 year. These topics included optimal and efficient block designs for comparing test treatments with a control, orthogonal arrays, sampling designs with desirable second-order inclusion probabilities, and topics relating to factorial designs.

Joint work with former visiting scholar Kwang-Hun Kim (Hyosung Women's University) determines A-optimal designs for comparing test treatments with a control in incomplete blocks within the class of Group Divisible Treatment Designs. Provided that the number of test treatments and the size of the blocks are small, A-optimal or highly efficient designs are suggested for any number of blocks.

Joint work with A. Hedayat (University of Illinois at Chicago) and Kewei Pu (Baxter Healthcare Corporation) explores some new ideas to use available concepts for the construction of asymmetrical orthogonal arrays. New arrays are obtained from general methods of construction that rely heavily on the well known concepts of difference schemes and resolvability.

Further, the previously reported joint work with A. Hedayat (see the *1989-90 Statistical Laboratory Annual Report*) on the preparation of a book on orthogonal arrays has been continued, albeit that progress is slow.

Some progress was made on studying the relations between orthogonal arrays and F-squares.

A paper on combinatorial and statistical aspects of sampling plans to avoid the selection of adjacent units studies the existence and construction of such plans. It also considers the use of these plans to obtain sampling plans with second-order inclusion probabilities that are a nondecreasing function of the distance between units. The results in this paper extend those in Hedayat, Rao, and Stufken (*Journal of Statistical Planning and Inference* 19:2 (1988) 159-170).

Joint work by John Stufken and Kui-Jang Wang explores how a concept for varietal trials in incomplete blocks can be used to obtain fractional factorial designs from a given design without altering the information matrix associated with a particular model. The concept of interest is that of t-trades, and the results suggest how this concept can be used to replace possibly undesirable runs in a two-level fractional factorial design without affecting a specified information matrix of interest.

Work by John Stufken on construction of asymmetrical orthogonal arrays concentrates on innovative use of available construction techniques and extension of such techniques for symmetrical orthogonal arrays.

Soumendra Lahiri's current research focuses on two topics—asymptotic expansion and the bootstrap approximations. Research on the first topic led to an Edgeworth-type expansion for the sum of weakly dependent random vectors under weaker moment conditions. For expectations of smooth functions, validity of such expansions is established under a minimum differentiability assumption, even when the summands do not satisfy a Cramér-type condition. This settled a conjecture of Götze and Hipp (1983). Extensions of these results to certain classes of nonparametric estimators (e.g., U-statistics, M-statistics) is currently under investigation.

In the context of bootstrapping the weighted empirical process (WEP), an interesting result is proved. It has long been known that, under certain regularity conditions, the weak convergence of WEP is completely determined by the (pointwise) convergence of its covariance function. Thus, if the covariance function does not have a pointwise limit, all the classical approaches of large sample approximations fail. In comparison, it is shown that Efron bootstrap provides a valid almost sure approximation to the distribution of WEP even in such situations.

Other Research

Yasuo Amemiya conducted research on topics in multivariate analysis. For the multivariate mixed model problem, exact and asymptotic procedures were developed for testing the rank of a covariance matrix in a general model often used by animal breeders. For various nonlinear model fitting problems with measurement errors, estimation of the true values was investigated.

Mervyn Marasinghe, continuing his research in the area of statistical expert systems, with Philip Iversen has constructed a PROLOG program that determines the model representing a specified experiment. A user

specifies the factors and the nesting relationships among them, and the program computes the appropriate linear model and the corresponding sources of variation, their degrees of freedom, and expected mean squares.

Carl Roberts assembled government documents and newspaper articles from the Third Reich, with the help of a minigrant, for an analysis of Nazi media coverage of twelve political events that occurred in Germany between 1933 and 1944. This continues work begun in 1978-79 when Roberts was in Germany on a fellowship.

Mack Shelley currently is extending previous research on the social impacts of agricultural biotechnology, presidential elections and primaries, Senate elections, content analysis of newspapers in China and the U.S., and interstate migration. New research is underway on drug policy in the states and on patterns of interaction of adult children with their elderly parents.

Richard Groeneveld is currently writing a paper with colleagues at the University of California-Riverside (Barry C. Arnold and Robert J. Beaver) and William Q. Meeker on estimation of the parameters of Azzalini's skew-normal distribution.

Visiting scholar Ismail Oğuz, through interactions with David Harville, Edward Pollak, and animal science faculty, identified a Ph.D. dissertation topic on which he will work in Turkey.

Robert Strahan's research continued in areas of vocational interest measurement, statistics teaching, personality assessment, and psychometrics generally; and, with other faculty, in the area of driving characteristics of the elderly.

Frederick Lorenz is one of four Iowa State faculty members working on the Iowa Youth and Families Project, which is affiliated with the Social and Behavioral Research Center for Rural Health at ISU. The panel study of 450 rural Iowa families, which began in 1988, is designed to increase our understanding of how children, adolescents, and their families are being influenced by the social and economic changes taking place in rural areas today. The study is sponsored by several agencies. Lorenz is one of four principal investigators under one of the grants, entitled Rural Family Resilience to Economic Stress, funded by the National Institutes of Mental Health (NIMH), and an investigator under two others funded by the National Institute on Drug Abuse.

Lorenz is also one of several faculty members who helped establish a Center for Family Research in Rural Mental Health, beginning in October 1990 at Iowa State with funding from NIMH. The center is designed to promote basic mental health research and applied research in the delivery of health care. Lorenz's role as statistician in the center is to oversee data management and data analysis.

Herbert T. David and Steve Vardeman are co-principal investigators, with principal investigator Way Kuo and co-principal investigator John Jackman of the Department of Industrial and Manufacturing Systems Engineering, on a National Science Foundation grant project, Functionality and Cost Engineering. The research team is studying problems in the engineering design of mechanical assemblies, taking account of the probabilistic nature of realized geometries and its impact on product reliability and life cycle costs.

Professional Activities

Wayne Fuller was elected vice president of the American Statistical Association (ASA) for 1991-1993. He is a member of the ASA Budget and Planning Committees of the Board of Directors. He is also a member of the ASA Committee on Fellows. Fuller completed four years of service on the Institute of Mathematical Statistics Council in 1990.

W. Robert Stephenson, chair-elect of the ASA Section on Statistical Education, became chair in 1991. Stephen Vardeman, chair-elect of the Section on Physical and Engineering Sciences, became chair in 1991. William Q. Meeker, Jr., completed five years of service on the section's advisory board in 1990.

Meeker is chair of the *Technometrics* Management Committee for 1991-1993. He continues to serve as president of the Iowa chapter of the American Statistical Association.

H. A. David, vice-chair of the Committee on ASA Archives and Historical Materials, became chair in 1991. Mervyn Marasinghe is the ASA representative on the Education Committee of the American Federation of Information Processing Societies, Inc., for 1990. Herbert T. David is on the Advisory Board on the ASA/NSF/NIST Fellowship Program for 1991-1993.

Wayne Fuller attended meetings of the Statistics Canada Advisory Committee on Statistical Methods on October 15-16, 1990, and April 21-23, 1991, in Ottawa, Ontario, Canada. He became chair of the committee in April 1991.

Noel Cressie served on the American Statistical Association's Advisory Committee on Energy Statistics through 1990; the committee met in Washington, D.C., on October 25-26. He completed his term as secretary-treasurer of the Statistical Computing Section for 1990 and continues to serve as a member of the ASA Review Committee for the EPA's Ecological Monitoring and Assessment Program; the committee met in Dallas, Texas, on April 19-20, 1991, and in Denver, Colorado, on June 17-18. Cressie is a member of the Committee on Fellows for the Statistical Graphics Section of ASA for 1990-1993. He completed duties on the National Research Council panel on Spatial Statistics and Digital Image Processing in 1990.

Mack Shelley II continued to serve as the Iowa State University Official Representative to the Inter-University Consortium for Political and Social Research.

For the 1990 joint statistical meetings in August, in Anaheim, California, Wayne Fuller led an ASA luncheon roundtable discussion on Confidentiality Protection for Micro Data.

Shashikala Sukhatme chaired a session on Parametric/Nonparametric Estimation and Related Topics at the International Symposium on Nonparametric Statistics and Related Topics held in Ottawa, Ontario, Canada, May 4-9, 1991.

William Q. Meeker was vice chair of the 1990 Gordon Conference in Chemistry and Chemical Engineering, July 30-August 3, 1990, New Hampton, New Hampshire, and will chair the 1991 conference. He was organizer of an invited paper session on Recent Advances and Future Developments in Reliability Modeling and Inference, for the 218th meeting of the Institute of Mathematical Statistics, a Special Topics Meeting on Statistics in Industry, held June 9-12, 1991, in Philadelphia, Pennsylvania.

Noel Cressie presented a short course on Statistics for Spatial Data for the Dipartimento Statistico, Università degli Studi di Firenze, October 8-17, 1990, in Florence, Italy.

Wayne Fuller and Stephen Miller (now at the U.S. Bureau of Labor Statistics) gave a short course on Measurement Error Models at the 1990 International Conference on Measurement Errors in Surveys, on November 11 in Tucson, Arizona.

Paul Hinz was guest lecturer in courses in probability and in regression analysis at Luther College on November 15 and 16.

Noel Cressie presented an invited workshop on Census Undercount at the Australian Bureau of Statistics, Canberra, April 4, and two invited workshops on Analysis of Spatial Data at the Australian Bureau of Agricultural and Resource Economics, Canberra, April 12 and 23.

In September 1990, Derrick Rollins received an award for an outstanding paper and presentation at the Minority Technical Student Symposium held during the 62nd annual conference of the National Technical Association in Columbus, Ohio, July 1990. The paper, by Rollins and J. F. Davis, was entitled "Gross error detection in chemical processing plants: Test statistics, power functions, and confidence intervals." Three awards were funded by a grant from AT&T.

Morgan Wang won the first-place award for best student statistics paper presentation at the spring 1991 meeting of the Iowa chapter of the American Statistical Association held in conjunction with the joint statistics/mathematics meetings at Drake University in Des Moines in April. The title of the winning paper appears on p. 21.

For the third 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 teams were given a data set, provided by John Deere, consisting of x,y,z coordinates representing the position of a robot welding arm after each of 2,500 repetitions of a welding path. They were asked to decide if the arm was performing the task in a repeatable manner and to give an oral report to a group of managers explaining the data. Bringing home the traveling Oscar Hogg Trophy were Jingyu Liu, Rochelle Milbrath, James Robison-Cox, and Alan Zimmermann.

Editorial Activities

In 1990 William Q. Meeker, Jr., completed duties as editor of *Technometrics*; Denise Riker has served as editorial assistant. Stephen Vardeman continued as an associate editor. Meeker is continuing as a co-editor of *Selected Tables in Mathematical Statistics*.

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

Krishna Athreya is an associate editor of *Statistics & Probability Letters* and completed duties as associate editor of *Probability Theory and Related Fields* in December 1990.

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

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*.

W. Robert Stephenson is 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 15th International Biometric Conference in Budapest, Hungary, July 2-6:

Andrews, D. M. (Wittenberg University), and **H. A. DAVID:** "Nonparametric analysis of unbalanced paired-comparison or ranked data";

Lewis, Jerry W. (Marion Laboratories), and **Edward POLLAK:** "Genetic identity in subdivided populations. II. Two subpopulations of unequal size."

At the 1990 joint statistical meetings of the American Statistical Association and the Biometric Society (ENAR and WNAR) in Anaheim, California, August 6-9:

AMEMIYA, Yasuo: "Some issues in the nonlinear errors-in-variables problem";

CRESSIE, Noel: "Nonstationary spatial prediction";

GROENEVELD, Richard A.: "An influence function approach to describing the skewness of a distribution";

ISAACSON, Dean L.: "The B.S. program in statistics at Iowa State University";

Jensen, Karen L. (Alcoa Laboratories), and **William Q. MEEKER:** "ALTPLAN: A computer program for planning accelerated life tests";

KOEHLER, Kenneth J.: "On the construction of multivariate distributions with specific univariate marginal distributions";

Lin, C. H., and Shashikala SUKHATME: "Hoeffding type theorem and power comparison of two sample rank tests under Lehmann alternatives";

MARASINGHE, Mervyn G., and Paul L. Darius: "A structure-based approach for model determination in experimental designs";

MEEKER, William Q.: "Future directions in computing for survival analysis";

Nanayakkara, Nuwan (North Dakota State University): "On the robustness and Johnson's modification of the one sample t-statistic";

Nusser, Sarah M. (the Procter & Gamble Company, Miami Valley Laboratories): "Survival analysis for independent groups of correlated individuals";

Park, Heon Jin, and Wayne A. FULLER: "Alternative estimators for the parameters of the autoregressive processes";

Rathbun, Stephen L., and Noel CRESSIE: "Space-time survival point processes";

Sarkar, Sahadeb, and Wayne A. FULLER: "Nonlinear least squares estimators with differential rates of convergence";

SHELLEY, Mack C. II: "A vector autoregressive analysis of congressional voting behavior";

STEPHENSON, W. Robert, and Dennis F. Sinclair: "Why fit by eye? Removing subjectivity from normal plots";

Sullivan, Gary, and Wayne A. FULLER: "Construction of masking error for categorical variables";

Vander Wiel, S. A.: "Algorithmic statistical process control: Monitoring a closed loop process";

Vander Wiel, S. A., W. Tucker, F. Faltin, and N. Doganaksoy: "Algorithmic statistical process control: Concepts and an application";

VARDEMAN, Stephen: "Teach the other intervals early!"

Ver Hoef, Jay M., Noel A. C. CRESSIE, and David C. Glenn-Lewin: "Nested ANOVA and variogram analysis for spatial pattern";

Wang, Morgan C., and William J. KENNEDY: "Comparison of algorithms for multivariate normal probability over a rectangular region based on self-validated results from interval analysis";

WIEAND, Sam, Paul Murtaugh, Daniel Schaid, and Steve Cha: "Application of ROC curve methodology when markers are repeated measures."

At the joint spring meeting of the Biometric Society (ENAR), held jointly with the Institute of Mathematical Statistics and American Statistical Association on March 24-27 in Houston, Texas:

Beam, Craig (Duke University Medical Center): "An empirical investigation of the small sample properties of maximum likelihood ROC curve area estimates";

Nusser, Sarah M. (Procter & Gamble Miami Valley Laboratories): "Survival analysis for repeated measure event time data";

Ver Hoef, Jay: "Multivariable spatial prediction";

WIEAND, H. Sam: chair, ENAR—Contributed Papers Session on Logistic Regression and Generalized Linear Models;

"Application of ROC curve methodology when markers are repeated measures," by Paul A. Murtaugh, Wieand, and D. Schaid.

At the joint meeting of the Iowa sections of the Mathematics Association of America, the American Statistical Association, and the MATYC, April 5-6, in Des Moines, Iowa:

ATHREYA, K. B.: "On measures of nondegeneracy";

Lu, C. Joseph, and William Q. MEEKER, Jr.: "Using degradation measures to estimate a time-to-failure distribution";

STEPHENSON, W. Robert: "The statistics experience versus experiencing statistics";

Wang, Morgan C.: "Self-validating computations of probabilities for central and noncentral chi-square distributions."

At the Midwest Sociological Society annual meeting, April 13-16 in Des Moines, Iowa:

LORENZ, Frederick O., Ronald L. Simons, and Elizabeth B. Robertson: "Friends and social life: The effects of economy and life events on perceptions of social support";

LORENZ, Frederick O.: "Studying families and lives";

SHELLEY, Mack C. II: "Analysis of the Tiananmen Square crisis: A methodological approach," by Ellen B. Pirro, Shelley, Liangfu Wu, and Xia Li;

"Interaction of adult children with their parents: The effects of health, proximity, and number of siblings," by Joyce McDonough Mercier, Shi-Jiuan Wu, and Shelley;

"The corporate university: Biotechnology, entrepreneurship, and the goals of academe," by William F. Woodman, William J. Kinney, and Shelley.

At the 3rd annual Kansas State University Conference on Applied Statistics in Agriculture, April 28-30 in Manhattan, Kansas:

CARRIQUIRY, Alicia L., Aziz Bouzaher, and Lowell Hill: "Multiproduct yield prediction when products are not independent";

CARRIQUIRY, Alicia L., Helen H. Jensen, Sarah M. Nusser (the Procter & Gamble Company), and Wayne A. FULLER: "Assessment of exposure to food-borne hazards and associated data requirements";

HINZ, Paul N., and John P. Lagus: "Evaluation of four covariate types used for adjustment of spatial variability."

At the national meetings of the Institute of Management Science and the Operations Research Society of America, May 12-15 in Nashville, Tennessee:

Woo, Hoon-Shik, and H. T. DAVID: "Line balancing in deterministic lineal pull production systems";

Artiles-Leon, Noel, Herbert T. DAVID, and Howard D. Meeks: "Statistical optimal design of control charts with supplementary stopping rules."

At other locations:

ATHREYA, Krishna B.: "Reflecting Ito processes in a stochastic control problem," colloquium, Indian Statistical Institute, Bangalore, India, August 2, 1990.

"Limit theorems for the bootstrap," colloquium, Institute of Statistics, Academia Sinica, Taipei, Taiwan, August 22.

"Stochastic games in continuous time," colloquium, Institute of Mathematics, Academia Sinica, Taipei, August 23.

"On Doob's maximal inequality for submartingales," seminar, Department of Mathematics, Indiana University, November 19.

"Limit theorems for the bootstrap," colloquium, Department of Statistics, Purdue University, November 20.

"On the maximum sequence in a multitype critical branching process," seminar, Department of Statistics, University of Georgia, Athens, January 10, 1991.

"Ehrenfest model of heat exchange," colloquium, Department of Mathematics, Iowa State University, April 24.

"On the rates of decay of the survival probability of a slightly advantageous mutant gene," at the Joint IMS/AMS/SIAM Summer Research Conference in Mathematical Sciences: Stochastic Modeling and Statistical Inference for Selected Problems in Biology, Seattle, Washington, June 24.

BAILEY, Theodore: Discussion leader for a session on Use of Molecular Markers in Plant Breeding, January 7, during the 1991 Gordon Research Conference on Quantitative Genetics, in Oxnard, California.

"Old problems and under-used statistical procedures for plant scientists," seminar, Department of Agronomy, Iowa State University, February 21.

CARRIQUIRY, A. L.: "Bayesian estimation of variance components in mixed linear models," at the 4th World Congress of Genetics Applied to Livestock Production, Edinburgh, Scotland, July 26, 1990.

"Statistical evaluation of dendritic growth models," by Carriquiry, Wolfgang Kliemann, and Etsuro Uemura, at the 4th Latin American Congress on Probability and Mathematical Statistics, Mexico City, Mexico, September 26.

COX, David F.: "Comments on the experimental procedures section of the guidelines for authors, *Journal of Animal Science,*" at the 82nd annual meeting of the American Society of Animal Science, Ames, Iowa, August 3, 1990.

"What do we know, how do we know it?" for Crop Physiology Reading Circle, Iowa State University, October 11.

CRESSIE, Noel: "Space-time survival point processes: Longleaf pines in southern Georgia," by Cressie and **Stephen L. Rathbun,** at the 5th International Congress of Ecology, Yokohama, Japan, August 24.

"The origins of kriging," seminar, Dipartimento di Ingegneria Civile, Università degli Studi di Firenze, Florence, Italy, October 17.

"Small-area prediction of undercount using the general linear model," at Symposium 90, Statistics Canada, Ottawa, Ontario, Canada, October 29.

"Spatial mapping of rates," seminar, Department of Mathematics, Carleton University, Ottawa, Ontario, Canada, October 30.

"Mapping of regional variables," at the International Geographical Union Workshop, Boston, Massachusetts, November 8.

"Spatial mapping of rates," seminar, Department of Biostatistics, Harvard University, November 9.

"Smoothing regional maps using empirical Bayes predictors," seminar, Centre for Mathematics and Its Applications, Australian National University, Canberra, January 29, 1991.

"Estimating undercount in the USA," at a meeting of the Canberra Branch, Statistical Society of Australia, February 26.

"Nonstationary spatial prediction" and "Prediction and shrinkage with the general linear model," seminars, Centre for Mathematics and Its Applications, Australian National University, Canberra, April 11 and 18, respectively.

"Mapping disease incidence," at a meeting of the New South Wales Branch, Statistical Society of Australia, Sydney, May 14.

Invited workshop participant at the National Center for Geographic Information and Analysis Specialist Meeting, Initiative 7: Visualization of the Quality of Spatial Data, held in Castine, Maine, June 8-12.

DAVID, H. A.: "Concomitants of order statistics: Review and recent developments," at a Symposium on Biostatistics and Statistics in Honour of Charles W. Dunnett, at McMaster University, Hamilton, Ontario, Canada, May 29, 1991.

DAVID, Herbert T.: "Three shrinkage constructions for Pitman-closeness in the one-dimensional location case," by David and A. Shawki Salem, at the Conference on Pitman's Measure of Closeness, at the University of Texas at San Antonio, June 15, 1991.

FULLER, Wayne A.: "The analysis of masked microdata," seminar, U.S. Bureau of the Census, Washington, D.C., October 24; also seminar, Department of Biostatistics, Harvard University, February 11, 1991.

"Regression estimation in the presence of response error," at the 1990 International Conference on Measurement Errors in Surveys, Tucson, Arizona, November 12, 1990.

"Masked microdata," seminar, Department of Decision and Information Systems, Arizona State University, November 15.

"Use of masking procedures for disclosure limitation," at the Conference on Data Access through Disclosure Limitation sponsored by the Panel on Confidentiality and Data Access of the Committee on National Statistics and the Social Science Research Council, March 1, 1991.

Genalo, Toni: "Survey research," by Genalo and Dan Hoyt, seminar for the Research Information Specialists' Colloquium, Iowa State University, April 16.

HARVILLE, David A.: "Statistical inference about variance components: Current status and future directions," seminar at the National Institute of Standards and Technology, Gaithersburg, Maryland, January 18, 1991.

HINZ, P. N.: "Interpretation of multiple regression analysis," at the 82nd annual meeting of the American Society of Animal Science, Ames, Iowa, August 3, 1990.

LAHIRI, Soumendra: "On bootstrapping the studentized sample mean of lattice data," at the Department of Statistics, University of Southwestern Louisiana, November 8.

LORENZ, Frederick O.: "Measurement and methodological issues in the study of rural family processes," presented at the Rural Sociological Society meetings in Norfolk, Virginia, August 11, 1990.

"Family characteristics and adolescent self esteem," by L. B. Whitbeck, R. L. Simons, Lorenz, and R. D. Conger, at the annual meetings of the National Council on Family Relations, Seattle, Washington, November 12.

"Statistical issues in longitudinal research," seminar presented at the College of Family and Consumer Sciences' Longitudinal Research Workshop, Iowa State University, March 22, 1991.

"A family process model of economic hardship influences on adolescent adjustment," by R. D. Conger, G. H. Elder, Lorenz, R. L. Simons, and L. B. Whitbeck, in a symposium on Impact of Life Stressors on Adult Relationships and Adolescent Ad-

justment, during the 1991 biennial meeting of the Society for Research in Child Development, Seattle, Washington, April 19.

Medak, Fred: "Hierarchical testing of parametric models using the power-divergence family of test statistics," seminar, Los Alamos National Laboratory, Los Alamos, New Mexico, February 19, 1991, and California Polytechnic State University, San Luis Obispo, California, March 4.

MEEKER, William Q.: "Using degradation measures to estimate a time-to-failure distribution," by **C. Joseph Lu** and Meeker [also see Iowa meeting above], at the Reliability and Product Performance Workshop, Department of Statistics, University of Waterloo, Ontario, Canada, July 25, 1990, and at Oak Ridge National Laboratory, October 5.

"Optimum accelerated life tests with nonconstant SIGMA," by **Carol A. Meeter** (Merck and Company, Inc.) and Meeker, seminar at the Department of Statistics, University of Tennessee, October 4.

"Assessing influence in regression analysis with censored data," colloquium for Department of Statistics and Actuarial Science, University of Iowa, October 18.

"Statistical models for accelerated life test data based on reliability kinetics," by Michael J. Luvalle and Meeker at the 218th meeting of the Institute of Mathematics, a Special Topics Meeting on Statistics in Industry, June 10, 1991, in Philadelphia, Pennsylvania.

ROBERTS, Carl W.: "Polynomial trends in mobility: Applications to U.S. white males, 1952 to 1984," by Roberts and Danny Hoyt, at the American Sociological Association meeting, Washington, D.C., August 15, 1990.

"Linguistic content analysis," at the Midwest Sociological Society meeting, Des Moines, Iowa, April 12, 1991.

ROLLINS, D. K.: "Gross error detection in on-line operations: α-level tests, power functions, unbiased estimates, and confidence intervals," by Rollins and J. F. Davis, at the annual conference of the American Institute of Chemical Engineers, Chicago, Illinois, held on November 14-15, 1990.

"On-line diagnosis of process and manufacturing operations: The integration of knowledge-based, neural net and conventional numeric approaches," by J. F. Davis, P. R. Prasad, J. K. McDowell, J. R. Whiteley, K. Sravana Kumar, Rollins, D. R. Myers, and M. S. Gandikota, at the International Conference on Probabilistic Safety Assessment and Management (PSAM), Beverly Hills, California, February 5, 1991.

SACKS, Jerome M.: "Spaced plots as an operational definition of an experimental unit in field study," for a site visit to the Soil Management Research Laboratory, Morris, Minnesota, June 12, 1990.

"Remote monitoring of storage quality," for a site visit to the Red River Valley Potato Research Laboratory, East Grand Forks, Minnesota, June 13-14.

"Multidimensional scaling of subjective scales," for a site visit to the Biological Control of Insects Research Laboratory, Columbia, Missouri, September 19.

"Prevalence and transmission of pseudorabies in an isolated population of feral swine," by E. C. Pirtle, Sacks, V. F. Nettles, and E. A. Rollor, at a meeting of the North Central Branch, American Society of Microbiology, October 6, in Vermilion, South Dakota.

"Baseline levels in gnotobiotic calves and pigs," National Animal Disease Center noon seminar, in November in Ames, Iowa.

"A flow cytometric procedure for biological cloning of noncytopathic and cytopathic Bovine Viral Diarrhea viruses," by S. R. Bolin, J. F. Ridpath, and Sacks, at the 71st Conference of Research Workers in Animal Diseases, December 1990, in Chicago, Illinois.

SHELLEY, Kathleen D.: "Automating the production of graphs which use 'BY variable' processing," at the Midwest SAS Users Group Convention, Bloomington, Minnesota, September 10.

SHELLEY, Mack C. II: Invited participant in roundtable discussion on the 1990 elections, at the Iowa Conference of Political Scientists, November 3 in Des Moines.

"New alignments in American voting behavior: A three-stage least squares analysis of the 1988 presidential election," presented at the annual meeting of the Midwest Political Science Association, in Chicago, Illinois, April 18, 1991.

SKINNER, Christopher J. (University of Southampton, U.K.): "Pseudo-likelihood and quasi-likelihood estimation for complex sampling schemes," by Skinner and E. A. Molina, at the 5th International Workshop on Statistical Modelling, in Toulouse, France, held July 9-13, 1990.

"The effect of measurement error on event history analysis," by D. Holt and Skinner, at the 1990 International Conference on Measurement Errors in Surveys, Tucson, Arizona, November 14.

SPOSITO, V. A.: "Multiple goal programming applications in natural resource policy analysis," by Jay Atwood and Sposito, at the 1990 Atlantic Economic Society meetings, Williamsburg, Virginia, October 11, 1990.

SUKHATME, Shashikala: "Two sample rank tests with truncated populations," at the International Symposium on Nonparametric Statistics and Related Topics, Ottawa, Ontario, Canada, May 6, 1991.

VARDEMAN, Stephen B.: "Teaching statistics to engineers: Some observations, experiences, suggestions, and benefits," at the Michigan Conference on the Teaching and Use of Statistical Theory and Methods, October 25, 1990, in East Lansing, Michigan.

"Introductory engineering statistics at Iowa State University," at the annual conference of the American Society for Engineering Education, June 18, 1991, in New Orleans, Louisiana.

Ver Hoef, Jay: "Ecological gradients and spatial prediction," seminar, Department of Botany, Iowa State University, April 26.

WIEAND, H. Samuel: "A method for evaluating repeated measurements of monoclonal antibodies used as markers for recurrence of cancer," seminar, Department of Statistics, Harvard University, March 19, 1991.

■ Other Meetings

Edith Landin attended the annual convention of Professional Secretaries International in Salt Lake City, Utah, July 23-26, 1990.

Jauvanta Walker helped organize and conduct the annual meeting of the Iowa State Association, National League of American Pen Women, Inc., in Des Moines September 26, as secretary and state art chair.

Dean Isaacson attended the 1990 Governor's Industry Recognition Awards and Iowa Quality Recognition Awards meeting in Des Moines, October 10.

Krishna Athreya, Soumendra Lahiri, and Anand Vidyashankar attended the 12th Midwest Probability Colloquium, October 19-20, at Northwestern University.

Shashikala Sukhatme attended the Way Up VII Conference, Women of the 90s, held in Cedar Rapids, Iowa, November 8-9.

Frederick Lorenz went to Tucson, Arizona, to attend a meeting of Western Regional conference committee WRCC-64 and the International Conference on Measurement Errors in Surveys, both held on November 11-14, 1991. The meeting of WRCC-64 was to finalize an Iowa Agriculture and Home Economics Experiment Station research proposal to study the effects of questionnaire wording and context on response patterns. Dianne Anderson, Joseph Croos, Mary Genalo, and Todd Sanger also attended the measurement error conference.

Kathy Shelley went to the Iowa SAS Users Group meetings in Marshalltown, November 15, in Des Moines, February 21, 1991, and in Iowa City, May 16. She serves as liaison for the group with the SAS Institute.

William Q. Meeker participated in an Accelerated Testing Workshop sponsored by Sandia National Laboratories in Albuquerque, New Mexico, December 12-13.

Daniel Mundfrom, James Robison-Cox, and Todd Sanger attended the 1991 Winter Conference: Statistics and the Environment, held by the American Statistical Association in New Orleans, Louisiana, January 3-5, 1991.

Theodore Bailey attended the annual meeting of the North Central Regional-21 Technical Committee in Oxnard, California, January 5-6, 1991.

Herbert T. David took part in a meeting of the National Science Foundation/American Statistical Association/NIST Board February 22 in Arlington, Virginia. On March 25-28 he attended a workshop in Las Vegas, Nevada, Characterizing Heterogeneous Hazardous Wastes, sponsored by the Department of Energy/EPA.

Alicia Carriquiry attended the meetings of the Biometric Society held in Houston, Texas, on March 24-27, and the National Science Foundation Seminars on Bayesian Inference in Econometrics and Statistics held in Minneapolis, Minnesota, on April 5-6.

Dean Isaacson attended a meeting at the University of Northern Iowa April 3 on university/community college transfer articulation.

Daniel Mundfrom attended the annual conference of the American Educational Research Association in Chicago, Illinois, April 3-6.

Richard Groeneveld, Krishna Athreya, William Q. Meeker, W. Robert Stephenson, and graduate students Jingyu Liu, Rochelle Milbrath, James Robison-Cox, Morgan Wang, and Alan Zimmermann attended the American Statistical Association Iowa chapter meeting April 5 and the joint meeting of the Iowa sections of the Mathematics Association of America, the ASA, and the MATYC April 5-6 in Des Moines.

Alicia Carriquiry, David F. Cox, Paul Hinz, Marie Loughin, Jerome Sacks, and graduate students Baiching An, Jingyu Liu, Thomas Loughin, Morgan Wang, Paul Wenz, and Barbara Worth went to the 3rd Annual Kansas State University Conference on Applied Statistics in Agriculture held in Manhattan, Kansas, April 28-30.

Muhammad Tiro attended the International Symposium on Nonparametric Statistics and Related Topics held in Ottawa, Ontario, Canada, May 4-9.

Dianne Anderson and Toni Genalo attended the Field Directors and Field Technologies Conference in San Diego, California, May 12-16. Genalo was a discussion leader for an open discussion session on Sensitive Topics in Surveys.

On May 22-24, Jerome Sacks attended the 14th annual Midwest Biopharmaceutical Statistics Workshop at Ball State University. On June 4 he made a site visit to the Fruit and Vegetable Harvesting Research Laboratory in East Lansing, Michigan.

Robert Strahan attended the annual convention of the American Psychological Society in Washington, D.C., June 13-16.

Seongmo Yoo attended the Conference on Pitman's Measure of Closeness held at the University of Texas at San Antonio on June 14-15.

Derrick Rollins attended the annual meeting of the American Society for Engineering Education in New Orleans, Louisiana, June 16-19, and the National Effective Teaching Institute held there June 20-22.

Shonda Roelfs works on a poster paper on gross error detection, to be presented jointly with Derrick Rollins at a July 1991 conference.

acetates, and a handbook entitled *An Introduction to Critical Thinking and Writing in American Politics.*

▓ Published Research

AMEMIYA, Yasuo, and T. W. Anderson. Asymptotic chi-square tests for a large class of factor analysis models. *The Annals of Statistics* 18:3 (1990) 1453-1463.

Three types of asymptotic χ^2 goodness-of-fit tests derived under the normal assumption have been used widely in factor analysis. Asymptotic behavior of the test statistics is investigated here for the factor analysis model with linearly or nonlinearly restricted factor loadings under weak assumptions on the factor vector and the error vector. In particular, the limiting χ^2 result for the three tests is shown to hold for the factor vector, either fixed or random with any distribution having finite second-order moments, and for the error vector with any distribution having finite second-order moments, provided that the components of the error vector are independent, not just uncorrelated. As special cases, the result holds for exploratory and confirmatory factor analysis models and for certain nonnormal structural equation (LISREL) models.

AMEMIYA, Yasuo, T. W. Anderson, and Peter A. W. Lewis. Percentage points for a test of rank in multivariate components of variance. *Biometrika* 77:3 (1990) 637-641.

In the balanced one-way multivariate analysis of variance with random effects, the likelihood ratio criterion for testing that the rank of the covariance matrix of the effect vector is not greater than a specified number is considered. The limiting distribution of -2 times the logarithm of the criterion is the distribution of the sum of squares of the positive characteristic roots of a certain random symmetric matrix. This paper presents exact and simulated quantiles of this limiting distribution for a number of cases depending on the difference between the dimensionality and the specified rank.

AMEMIYA, Yasuo. Instrumental variable estimation of the nonlinear measurement error model. Pp. 147-156 in *Statistical Analysis of Measurement Error Models and Applications,* edited by Philip J. Brown and Wayne A. Fuller. *Contemporary Mathematics,* Vol. 112. Providence, Rhode Island: American Mathematical Society. 1990.

Estimation of the parameter in the nonlinear functional measurement error model is considered under the assumption that instrumental variables are available. The approximate bias in the ordinary instrumental variable estimator of the parameter due to the nonlinearity of the relationship is given. 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. A-

Publications

In the Statistical Laboratory preprint series, 24 titles (#90-11 to 90-34) were added during the last half of 1990 and 18 more (#91-1 to 91-18) in the first half of 1991. 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 1991.

In the listing of published work that follows, the names of authors from the ISU statistics center are in boldface type—all caps for faculty and caps and lower case letters for graduate students. When a publication is presenting work done wholly or in part at ISU but the author identified in boldface type is no longer here, present location is shown in parentheses.

▓ Books

Brown, Philip J., and **Wayne A. FULLER,** editors. *Statistical Analysis of Measurement Error Models and Applications. Contemporary Mathematics,* Vol. 112. American Mathematical Society, Providence, Rhode Island. 1990. xii + 248 pp.

This volume contains papers presented at the conference Statistical Analysis of Measurement Error Models and Applications, held June 10-16, 1989, at Humboldt State University, Arcata, California. Measurement error models describe functional relationships among variables observed subject to random errors of measurement. Examples include linear and nonlinear errors-in-variables regression models, calibration and inverse regression models, factor analysis models, latent structure models, and simultaneous equation models. The papers of this volume treat measurement error models as an area of statistical methodology.

Schmidt, Steffen W., **Mack C. SHELLEY II,** and Barbara A. Bardes. *American Government and Politics Today.* St. Paul: West, 1991-1992 edition. 1991. xxxiii + 689 pp.

This is the fourth 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 opinion poll results in the light of sampling procedures and other considerations. Results of the 1988 and 1990 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

symptotic properties of the estimators are investigated. It is shown that the two two-stage estimators do not have the asymptotic bias due to the nonlinearity.

Andrews, D. M. (Wittenberg University), and **H. A. DAVID:** Nonparametric analysis of unbalanced paired-comparison or ranked data. *Journal of the American Statistical Association* 85:412(1990) 1140-1146.

Row-sum scores widely used in balanced paired-comparison experiments are clearly unsuitable for unbalanced data. In David (*Biometrika,* 1987) a simple method for scoring objects is proposed that takes into account differences in the strength of the competition encountered by each object, as well as possible differences in object replication numbers. Statistical properties of these scores are developed here. A test for equality of the objects and related procedures are discussed. The approach is then extended to unbalanced ranked data.

Callanan, Terrance P. (Eastman Kodak Company), and **David A. HARVILLE.** Some new algorithms for computing restricted maximum likelihood estimates of variance components. *Journal of Statistical Computation and Simulation* 38 (1991) 239-259.

An earlier version of this paper was published in 1990 (under the slightly different title "Some new algorithms for computing maximum likelihood estimates of variance components") in *Computing Science and Statistics: Proceedings of the 21st Symposium on the Interface,* edited by Kenneth Berk and Linda Malone, American Statistical Association (Alexandria, Virginia). Let $\mathbf{y}$ represent an $n \times 1$ observable random vector that follows the general mixed linear model $\mathbf{y} = \mathbf{X}\beta + \mathbf{Z}_1\mathbf{s}_1 + \ldots + \mathbf{Z}_c\mathbf{s}_c + \mathbf{e}$, where β is a $p \times 1$ vector of unknown parameters, $\mathbf{s}_i$ is a $q_i \times 1$ unobservable random vector whose distribution is $MVN(\mathbf{O}, \sigma_i^2\mathbf{A}_i)$ (multivariate normal with mean vector $\mathbf{O}$ and variance-covariance matrix $\sigma_i^2\mathbf{A}_i$) $(i = 1, \ldots, c)$, and $\mathbf{e}$ is an $n \times 1$ unobservable random vector whose distribution is $MVN(\mathbf{O}, \sigma_{c+1}^2\mathbf{R})$. The problem considered is that of computing restricted maximum likelihood (REML) estimates of σ_i^2 $(i = 1, \ldots, c+1)$. In general, closed-form expressions for the REML estimates do not exist, in which case the estimate must be computed by an iterative numerical method. Before applying an iterative algorithm, it may be advisable to reparameterize, to "linearize" the likelihood equations, or to eliminate one or more of the likelihood equations (by absorption). "Linearized" versions of two common algorithms, the method of successive approximations (MSA) and the Newton-Raphson (NR) algorithm, are proposed. Numerical results suggest that these algorithms improve on the MSA and the NR algorithm and are superior to other widely used algorithms like the method of scoring and the EM algorithm.

CARRIQUIRY, A. L. Bayesian estimation of variance components in mixed linear models. Pp. 429-432 in Vol. XIII, *Proceedings of the 4th World Congress of Genetics Applied to Livestock Production,* held in Edinburgh, Scotland. 1990.

A Bayesian method for estimating variance components in a mixed linear model with two random vectors is presented. The procedure allows for the estimation of the ratio of variances and of any (monotone, differentiable) function of the ratio, such as heritability h^2. Prior information is incorporated into the process of inference in a general manner. The methodology can therefore be used for a wide range of prior beliefs, with no modifications. Point estimators of the variance ratio (or of h^2) can be obtained by numerical evaluation of one (or in some cases two) one- dimensional integral(s). The solution of the eigensystem of a certain positive semi-definite matrix simplifies computations.

CARRIQUIRY, Alicia L., Helen H. Jensen, and **Sarah M. Nusser** (the Procter & Gamble Company). Modeling acute vs. chronic human health risk from contaminants in the food. Pp. 69-87 in *The Economics of Food Safety,* J. A. Caswell, editor. Elsevier: New York. 1991.

Consumers in the United States are increasingly concerned about the food they eat. Questions of food safety have focused recently on the pesticide residues in the food. In order to accurately estimate the health risk associated with ingesting a particular pesticide in the food, it is necessary to have a reliable assessment of the exposure of the population to the residue. For pesticides with an acute adverse health effect, it is important to assess the probability of occasional exposure. However, the long-term or usual exposure is relevant for the case of residues posing a cumulative or chronic health threat. A review of exposure assessment methodology currently in use by the U.S. government is presented and critiqued. Statistical procedures for assessing exposure to food-borne hazards with potential chronic and acute health effects are described.

McComber, Diane R., Rebecca Clark, and **D. F. COX.** Consumer preference for pork loin roasts cooked to 160°F and 185°F. *Journal of the American Dietetic Association* 90:12 (1990) 1718-1719.

The purpose of the present study was to determine whether a relatively large group of untrained midwestern consumers of various ages preferred pork loin roasts cooked to 160°F or to 185°F. Of the 85 percent who did have a preference in consumer testing, 57 percent preferred pork samples cooked to 160°F, compared to 43 percent preferring samples cooked to 185°F, a statistically significant difference ($p < 0.05$). Differences among age and sex groups were not significant. Cooking losses were significantly higher in the roasts cooked to the higher internal temperature. Implications of these results and related consumer comments for consumer acceptance or nonacceptance of a lower range of suggested temperatures (down to 145°F) are pointed out.

Russell, L., **D. F. COX,** G. Larsen, K. Bodwell, and C. E. Nelson. Incidence of molds and mycotoxins in commercial animal feed mills in seven midwestern states, 1988-1989. *Journal of Animal Science* 69:1 (1991) 5-12.

The 1988 growing season in the U.S. Midwest was characterized by a severe drought. This study was undertaken to monitor the identity of the molds and mycotoxins in corn arriving at 82 commercial feed mills in seven midwestern states from July 1988 through June 1989. Samples from a composite of the grading samples taken by random sampling procedures from each incoming load of corn were also tested for their ability to resist microbiological degradation when exposed to environmentally stressful conditions. The data indicate that mold and mycotoxin contamination of mixed samples of corn is widespread, even in the midwestern Corn Belt of the U.S.

CRESSIE, Noel A. C. Weighted smoothing of estimated undercount. Pp. 301-325 in *Proceedings of Bureau of the Census 1990 Annual Research Conference.* Bureau of the Census, Washington, D.C. 1990.

Suppose the nation is divided into I small areas. Let the ith area have census count C_i and true count T_i. The undercount and the adjustment factor in the ith area are defined as $U_i = (T_i - C_i)/T_i$, and $F_i = T_i/C_i$, respectively. Regression of F or U on variables $z_1, ..., z_p$, thought to correlate highly with undercount, could be used to smooth post-enumeration-survey data (Y_i: i = 1, ..., I). The following model is examined: $Y_i = \sum_{k=1}^{p} \beta_k z_{k,i} + \epsilon_i + v_i$, where ($v_i$) are zero-mean independent sampling errors with var (v_i) = σ_i^2 known (i = 1, ..., I); and (ϵ_i) are zero-mean independent model errors, independent of (v_i), with var (ϵ_i) = τ_i^2 (i = 1, ..., I).

This paper, among other things, compares two models for (τ_i^2). The standard model is $\tau_i^2 = \tau^2$, whereas the more appropriate model is $\tau^2 = \tau_i^2/C_i$; in either case, τ^2 is an unknown parameter that must be estimated. The effects of subsequent weighting and misweighting are assessed on the PEP 3-8 series of the 1980 post-enumeration survey.

CRESSIE, Noel. Reply [to Comment on Cressie, by Grace Wahba]. *The American Statistician* 44:3, 256-258. 1990.

This note compares kriging with splines and argues that kriging is to be preferred because it adapts to the quantity and quality of dependence in spatial data.

CRESSIE, Noel. Geostatistical analysis of spatial data. Pp. 87-108 in *Spatial Statistics and Digital Image Analysis,* by the Panel on Spatial Statistics and Image Processing, National Research Council. National Academy Press, Washington, D.C. 1991.

An introductory account of the analysis of geostatistical data is given. Applications to acid rain and hydrology are featured, and simulation methods are discussed.

CRESSIE, Noel, and Aref Dajani. Empirical Bayes estimation of U.S. undercount based on artificial populations. *Journal of Official Statistics* 7:1 (1991) 57-67.

Estimators of undercount are difficult to assess and compare because true population counts are not available. Isaki et al. (1988) made the comparison by constructing an artificial population where "true" population counts were known. We show that the synthetic estimator they used is a special case of an empirical Bayes estimator of undercount, derived from a compound-distribution model for the undercount mechanism. The validity of this model, for the artificial population, can then be estimated.

Crowder, Lee Josvanger (Albuquerque, New Mexico), and **V. A. SPOSITO.** Sequential linear goal programming: Implementation via MPSX/370E. *Computers and Operations Research* 18:3 (1991) 291-296.

This note shows how one can solve linear goal programming problems using a preemptive priority structure in a very efficient manner. In particular, the entire sequence of computational steps needed can easily be incorporated in MPSX/370E's control program. The procedure does not require the user to interface a FORTRAN program to the user's MPSX/370 program as previous studies have suggested.

Siha, Samia M., and **Herbert T. DAVID.** Pull and push low-volume production systems. Pp. 99-119 in *People and Product Management in Manufacturing* (Advances in Industrial Engineering, Vol. 9), edited by Johnson A. Edosomwan. Amsterdam: Elsevier Science Publishers B.V. 1990.

A comparative study of pull and push production order systems was made. For this purpose, work stations involved in the production process were configured as a series system, and a stochastic model was developed using continuous-time Markov-process modeling. In the case of pull production, this was compatible with the Japanese "Kanban" system. It was found that pull (just-in-time demand-based) systems tend to outperform push (traditional) systems, although, with low production rates—i.e., "underpowered" systems—and small station capacities, the reverse can be true. Further study was done on the pull system to compare series and confluent production systems from the standpoint of optimal resources allocation.

Francisco, Carol A. (Syntex Laboratories), and **Wayne A. FULLER.** Quantile estimation with a complex survey design. *The Annals of Statistics* 19:1 (1991) 454-469.

Estimation of the finite population distribution function and related statistics, such as the median and interquartile range, is considered. Large-sample properties of estimators constructed from stratified cluster samples, and properties of large-sample confidence intervals, are established. The results are obtained within the context of a sequence of finite populations generated from a superpopulation.

FULLER, W. A. Simple estimators for the mean of skewed populations. *Statistica Sinica* 1:1 (1991) 137-158.

Simple estimators of the mean are developed and investigated. The Weibull is used as the distributional model for the tail of the observed distribution. No assumption is made about the left portion of the distributions. It is proven that the once-Winsorized mean is superior to the sample mean for Weibull populations with shape parameter greater than one. Estimators for the mean based upon a simple preliminary test for the exponential distribution are illustrated.

FULLER, Wayne A. Analysis of repeated surveys. *Survey Methodology* 16:2 (1990) 167-180.

Repeated surveys in which a portion of the units are observed at more than one time point and some units are not observed at some time points are of primary interest. Least squares estimation for such surveys is reviewed. Included in the discussion are estimation procedures in which existing estimates are not revised when new data become available. Also considered are techniques for the estimation of longitudinal parameters, such as gross change tables. Estimation for a repeated survey of land use conducted by the U.S. Soil Conservation Service is described. The effects of measurement error on gross change estimates is illustrated, and it is shown that survey designs constructed to enable estimation of the parameters of the measurement error process can be very efficient.

FULLER, Wayne A. Prediction of true values for the measurement error model. Pp. 41-57 in *Statistical Analysis of Measurement Error Models and Applications,* edited by Philip J. Brown and Wayne A. Fuller. *Contemporary Mathematics,* Vol. 112. American Mathematical Society, Providence, Rhode Island. 1990.

Prediction of the random true values for the multivariate measurement error model is investigated. A two-step generalized least squares method for estimating the grand mean and the covariance matrix of the true values is outlined for the model with unequal error covariance matrices. An estimator of the conditional variance of the prediction error, conditional on the observation for the unit whose true value is being predicted, is developed. Monte Carlo simulation indicates that confidence limits constructed with the estimated conditional variance provide coverage levels close to the nominal level for the model with normal errors and a relatively large variance for the true values. The coverage probability is greater than the nominal probability for models with a small variance for the true values.

FULLER, Wayne A. T. W. Anderson and autoregressive models. Pp. 1603-1605 in *The Collected Papers of T. W. Anderson: 1943-1985, Volume 2,* edited by George P. H. Styan. New York: John Wiley & Sons, Inc. 1990.

The contributions of T. W. Anderson to the estimation of the parameters of stochastic difference equations are described.

Gan, F. F. (National University of Singapore), and **K. J. KOEHLER.** Goodness-of-fit tests based on P-P probability plots. *Technometrics* 32:3 (1990) 289-303.

Alternatives to proposed probability models are assessed by displaying curves on percentage-percentage (P-P) plots to represent families of alternative models. A single curve can represent an entire family of alternatives indexed by both location and scale parameters. Two goodness-of-fit statistics, based on measures of linearity for standardized P-P plots, are proposed and simple approximations for percentage points of these statistics are presented for testing the fit of exponential, Gumbel (Weibull), and normal (lognormal) probability models with unknown parameters. Results of extensive Monte Carlo power comparisons with other goodness-of-fit tests are summarized.

Gan, F. F. (National University of Singapore), **Kenneth J. KOEHLER,** and **John C. Thompson** (Doane Marketing Research). Probability plots and distribution curves for assessing the fit of probability models. *The American Statistician* 45:1 (1991) 14-21.

Properties of P-P and Q-Q probability plots for visually assessing the fit of probability models are reviewed. It is shown how to construct families of curves for standardized P-P plots, which are useful for identifying viable alternatives to a proposed probability model. The effectiveness of such curves is illustrated with plots of real and simulated data. Percentiles of a related correlation test of goodness of fit are presented for testing the fit of either the normal, exponential, or Gumbel distribution with unknown location and scale parameters.

Gotway, Carol A. (Sandia National Laboratories), and **Noel A. C. CRESSIE.** A spatial analysis of variance applied to soil-water infiltration. *Water Resources Research* 26:11 (1990) 2695-2703.

A spatial analysis of variance uses the spatial dependence among the observations to modify the usual inference procedures associated with a statistical linear model. When spatial correlation is present, the usual tests for presence of treatment effects may no longer be valid, and erroneous conclusions may result from assuming that the usual F ratios are F distributed. This is demonstrated using a spatial analysis of soil-water infiltration data. Emphasis is placed on modeling the spatial dependence structure with geostatistical techniques, and this spatial dependence structure is then used to test hypotheses about fixed effects using a nested linear model.

GROENEVELD, Richard A. Ranking teams in a league with two divisions of t teams. *The American Statistician* 44:4 (1990) 277-281.

A league with an equal number of teams in each of two divisions is considered. Each team plays every other in its division g_1 times and every team in the other division g_2 times. Based on the numbers of wins and losses in games between each pair of teams, several methods of ranking all of the teams are discussed and compared. A nonparametric ranking method based on the numbers of iterated wins and losses of each team is shown to have suitable theoretical properties. Analysis of National League baseball data (1973-88) suggests that this method performs well in relation to ranking based on the classic Bradley-Terry parametric procedure. The nonparametric ranking method has the advantage of ease of computation and simplicity of explanation.

GROENEVELD, Richard A. An influence function approach to describing the skewness of a distribution. *The American Statistician* 45:2 (1991) 97-102.

Skewness, like kurtosis, is a qualitative property of a distribution. A comparison of several measures of skewness of univariate distributions is carried out. Hampel's influence function is used to clarify the differences and similarities among these measures. A general concept of skewness as a location- and scale-free deformation of the probability mass of a symmetric distribution emerges. Positive skewness can be thought of as resulting from movement of mass to the right of the median from the center to the right tail of the distribution, together with movement of mass to the left of the median from the left tail to the center of the distribution.

HARVILLE, David A., and Terrance P. CALLANAN (Eastman Kodak Company). Computational aspects of likelihood-based inference for variance components. Pp. 136-176 in *Advances in Statistical Methods for Genetic Improvement of Livestock,* edited by Daniel Gianola and Keith Hammond. Springer-Verlag (Heidelberg). 1990.

In this paper, iterative algorithms for computing restricted maximum likelihood (REML) estimates of variance components are discussed in the context of a possibly unbalanced, mixed linear model that contains a single set of m random effects. The coverage includes the Newton-Raphson algorithm, the method of scoring, the EM algorithm, and the method of successive approximations.

Before applying these various algorithms, it may be advisable to reparameterize, to "linearize" the likelihood equations, or to eliminate one of the likelihood equations (by absorption). The computations required to implement the algorithms can sometimes be reduced by diagonalizing or tridiagonalizing a certain m × m matrix. The computations required to obtain likelihood-based confidence intervals are similar in nature to those encountered in REML estimation, but are more extensive.

HARVILLE, David A. BLUP (Best Linear Unbiased Prediction) and beyond. Pp. 239-276 in *Advances in Statistical Methods for Genetic Improvement of Livestock,* edited by Daniel Gianola and Keith Hammond. Springer-Verlag (Heidelberg). 1990.

The problem considered is that of predicting the value of an unobservable random variable w from the value of an observable random vector **y.** This problem is considered under each of four states of knowledge about the joint distribution of w and **y,** ranging from complete knowledge to "no" knowledge. Point predictors, estimators of the mean squared error of prediction, and interval predictors are presented for each case. Both frequentist and Bayesian approaches are discussed, and relationships between the two are pointed out. Specifics are given for the prediction of a linear combination of the fixed and random effects in a mixed linear model. The results are illustrated by applying them to some animal breeding data.

HARVILLE, David A.: Comment on "That BLUP is a good thing: The estimation of random effects," by G. K. Robinson. *Statistical Science* 6:1 (1991) 35-39.

KEMPTHORNE, Oscar. Discussion of paper by C. B. Begg, "On inferences from Wei's biased coin design for clinical trials." *Biometrika* 77:3 (1990) 481-483.

KOEHLER, Kenneth J., and F. F. Gan (National University of Singapore). Chi-squared goodness-of-fit tests: Cell selection and power. *Communications in Statistics—Simulation* 19:4 (1990) 1265-1278.

To use the Pearson chi-squared statistic to test the fit of a continuous distribution, it is necessary to partition the support of the distribution into k cells. A common practice is to partition the support into cells with equal probabilities. In that case, the power of the chi-squared test may vary substantially with the value of k. The effects of different values of k are investigated with a Monte Carlo power study of goodness-of-fit tests for distributions where location and scale parameters are estimated from the observed data. Allowing for the best choices of k, the Pearson and log-likelihood ratio chi-squared tests are shown to have similar maximum power for wide ranges of alternatives, but this can be substantially less than the power of other well-known goodness-of-fit tests.

Wilson, Jeffrey R., and **Kenneth J. KOEHLER.** Hierarchical models for cross-classified overdispersed multinomial data. *Journal of Business & Economic Statistics* 9:1 (1991) 103-110.

When a vector of sample proportions is not obtained through a simple random sampling, the covariance matrix for the sample vector can differ substantially from the one corresponding to the multinomial model (Wilson 1989). For example, clustering effects of subject effects in repeated-measure experiments can cause the variance of the observed proportions to be much larger than variances under the multinomial model. The phenomenon is generally referred to as overdispersion.

Tallis (1962) proposed a model for identically distributed multinomials with a common measure of correlation and referred to it as the generalized multinomial model. His model is extended in this article to account for overdispersion by allowing the vectors of proportions to vary according to a Dirichlet distribution. The generalized Dirichlet-multinomial model allows for a second order of pairwise correlation among units, a type of assumption found reasonable in some biological data (Kupper and Haseman 1978) and introduced here to business data. An alternative derivation allowing for two kinds of variation is also considered. Asymptotic normal properties of parameter estimators are used to construct Wald statistics for testing hypotheses. The methods are illustrated with applications to performance evaluation monthly data and an integrated circuit yield analysis.

LAHIRI, Soumendra. Second order optimality of stationary bootstrap. *Statistics & Probability Letters* 11:4 (1990) 342-345.

This paper proves the second order correctness of the stationary bootstrap procedure for normalized, multivariate sample mean of weakly dependent observations. Similar results are shown to hold for more general vector valued statistics based on sample means.

Lin, Tsung-Hua (Sandoz Pharmaceuticals), and **David A. HARVILLE.** Some alternatives to Wald's confidence interval and test. *Journal of the American Statistical Association* 86:413 (1991) 179-187.

The problem considered is that of inference for the variance ratio $\lambda = \sigma_s^2/\sigma_c^2$ in mixed linear models of the form $\mathbf{y} = \mathbf{X}\beta + \mathbf{Z}\mathbf{s} + \mathbf{e}$, where β is a column vector of unknown parameters and $\mathbf{s}$ and $\mathbf{e}$ are statistically independent, multivariate-normal random vectors, with $E(\mathbf{s}) = \mathbf{O}$, $\text{var}(\mathbf{s}) = \sigma_s^2\mathbf{I}$, $E(\mathbf{e}) = \mathbf{O}$, and $\text{var}(\mathbf{e}) = \sigma_e^2\mathbf{I}$. The case where there is a known upper bound on λ is emphasized. The $100(1-\alpha)\%$ confidence sets, corresponding to the following two-sided tests of the null hypothesis H_0: $\lambda = \lambda_0$, are discussed and compared: (1) a size-α Wald's test and (2) the test that rejects H_0 whenever H_0 is rejected by the most-powerful size-α_1 invariant test of H_0 versus the alternative $\lambda = \lambda_u^*$ or by the most-powerful size-α_2 invariant test of H_0 versus the alternative $\lambda = \lambda_\ell^*$ ($\alpha_1 + \alpha_2 = \alpha$, $\lambda_\ell^* < \lambda_0 < \lambda_u^*$). If λ_u^* and λ_ℓ^* are close to λ_0, the latter test is essentially equivalent to a two-sided version of the locally-most-powerful invariant test.

LORENZ, Frederick O., Rand D. Conger, Ronald L. Simons, Les B. Whitbeck, and Glen H. Elder, Jr. Economic pressure and marital quality: An illustration of the method variance problem in the causal modeling of family processes. *Journal of Marriage and the Family* 53:2 (1991) 375-388.

A sample of 76 white, middle-class couples from a rural midwestern county was used to examine the effects of method variance on models linking family economic pressure, marital quality, and expressions of hostility and warmth. Reports of hostility and warmth were obtained from three sources: self-report, spouse's report, and observer ratings from videotapes of family interactions. Using observer reports of hostility and warmth yielded results consistent with previous literature linking economic pressure to marital quality indirectly through interactional processes such as hostility. When the models were based on information obtained from self-reports or spouses' reports, however, it was difficult empirically to separate the interactional processes of hostility and warmth from the distinct concept of marital quality.

Conger, Rand D., Glen H. Elder, Jr., **Frederick O. LORENZ,** Katherine J. Conger, Ronald L. Simons, Les B. Whitbeck, Shirley Huck, and Janet Melby. Linking economic hardship to marital quality and instability. *Journal of Marriage and the Family* 52:3 (1990) 643-656.

A series of analyses, utilizing a sample of 76 white, middle-class couples from a rural midwestern county, supported two propositions: (a) the negative impact of economic hardship on a spouse's marital quality (happiness/satisfaction) or marital instability (thoughts or actions related to divorce) is in part a function of its influence on the affective quality of marital interactions, and (b) this process is particularly applicable to the hostile, irritable response of men to financial difficulties. Economic pressures had an indirect association with married couples' evaluation of the marriage by promoting hostility in marital interactions and curtailing the warm and supportive behaviors spouses express toward one another. The hypothesized process was most pronounced for husbands, whose behavior was more strongly associated than wives' with economic problems. Findings from the study are consistent with previous research that identifies negative affect as a principal behavioral correlate of marital distress; however, the results also suggest that more research needs to be done on the role of warmth and supportiveness in promoting marital quality.

Varland, Daniel E., Erwin E. Klaas, and **Thomas M. Loughin.** Development of foraging behavior in the American kestrel. *Journal of Raptor Research* 25:1 (1991) 9-17.

We observed the development of foraging behavior after nest departure in 12 sibling groups of American kestrels (*Falco sparverius*). Perch resting decreased whereas perch hunting, eating self-captured prey, and flying increased over the five-week period that young were observed. Kestrels used perch hunting more than other types of hunting and fed exclusively on invertebrates, primarily grasshoppers. We observed social hunting among siblings and families, and also among unrelated kestrels. Social hunting occurred during both perch hunting and ground hunting.

Weston, Susan A., and **William Q. MEEKER, Jr.** Coverage probabilities of nonparametric simultaneous confidence bands for a survival function. *Journal of Statistical Computation and Simulation* 38:1-4 (1991) 83-97.

Simultaneous confidence bands provide a useful adjunct to the popular Kaplan-Meier product limit estimator for a survival function, particularly when results are displayed graphically. They allow an assessment of the magnitude of sampling errors and provide a graphical view of a formal goodness-of-fit test. In this paper we evaluate a modified version of Nair's (1981) simultaneous confidence bands. The modification is based on a logistic transformation of the Kaplan-Meier estimator. We show that the modified bands have some important practical advantages.

Nanayakkara, Nuwan (North Dakota State University), and **Noel CRESSIE.** Robustness to unequal scale and other departures from the classical linear model. Pp. 65-113 in *Directions in Robust Statistics and Diagnostics, Part II,* edited by Werner Stahel and Sanford Weisberg. IMA Volumes in Mathematics and Its Applications, Vol. 34. Springer-Verlag, New York. 1991.

Consider the usual linear model with regression coefficients ß, but possibly heteroskedastic errors. A brief review of the literature regarding inference on ß is discussed. The one-sample, two-sample, and simple-linear regression problems are considered in detail and heteroskedasticity-robust procedures are presented. Robustness to other departures is also considered briefly.

Nanayakkara, Nuwan (North Dakota State University), and **Noel CRESSIE.** Combining two unbiased estimators of a common mean of two normal populations. *Australian Journal of Statistics* 33:1 (1991) 43-56.

Consider estimating the common mean μ of two normal populations. Let $(\bar{X}_1, S_1^2)$ and $(\bar{X}_2, S_2^2)$ be the means and variances of two independent samples obtained from these populations. We give sufficient conditions for the choices of α_1 and α_2 in the unbiased estimator

$$\hat{\mu}\,(r) = \left(\frac{\alpha_1}{S_1^r}\bar{X}_1 + \frac{\alpha_2}{S_2^r}\bar{X}_2 \right) \Big/ \left(\frac{\alpha_1}{S_1^r} + \frac{\alpha_2}{S_2^r} \right)(r > 0),$$

to yield a uniformly better estimator than either $\bar{X}_1$ or $\bar{X}_2$. Many authors have given necessary and sufficient conditions for the choices of α_1 and α_2 in the special case $r = 2$. We present an upper bound for the ratio of var $(\hat{\mu}^{(r)})$ to the UMVUE for this special case using a Kantorovich inequality.

Nusser, Sarah M. (the Procter & Gamble Company), **Alicia L. CARRIQUIRY,** Helen H. Jensen, and **Wayne A. FULLER.** A transformation approach to estimating usual intake distributions. Pp. 120-132 in *Applied Statistics in Agriculture 1990—* Proceedings of the 1990 Kansas State University Conference on Applied Statistics in Agriculture, held in Manhattan, Kansas, April 29-May 1, 1991.

Design of effective food and nutrition policies, efficient allocation of resources, and more precise targeting of food programs require good estimates of the percentage of the population with deficient, or excess, nutrient or other food component intake. An individual's mean daily intake of the dietary component is a good estimate of the individual's dietary status. However, to evaluate dietary adequacy of a population it is necessary to obtain an estimate of the distribution of usual intakes. Often, the distribution of usual intakes is estimated from the distribution of mean daily intakes. Two problems arise. First, distributions of usual intakes for most nutrients are skewed. Second, the variance of the distribution of mean daily intakes is larger than the variance of the true usual intake distribution, due to within-individual variability of daily intakes. We describe a method for estimating usual intake distributions that does not assume normality, and that takes into account the within-individual variation in daily intake. The method relies on appropriate transformation of the dietary data from the original space into normal space.

POLLAK, E. The effective population size of an age-structured population with a sex-linked locus. *Mathematical Biosciences* 101:1 (1990) 121-130.

Let a population have the same age distribution and age-specific sex ratios at times, 0,1,2,.... Expressions can then be derived for the fixation probabilities of a neutral allele if it first appears in one newborn male or in one newborn female. This leads to a formula for the effective population size, which is the same as for a population with discrete generations having the same means, variances, and covariances of male and female progeny during a lifetime and the same number of individuals entering the population per generation.

ROBERTS, Carl W. Linguistic content analysis. Pp. 283-309 in *Verstehen and Pragmatism: Essays in Interpretive Sociology,* edited by Horst J. Helle. Frankfurt a.M.: Peter Lang. 1991.

This chapter introduces linguistic content analysis (LCA) as a technique for quantifying texts and transcripts. By constraining the researcher to classify grammatical clauses among four ideal types, the technique focuses interpretations of clauses on the syntactic relations among the clauses' component words. The classification into clause types requires the researcher's subjective understanding of a clause within the written or spoken context in which it appeared. Yet, since the method has high inter-rater agreement, it is not open to charges of impressionistic (or subjectivist) lack-of-rigor. After a type is chosen for a clause, the researcher encodes the clause's words and word-relations according to the syntax of the clause type. By encoding words' syntactic interrelations, the method improves on current, more positivistic word-count methods of analyzing texts and transcripts. Once encoded as an LCA data matrix, rigorous statistical analyses can be performed on data normally thought of as qualitative in nature.

ROLLINS, Derrick K., and Kent S. Knaebel. Applicability of Cullinan's equation for liquid binary

diffusivities. *AIChE [American Institute of Chemical Engineers] Journal* 37:3 (1991) 470-474.

The purpose of this paper is to examine the validity of the equations developed by Cullinan (1985) for calculating mutual diffusion coefficients (D_{12}) in binary liquid solutions. They were originally presented without any comparisons to actual data so that their applicability was unclear. The range of mixtures considered spans from those with small deviations from Raoult's law to those having rather large deviations.

Richard, J. L., W. M. Peden, and **J. M. SACKS.** Effects of adjuvants-augmented germling vaccines in turkey poults challenged with *Aspergillus fumigatus*. *Avian Diseases* 35 (1991) 93-99.

Turkey poults were randomly assigned to each of 10 vaccines and vaccinated at one and two weeks of age, and their immunity was challenged by sublethal exposure to aerosols of *Aspergillus fumigatus* conidia at one month of age. The vaccines represented combinations of two different germling preparations of *A. fumigatus* NADC 0073 and three adjuvants. Additional poults were used as unvaccinated controls and exposure controls. Fewer turkeys in the groups given vaccines prepared from germlings grown on Dorset's and Henley's medium (D&H) had organisms in lung tissue at two weeks after challenge exposure as compared with those vaccinated with germling grown on neopeptone dialysate (Neo). *Pasteurella multocida* lipopolysaccharide appeared to be the most efficacious of the adjuvants in the D&H vaccine group. The differences in lung lesions were more marked at two weeks than at eight weeks after challenge exposure. Based on statistical analysis of hematology data using a t-test, the only significant difference among other parameters in the vaccinated turkeys was lower heterophil counts in poults given D&H-prepared vaccines than in unvaccinated controls.

Woods, R. D., E. C. Pirtle, **J. M. SACKS,** and E. P. J. Gibbs. Serologic survey for transmissable gastroenteritus virus neutralizing antibodies in selected feral and domestic swine in the southern United States. *Journal of Wildlife Diseases* 26:3 (1990) 420-422.

This report presents results of a survey conducted on sera collected from feral swine in Texas, Florida, and Georgia and domestic swine in Florida. Serum samples were assayed by plaque reduction for their virus neutralizing (VN) antibodies against the porcine transmissible gastroenteritus (TGE) virus. In addition, selected feral swine were experimentally infected and examined for seroconversion. Results indicate feral swine are not a significant reservoir for TGE virus in southern states, but are capable of becoming infected and developing VN antibodies against TGE.

SHELLEY, Mack C. II. The states and biotechnology: Interests, strategies, and dimensions. *Politics and the Life Sciences* 9:2 (1991) 240-244.

This article addresses a conceptual model, developed by Portz and Eisinger, of state government policy regarding biotechnology and economic development. Various aspects of decision making and policy consequences related to molecular biology are discussed.

SHELLEY, Mack C. II, and Hwarng-du Hwang. The mass media and public opinion polls in the 1988 presidential election: Trends, accuracy, consistency, and events. *American Politics Quarterly* 19:1 (1991) 59-79.

The authors examine the results of 48 national public opinion polls measuring support for George Bush and Michael Dukakis throughout the 1988 presidential campaign conducted or reported by five major media polling organizations. Polling trends are discussed, and the consistency of estimates across polls is assessed, across seven distinct time periods defined by key events during the 1988 election year, while accuracy is assessed by comparing final pre-election polls against election results. Time series transfer function methods are employed to assess the short-term and long-term effects of the two major national party conventions, the two Bush-Dukakis debates, and the Quayle-Bentsen debate on candidate support. Statistically significant positive effects on Bush support are obtained for the Republican convention and for the second presidential debate, while support for Dukakis was affected significantly, and in opposite directions, by the two party conventions. The results are discussed in the context of recent research conducted by Crespi and others.

SHELLEY, Mack C. II, William F. Woodman, Brian J. Reichel, and William Kinney. "State legislators and economic development: University-industry relationships and the role of government in biotechnology. *Policy Studies Review* 9:3 (1990) 455-470.

This article examines relationships among business, legislative, and academic actors in economic development policy-making in the State of Iowa. The authors find two major dimensions underlying these relationships, one addressing cooperation and the other emphasizing the barriers to cooperative research. Path analysis is employed to test models regarding the potential for cooperative undertakings for economic development.

SHELLEY, Mack C. II, William F. Woodman, Brian J. Reichel, and Paul Lasley. Economic development and public policy: What is the role for biotechnology? Pp. 181-198 in *Biotechnology: Assessing Social Impacts and Policy Implications,* edited by David J. Webber. Greenwood Press, Westport, Connecticut. 1990.

This book chapter outlines general patterns of thought regarding economic development strategies pursued by state and local governments. The discussion then turns to an in-depth analysis of the State of Iowa's commitment to fund research and development activities in biotechnology. The analysis focuses upon attitudes toward university-industry cooperation through research parks, using results from statewide, local, and national surveys.

SPOSITO, V. A. Using OSL at Iowa State University. *URM 189,* Iowa State University Computation Center. 1990. 4 pp.

This is a Computation Center User's Reference Manual on how to use IBM's Optimization Subroutine Library (OSL).

STEPHENSON, W. Robert. A study of student reaction to the use of Minitab in an introductory statistics course. *The American Statistician* 44:3 (1990) 231-235.

Traditionally, the introductory statistics course, Principles of Statistics (STAT 101), at Iowa State University has been taught without reference to a statistical analysis computing package. Although important for the implementation of statistical techniques, a computer component has been perceived by instructors to take time away from the coverage of statistical topics. To gauge students' reactions to the usefulness of a statistical computing package, an experiment was conducted during the fall term of 1986. Volunteers from a STAT 101 class were randomly assigned to either a control group or a computer use group. Both groups filled out questionnaires at the beginning and end of the semester. During the semester, the computer use group had access to and instruction in the use of Minitab. That instruction was tied to homework and laboratory assignments for the course. This article presents results of the experiment. On the basis of the responses to the questionnaires, the value of a statistical computing package as a pedagogical tool is examined. Recommendations for the use of a statistical computing package in a large introductory statistics course are made.

STEPHENSON, W. Robert. A computer program for the quick and easy analysis of unreplicated factorials. *Journal of Quality Technology* 23:1 (1991) 63-67.

Lenth (1989) proposes a quick and easy method for the analysis of unreplicated factorial and fractional factorial experiments. This article presents a FORTRAN computer program that uses Lenth's method to produce the simple graph, similar to the analysis-of-means, for determining the importance of the various effects (contrasts).

STEPHENSON, W. Robert. Mu Sigma Rho: Supporting the statistical profession. *Stats* No. 5 (1991) 22.

The purpose of Mu Sigma Rho and the society's role on the national level are described. In particular, the society's efforts to encourage participation in professional statistical societies and associations in 1990 and 1991 are discussed.

STUFKEN, John. Discussion of the paper: "The non-orthogonal design of experiments," by R. Mead. *Journal of the Royal Statistical Society,* Series A, 153:Part 2 (1990) 195.

STUFKEN, John. Some families of optimal and efficient repeated measurements designs. *Journal of Statistical Planning and Inference* 27:1 (1991) 75-83.

Conditions that ensure simple information matrices for the estimation of direct and residual treatment effects under an additive, homoskedastic model are given. Examples of designs that satisfy these conditions are presented. For the number of periods not exceeding the number of treatments, designs that satisfy the conditions are derived from orthogonal arrays of index unity. Their efficiency is considered and some of these, as well as some other designs, are shown to be universally optimal over certain subclasses of designs.

STUFKEN, John. On group divisible treatment designs for comparing test treatments with a standard treatment in blocks of size 3. *Journal of Statistical Planning and Inference* 28:2 (1991) 205-221.

When comparing v test treatments with a standard treatment in incomplete blocks of size k, two classes of designs that are useful are the so-called balanced treatment incomplete block designs and the group divisible treatment designs. The latter class of designs includes the former, but the design construction problem has, except for some scattered results, only received attention for the balanced treatment incomplete block designs. This paper provides, in some sense, a complete solution for the construction of group divisible treatment designs for k = 3 and v = 4 or 6, two cases that are among those of most practical interest.

Sung, N. K. (Ewha Womens University). A generalized Cramér-Rao analogue for median-unbiased estimators. *Journal of Multivariate Analysis* 32:2 (1990) 204-212.

An analogue of the Cramér-Rao inequality for median-unbiased estimators given by Sung, Stangenhaus, and David [Preprint Series 88-29, Department of Statistics, Iowa State University] is extended to the case of multivariate observations with vector-valued parameter. The resulting inequality is then compared to the generalized Cramér-Rao inequality.

Sung, N. K. (Ewha Womens University), G. Stangenhaus, and **H. T. DAVID.** A Cramér-Rao analogue for median-unbiased estimators. *Trabajos de Estadistica* 5:2 (1990) 83-94.

Adopting a measure of dispersion proposed by Alamo [1964, *Trabajos de Estadistica* 15, 93-102], and extending the analysis in Stangenhaus [1977, unpublished Ph.D. dissertation, Iowa State University] and Stangenhaus and David [1978, unpublished paper, Department of Statistics, Iowa State University], an analogue of the classical Cramér-Rao lower bound for median-unbiased estimators is developed for absolutely continuous distributions with a single parameter, in which mean-unbiasedness, the Fisher information, and the variance are replaced by median-unbiasedness, the first absolute moment of the sample score, and the reciprocal of twice the median-unbiased estimator's

density height evaluated at its median point. We exhibit location-parameter and scale-parameter families for which there exist median-unbiased estimators meeting the bound. We also give an analogue of the Chapman-Robbins inequality that is free from regularity conditions.

Takahashi, Hiroshi, Lauren L. Christian, Max F. Rothschild, **David A. HARVILLE,** and Takashige Sugimoto. Estimates of inbreeding depression of growth and backfat of Duroc pigs. *Animal Science and Technology* 62:4 (1991) 323-329.

Estimates of inbreeding depression on age in days at 105 kg (D105) and average backfat thickness (ABF) in Duroc pigs were obtained by using a single trait animal model. The animal model used for the analysis included the fixed effects of birth-year-month (BYM), sex of the pig, parity of the dam (gilt vs. sow, MAT), and a partial linear regression coefficient on F of the pig. Random effects were litter within BYM and MAT and the additive genetic effect (breeding value) of pigs within litter. The average F value was .013 ± .033, with a range of from zero to 0.25. The estimates of the effects of inbreeding per 10 percent increase in F were +1.47 days for D105 and -0.17 mm for ABF. The effect of inbreeding was significant (P<.05) for D105 but not for ABF.

Vander Wiel, Scott A., and **William Q. MEEKER.** Accuracy of approx[imate] confidence bounds using censored Weibull regression data from accelerated life tests. *IEEE Transactions on Reliability* 39:3 (1990) 346-351.

Censored data arise from most accelerated life tests. Thus special statistical inference methods like maximum likelihood estimation and large-sample approximate confidence bounds must be used. The most common method to set confidence bounds for the parameters, distribution percentiles, etc., is to use the large-sample normal distribution of the maximum likelihood estimates. The intervals are easy to compute and are available from most computer programs that analyze censored data. The approximations are crude, however, when there are only a few failures (say less than 50). An alternative method is to set confidence bounds based on likelihood ratio tests. For typical accelerated life tests, however, likelihood-ratio based confidence intervals are better than those based on asymptotic normal theory. Likelihood-ratio based confidence intervals do require more computation than do intervals based on the asymptotic normality of the maximum likelihood estimators.

Wang, Morgan, and **William J. KENNEDY.** Comparison of algorithms for bivariate normal probability over a rectangle based on self-validated results from interval analysis. *Journal of Statistical Computation and Simulation* 37:1+2 (1990) 13-25.

Comparison of algorithms for computing probabilities and percentiles is often carried out in an effort to identify the best algorithm for various applications.

One requirement when conducting comparative studies is some useable source of "satisfactory approximations to correct answers" to use as a basis when making accuracy comparisons. This paper reports success in applying elements of interval analysis to obtain a self-validating computational method for bivariate normal probabilities. Results from applying this method can be used to provide a basis for accuracy studies of algorithms for bivariate normal probabilities. A study to compare several methods for computing probabilities over rectangles for this probability distribution, using the self-validated base values, was carried out. The paper reports a choice of best method.

Schaid, Daniel J., **Sam WIEAND,** and Terry M. Therneau. Optimal two-stage screening designs for survival comparisons. *Biometrika* 77:3 (1990) 507-13.

A two-stage design is presented that enables the screening, at the first stage, of several new experimental treatments for survival improvement over a standard regimen. Only promising treatments are carried forward to the second stage for definitive evaluation. Our design offers a substantial reduction in patient numbers when the hazard rate is large relative to the patient accrual rate, a situation often encountered in clinical trials in advanced cancer. Although computations are based on asymptotic results, simulations verify that the approximations are adequate for most trials of interest.

Therneau, Terry M., **H. S. WIEAND,** and Myron Chang. Optimal designs for a grouped sequential bionomial trial. *Biometrics* 46:3 (1990) 771-781.

Several designs have been proposed for testing a one-sample study in a grouped sequential fashion, all of which create an approximately optimal design. We give a geometric characterization of the actual optimal (or admissible) designs for the special case of a Bernoulli outcome, and from this derive an enumeration algorithm that may be used to explicitly construct all of the admissible designs for a user-specified range of size and power. A computer implementation of the method is fast and efficient.

Zimmerman, Dale L. (University of Iowa), and **David A. HARVILLE.** A random field approach to the analysis of field-plot experiments and other spatial experiments. *Biometrics* 47:1 (1991) 223-239.

Several "nearest-neighbor" methods for the analysis of data from spatial experiments (e.g., agricultural field experiments) have recently been proposed. These methods attempt to account for the effect of spatial heterogeneity on the estimation of treatment contrasts; typically, this is accomplished indirectly by differencing or by using residuals from neighboring plots to construct covariates. We examine an alternative approach in which the spatial heterogeneity is modeled directly. The model underlying our approach is similar to the model underlying a geostatistical kriging analysis and, as in the latter model, the observations are regarded collectively as a partial realization of a random field. A randomization study of uniformity trial data suggests

that the random field approach often provides more accurate estimates of treatment contrasts than nearest-neighbor approaches. In addition, the random field approach is devoid of ambiguities as to the handling of border plots and is generally more flexible than nearest-neighbor approaches.

■ Book Reviews, Etcetera

DAVID, H. A. Solution to Problem 90-4. *The IMS Bulletin* 19:5 (1990) 608.

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

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) 213-220.

MEEKER, William Q., Jr. *Accelerated Testing: Statistical Models, Test Plans, and Data Analyses,* by Wayne Nelson, New York: John Wiley, 1990, xiv + 601 pp., $69.95. Reviewed in *Technometrics* 33:2 (1991) 236-238.

SPOSITO, V. A. *Nonlinear L_p-Norm Estimates,* by Rene Gonin and Arthur Money. Marcel Dekker, Inc. 1989. Reviewed in *Technometrics* 32:4 (1990) 450-451.

STEPHENSON, W. Robert. *Distribution Free Tests,* by H. R. Neave and P. L. Worthington. London: Unsin Hyman, 1988, xvi + 430 pp., $24.95. Reviewed in *Technometrics* 32:4 (1990) 454- 455.

STEPHENSON, W. Robert. *Empirical Bayes Methods, 2nd ed.,* by J. S. Maritz and T. Lwin. Chapman and Hall, London, U.K. and New York, NY, 1989. xi + 284 pp. $55.00. Reviewed in *Journal of Quality Technology* 22:3 (1990) 249-250.

■ Theses

Biele, Jonathan. Sample-size-optimal Bayesian schemes in sequential sampling. Ph.D. thesis, Iowa State University Library. August 1990.

Sequential sampling schemes have traditionally used *ad hoc* rules for sample size. The variable-sample-size sequential probability ratio test (VPRT), developed by Cressie and Morgan [*Preprint No. 86-17,* Statistical Laboratory, Iowa State University, 1986], generalizes the Wald-Wolfowitz one-at-a-time sampling plan. The VPRT finds the sample size that maximizes the expected net gain of sampling, conditional on the accumulated data at hand. In this dissertation, we explore that idea, both theoretically and numerically, using a technique of computation known as backward induction. Applications to sequential testing of means of Gaussian data, and to a sequential procedure of testing efficacy of a pharmaceutical (developed by Berry and Ho [*Biometrics*

44 (1988) 219-227]), are presented. The relevance of sample size optimization to sequential clinical trials is discussed.

Carley, Michael J. Knowledge-based support systems for statistical software. Ph.D. thesis, Iowa State University Library. August 1990.

Much recent work in the application of knowledge-based programming techniques to statistical problems has involved the development of the statistical expert systems that guide a user through a correct statistical analysis or assist the user in choosing an appropriate statistical tool. A more basic need for users of statistical software is support (guidance and training) in the use of statistical software from a programming standpoint rather than an analysis standpoint. This research investigates the development of knowledge-based systems to help support the use of statistical software. Two systems are developed, EG Expert and EG Network. The design and development of each is described along with issues pertaining to computer implementation using Prolog.

Freire, Clarice Azevedo de Luna. Applications of resampling methods to the estimation of ecological diversity. Ph.D. thesis, Iowa State University Library. August 1990.

Many measures have been proposed and used to quantify the diversity of an ecological community. The evaluation of such measures generally requires information obtained by sampling a community. Often it is impractical to randomly sample individual members of a community, and, commonly, estimates are based on what is observed in a random sample of quadrats (plots of land, volumes of water, etc.). More complex schemes are also used that involve stratification or subsampling from quadrats. It is generally straightforward to compute point estimates of measures of diversity, but formulas for variances and confidence intervals are often unavailable.

In this dissertation, bootstrap and jackknife resampling procedures are used to obtain numerical values for variance estimates and confidence intervals without requiring the development of explicit mathematical formulas. Confidence intervals for species richness based on the percentiles of bootstrap samples tend to be superior to those based on the jackknife procedure when the samples are large enough for these procedures to provide reliable results. It is also shown that a recently developed empirical Bayes estimator of species richness tends to overestimate the number of species and is more variable than the resampling estimators. Bootstrap estimators of measures of diversity, including the popular Simpson and Shannon indices, are developed as a special case of the more general problem of bootstrap estimation of functions of means or proportions for complex sample surveys.

The bootstrap procedures are used to compare species richness and diversity among habitats in a study of birds in Ames, Iowa. Comparisons with corresponding results for the Wilcoxon test suggest that the bootstrap procedure can have much greater power for

detecting differences than nonparametric procedures previously used in such studies.

Homblé, Patrick René. On the stability of linear stochastic difference equations. Ph.D. thesis, Iowa State University Library. August 1990.

Several systems in the physical, biological, social, and engineering sciences evolving in discrete time could be modeled as a sequence $\{x_n\}$ of random variables taking values in a d-dimensional Euclidean space whose dynamics are governed by an equation of the form $x_{n+1} = A(\xi_n)x_n$, where $\{\xi_n\}$ is a stationary ergodic Markov chain on an appropriate space S and $A(\cdot)$ is a mapping of S into the space GL (d,IR) of d×d matrices with real coefficients. This is a discrete analog of a continuous time model investigated by Ludwig Arnold and his co-workers.

In this thesis it is shown that (a), if the Markov chain $\{x_n\}$ satisfies some smoothness conditions, the enlarged chain $\{(x_n,\xi_n)\}$ possesses a stationary distribution and (b) the Lyapunov exponent for the sequence $\{x_n\}$ is almost surely unique and independent of the initial value. The second result is then used to study the asymptotic stability of the system by employing both almost-sure Lyapunov and moment Lyapunov exponents. A computer simulation on a discretized version of the linear oscillator with damping and restoring force is also included in the thesis.

Li, Seung-Chun. Some admissible nonparametric tests and a minimal complete class theorem. Ph.D. thesis, Iowa State University Library. December 1990.

The purpose of this dissertation is to demonstrate the admissibility of some well-known nonparametric tests. It is found that many standard nonparametric tests, such as the Mann-Whitney-Wilcoxon test, Fisher-Yates test, Savage test, and median test, which are linear rank tests, are admissible for the two-sample nonparametric testing problem. It turns out that the admissibility of a linear rank test depends on the regression constants, not the scores. We also prove that the Kruskal-Wallis test is admissible for the one-way layout testing problem.

Mundfrom, Daniel James. Estimating course difficulty. Ph.D. thesis, Iowa State University Library. May 1991.

The difficulty level of college courses has been identified as a value that varies across courses. A sample of 50 introductory-level college courses was selected, and four different measures of course difficulty, (1) perceived difficulty, (2) perceived amount of work, (3) average grade awarded, and (4) average ACT composite of enrolled students, were calculated for each course. The difficulty estimates were examined for consistency for each measure individually, over time, and in comparison with the others. Correlation analysis, multiple regression, factor analysis, hierarchical cluster analysis, and analysis of variance procedures were used. The four measures were combined into one composite index of course difficulty, and the resulting estimates were used to improve the prediction of academic achievement.

Nusser, Sarah. Failure time analyses for data collected from independent groups of correlated individuals. Ph.D. thesis, Iowa State University Library. August 1990.

A method of estimating failure time distributions for data collected from independent groups of correlated individuals is developed. This method is appropriate for commonly interval-censored data (e.g., when individuals are inspected at regular common intervals) or exact time data, including possibly right-censored data. The technique improves upon previously published methods by allowing for large and variable group sizes, heterogeneous correlation structures, and the incorporation of explanatory variable information. Both parametric and nonparametric failure time models can be estimated, and correlations may be modeled as well.

The new methodology is applied to commonly interval- censored data from a study comparing the effectiveness of three smoking cessation programs, and to an exact time data set assessing the developmental responses of rat pups to prenatal doses of methylmercuric chloride.

Research is also presented on the properties and performance of estimators of correlation coefficients for clustered binary data. Several consistent estimators are developed, and their empirical performance is evaluated in a small simulation.

Park, Heon Jin. Alternative estimators of the parameters of the autoregressive process. Ph.D. thesis, Iowa State University Library. December 1990.

We consider estimation for the pth order autoregressive time series

$$Y_t = \alpha_1 Y_{t-1} + \ldots + \alpha_p Y_{t-p} + \epsilon_t,$$

where $Y_{-p+1}, \ldots, Y_0$ are initial conditions and $\{\epsilon_t\}$ is a sequence of martingale differences with finite $2 + \nu$ moments for $\nu > 0$. We investigate estimation of $(\alpha_1, \alpha_2, \ldots, \alpha_p) = \underset{\sim}{\alpha}$ under two assumptions. In the first, all roots of the characteristic equation,

$$m^p - \alpha_1 m^{p-1} - \ldots - \alpha_p = 0,$$

are less than one in absolute value. In the second, one characteristic root is equal to one and the other roots are less than one in absolute value. The vector $\underset{\sim}{\alpha}$, the sum of the elements of $\underset{\sim}{\alpha}$, denoted by θ_1, and the largest root of the characteristic equation are parameters of interest.

By considering the pth order autoregressive time series in the forward direction and in the backward direction, we obtain an estimation method called symmetric least squares. We investigate an estimator of the largest characteristic root based on the symmetric least squares method, an estimator of the largest root based on the maximum entropy method, and an estimator based upon standardized variables. The pivotal statistic for the ordinary least squares estimator and the pivotal statistic for the symmetric least squares estimator converge in distribution to different distributions. The

standardized least squares estimator, the symmetric least squares estimator, and the maximum entropy estimator converge to the same distribution.

The simulation results indicate that the ordinary least squares one-sided test for a unit root is the most powerful test in the model without an intercept. The ordinary least squares test is less powerful than the other tests in the model with an intercept. In the stationary case, the ordinary least squares estimator of θ_1 is less efficient than the symmetric least squares estimator in both the model with intercept and the model without intercept.

We also consider the first-order multivariate time series. Tests for a unit root of the characteristic equation based on the ordinary least squares estimator and the standardized least squares estimator are studied. The standardized least squares test for a unit root is more powerful than the ordinary least squares test for a unit root in the multivariate model.

Rathbun, Stephen Lynn. Estimation and statistical inference for space-time point processes. Ph.D. thesis, Iowa State University Library. August 1990.

A spatial point pattern consists of the location of events in some sample window $A \subset \mathbb{R}^d$. Events may be trees in a forest, towns in a country, or epicenters of earthquakes. Assume that the locations of events are realized from some spatial point process, a random mechanism for locating events in space. A number of techniques have been proposed for estimating the parameters of spatial point processes. However, very little is known about the statistical properties of these estimators. This research considers parameter estimation for an inhomogeneous Poisson process on $A \subset \mathbb{R}^d$ with intensity function $\lambda(\underset{\sim}{s}; \theta)$. It is shown that the maximum likelihood estimator $\tilde{\theta}_A$ and the Bayes estimator $\tilde{\theta}_A$ are consistent, asymptotically normal, and asymptotically efficient, as the sample region $A \uparrow \mathbb{R}^d$.

The marked spatial point pattern of trees and their diameters is the result of a dynamic process that takes place over time as well as space. Such marked point patterns are realizations of marked space-time survival point processes, where trees are born at some random location and time, and then live and grow for a random length of time. A model for a marked space-time survival point process is fitted to data from a longleaf pine forest in southern Georgia.

Remadi, Sellem. Discriminating between solvent and insolvent grain elevators. M.S. thesis, Iowa State University Library. August 1990.

The purpose of this study was to develop a reliable model to assess and predict as accurately as possible the financial health of grain elevators in the United States. Implementation of such a model would enable the regulatory authorities to evaluate financial conditions and identify grain elevators with a high risk of insolvency. The study focused on three objectives: (1) evaluation of the "discriminatory power" of a new variable, called ADA, hypothesized to be as effective as two of the five variables obtained by McConnon in discriminating between solvent and insolvent elevators; (2)

development of models based on two years of information to predict financial status one year into the future; and (3) application of a Classification and Regression Trees (CART) procedure to the problem of discriminating between solvent and insolvent elevators.

Sarkar, Sahadeb. Nonlinear least squares estimators with differential rates of convergence. Ph.D. thesis, Iowa State University Library. August 1990.

Assume observations Y_t, defined on a complete probability space $(\Omega, \mathfrak{F}, P)$, are generated by the model $Y_t = f_t(\theta^0) + e_t$, $t = 1, 2, \ldots$, where θ^0 is the true parameter vector lying in a subset Θ of a Euclidean space, f_t is a known function of both ω and θ, where ω is an element of Ω and $\underset{\sim}{\theta}$ is an element of Θ, $f_t(\omega, \bullet)$ is almost surely twice continuously differentiable with respect to $\underset{\sim}{\theta}$ in some open, convex neighborhood S of θ^0, and the e_t are zero mean unobservable random variables. The sums of squares of the first partial derivatives of $f_t(\theta)$ with respect to different components of the parameter $\underset{\sim}{\theta}$ are permitted to increase at different rates.

Under some regularity conditions it is demonstrated that there is a solution of the least squares equations that is a strongly consistent estimator of θ^0. Furthermore, the properly normalized estimator has an asymptotic distribution. Different components of the least squares estimator require different normalizers to obtain limiting distributions.

Our theory can be applied to the estimation of regression models with autoregressive errors and to nonlinear models with time trend or random walks among the explanatory variables. A small Monte Carlo study of the estimators for the autoregressive moving average model indicates that the large sample results provide a reasonable approximation for samples on the order of 100.

Shin, Dong Wan. Estimation for the autoregressive moving average model with a unit root. Ph.D. thesis, Iowa State University Library. August 1990.

We consider the model $Y_t = \rho Y_{t-1} + z_t$, $z_t + \alpha_1 z_{t-1} + \ldots + \alpha_p z_{t-p} = e_t + \beta_1 e_{t-1} + \ldots + \beta_q e_{t-q}$, $t = 1, \ldots, n$, where $\{e_t\}$ is an iid $(0, \sigma^2)$ sequence and $\{z_t\}$ is a stationary and invertible process. The parameter vector $(\underset{\sim}{\theta}, \rho, \sigma)$, where $\underset{\sim}{\theta} = (\alpha_1, \alpha_2, \ldots, \alpha_p, \beta_1, \beta_2, \ldots, \beta_q)'$, can be estimated by least squares or by maximum likelihood, where the likelihood is constructed under the assumption that $\{e_t\}$ is a sequence of normal $(0, \sigma^2)$ random variables. We show that the least squares estimator and the maximum likelihood estimator of $(\underset{\sim}{\theta}, \rho, \sigma)$ are strongly consistent when $\rho = 1$. When the true value of ρ is one, the limiting distributions of the two estimators of $(\underset{\sim}{\theta}, \rho)$ are the same. The limiting distribution of the estimator of ρ is the same as the limiting distribution of the ordinary least squares estimator of ρ in the first-order autoregressive model. The limiting distribution of the estimator of $\underset{\sim}{\theta}$ is multivariate normal.

For the model containing an intercept, we show that the estimators are weakly consistent. When $\rho = 1$, the limiting distribution of the estimator of ρ is the same

as the limiting distribution of the ordinary least squares estimator of ρ in the first-order autoregressive model.

Vander Wiel, Scott A. Some aspects of monitoring and control of univariate dynamic systems. Ph.D. thesis, Iowa State University Library. May 1991.

Four aspects of statistical monitoring and control of manufacturing processes are studied. First a machining process is modeled using a random walk observed with error and adjusted in discrete steps. An optimal adjustment policy is derived to minimize the expectation of variable off-target costs plus fixed adjustment costs. Under some regularity conditions the optimal policy is shown to make nonzero adjustments only when the process is perceived to be substantially off target.

A more common control objective is to minimize process variance. Monitoring techniques are studied for detecting abrupt changes in autoregressive moving average transfer function (ARMAX) systems under minimum variance feedback control. An example shows that a simple cumulative sum (CUSUM) monitoring scheme performs very favorably in comparison to several other schemes for detecting an underlying step shift in the process level.

Properties of a likelihood-ratio-based monitoring scheme for ARMAX systems can be investigated using a Markov chain to approximate the scheme's stochastic behavior. A general approach is described for approximating signaling time distributions for such monitoring schemes possessing a certain recursive calculation structure.

Finally, concepts and an application of algorithmic statistical process control (ASPC) are presented. ASPC refers to the use of feedforward and feedback techniques to reduce predictable quality variations in conjunction with statistical process monitoring to detect and remove root causes of unpredictable quality changes. The application describes the development of a minimum variance control algorithm and a CUSUM monitor for a polymerization process at the General Electric Company. The application resulted in a 35 percent reduction in off-specification material as well as several fundamental process improvements attributable to signals from the CUSUM monitor.

Wellman, Mark A. A genetic algorithm approach to optimization of asynchronous automatic assembly systems. M.S. thesis, Iowa State University Library. May 1991.

A simple genetic algorithm (GA) is described, implemented, and applied to the buffer allocation problem of a closed-loop, asynchronous, automatic assembly system (AAS). The analysis also involves investigation of GA parameter settings and how these parameters affect GA performance. It is shown that the GA shows acceptable performance for the AAS buffer allocation problem, but this performance comes at the expense of considerable computation time. Typical execution times for the GA implementation were approximately 5 hours (on a '386-based PC running at 25 MHz). Potential methods to improve the implementation of a GA to this type of stochastic optimization problem are discussed.

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 Liberal Arts and Sciences 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. Co-majors are not frequent at the M.S. level, but several Ph.D. students choose co-majors every year 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. More information is given in the departmental brochure, "Iowa State University—Graduate Program in Statistics," which is available upon request.

Several variations and additions to the regular teaching program were made in 1990-91.

Mack Shelley taught Stat 401, Research Methods for Research Workers, offcampus during the summer 1991 session, primarily to students employed in state and local governments in the Des Moines area. He also created and taught a new course, Political Analysis (Pol Sci 500x, now renumbered as 503), focused on epistemological and methodological issues in political science.

Derrick Rollins introduced new software for dynamically modeling and simulating chemical processes in Chem Engineering 421. A project was assigned to implement control algorithms to a simulated chemical process. This work was done on the Project Vincent™ workstations. Through the College of Engineering, Rollins received a 3M Manufacturing Technology Education Initiative grant beginning May 1991 to purchase computer hardware and software for teaching and research in advanced process control strategies.

Dan Mundfrom taught Stat 101, Principles of Statistics, in the ISU off-campus credit program fall semester in Des Moines, Iowa.

Efforts to strengthen and expand computational facilities available in the Department of Statistics and the Statistical Laboratory continued. As pp. 7-8 indicated, these efforts led to considerable success through Project Vincent™ 90, with the installation of nine workstations. One workstation was awarded to Frederick Lorenz, Carl Roberts, Mack Shelley, and

Robert Strahan for 210 Snedecor Hall. One was given to the statistical consulting group in the Iowa Agriculture and Home Economics Experiment Station. One went to William Q. Meeker and one to the engineering statistics group. Three were installed in the Statistical Computing Section, one was placed in the Survey Section, and one in Room 203 for use solely by students in statistics.

Through Project Vincent™ 91, 19 more workstations will be added during the summer. The university is providing SAS* campuswide on the Vincent system. The Department of Statistics assisted in the purchase of S-PLUS. One of the statistics graduate students, Heidi Geheb, was supported by the Statistical Laboratory to learn the Vincent system so that she could help with short courses for graduate students and faculty.

In preparation for new computers and 14 new computer tables, Room 203 in Snedecor Hall was repainted in June by Kenneth Koehler and several Iowa STAT-ers as a computer room for statistics students. It will hold five DEC workstations from Project Vincent™ 1991, one from Project Vincent™ 1990, and four 386-based personal computers. These machines in a remodeled room will greatly enhance our teaching and research programs.

Additional laser printers were added for support staff and one is available in Room 210 for general use by faculty and graduate students. Each graduate student may print 50 free pages each month for research, teaching, and other general educational purposes; other copies may be made at nominal cost—or the student may make arrangements for printing on the Computation Center's impact printer or its laser printer. Word processing software for support staff was upgraded to Wordperfect 5.1.

Graduate teaching assistants again gave yeoman service in undergraduate statistics courses. The 19 students who taught lecture sessions during the spring of 1991 received ratings that averaged 4.02 in students' evaluations of teaching performance, on a scale of 1 to 5 with 5 being far above average and 3 being average. In fact, the lowest individual evaluation was 3.28, so we can say that, as in Lake Wobegon, all of our TAs are above average. The class sizes ranged from 17 to 106, averaging 62.5. Thus these are large classes, and the exceptional evaluations are both surprising and pleasing.

Two teaching assistants, Ann Russey and Ibrahim Yansaneh, were selected to be part of a group of 18 experienced TAs who will help with university-wide orientation activities for new graduate students at ISU. Shelly Gregory taught introductory business statistics at Drake University summer 1990. Michael Hartfield and Elizabeth McMichael taught introductory statistics courses at Drake summer 1991. This is further evidence of the favorable regard which our TAs receive.

Course offerings for the 1990-91 academic year and the 1991 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.
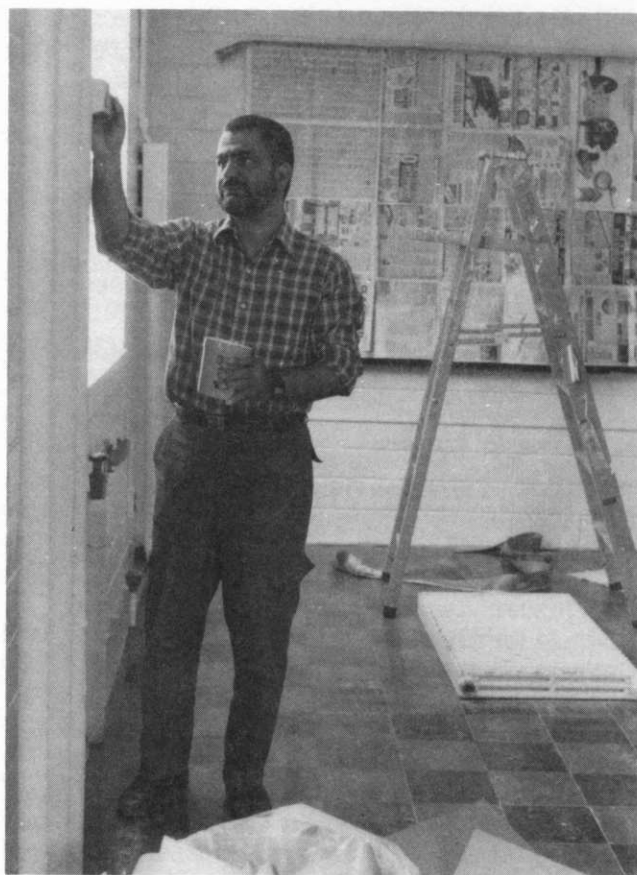
Color it light blue! Kenneth Koehler coordinated efforts to secure a set of workstations for student use. James Robison-Cox, Marie Coffin, Rochelle Milbrath, Brian Lindstrom, Jeff Helterbrand, Baiching An, and (shown above) Hamid Navvabpour contributed their time to painting and refurbishing Snedecor 203 as a computer room for statistics majors. This room will contain six DEC workstations, with EtherNet connections to the university's Vincent network of workstations, and several personal computers with connections to both the main frame computer and the VAX and Vincent networks. This facility represents a significant upgrade of computing facilities for student research and instruction.

■ 1990-91 Course Offerings in Statistics

Courses for Undergraduate Students Only

100	Orientation in Statistics and Biometry	R	F	Stephenson
101	Principles of Statistics	4	F,S,SS Coffin Cramer Dombroski Hartfield	Kirchoff Mundfrom Stephenson
104	Introduction to Statistics	3	F,S,SS Coffin Dubois Hotchkiss McMichael	Paterno Ross Sukhatme
105	Introduction to Statistics for Engineers	2	F,S Isaacson C. Novak	Sukhatme
201	Applied Regression Analysis for Business	2	F	Olin

227	Introduction to Business Statistics	5	F,S,SS	Chowdhury Drinkwater Gregory Howard	Lindstrom E. Novak Paterno Roback
231	Probability and Statistical Inference for Engineers	4	F,S	Manke McDonald	Olin Rollins
305	Engineering Statistics	3	F,S	Hall Vardeman	Zimmermann
328	Applied Business Statistics	3	F,S	Groeneveld	Meeker
333	Probability and Statistics for Electrical and Computer Engineers	3	F,S	Lahiri	Pollak
341	Introduction to Theory of Probability and Statistics	3	F	Coffin	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 Carriquiry Cox Hotchkiss Kennedy	Mundfrom Roberts Shelley Stephenson
402	Statistical Design and the Analysis of Experiments	3	F,S	Hinz Marasinghe	Strahan Stufken
403	Nonparametric Statistical Methods	2	F		Groeneveld
404	Statistics for the Social Sciences	3	F		Lorenz
405	Applied Econometric Statistics	3	S		Hickman
407	Methods of Multivariate Analysis	2	F		Shelley
421	Survey Sampling Techniques	3	S		Amemiya
436	Genetic Statistics for Research Workers	3	F		Bailey
447	Statistical Theory for Research Workers	4	S,SS	H. A. David	H. T. David
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	S		Marasinghe

Courses Primarily for Graduate Students, Major or Minor

| 500 | Statistical Methods | 4 | F | | Hinz |
| 501 | Multivariate Statistical Methods | 3 | S | | Koehler |

511	Theory and Application of Linear Models	3	S		Harville
512	Design of Experiments	3	F		Stufken
513	Response Surface Methodology	3	S		Stufken
521	Theory of Sample Surveys I	3	S		Sukhatme
531	Statistics for Quality and Productivity	3	S		Vardeman
534	Ecological Statistics	2	S		Pollak
538	Econometric Statistics	3	F		Fuller
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		H. A. David
543	Theory of Probability and Statistics	3	S		Lahiri
546	Theory of Nonparametric and Asymptotic Methods	3	S		Sukhatme
557X	Statistical Methods for Counts and Proportions	3	F		Koehler
579	Introduction to Computer Hardware and Software Systems for Statistical Computing	1	F		Marasinghe
580	Statistical Computing	3	F		Kennedy
590A	Special Topics: Theory	3	F,S,SS	Athreya Lahiri	Marasinghe
599	Creative Component	Var	F,S,SS	Amemiya Athreya Bailey Carriquiry H. T. David Harville Hickman Hinz Isaacson Kennedy	Koehler Lahiri Lorenz Marasinghe Meeker Roberts Sacks Sposito Stephenson Stufken

Courses for Graduate Students, Major or Minor

611	Advanced Linear Model Theory	3	F		Harville
642	Advanced Probability Theory	3	S		Athreya
643	Theory of Estimation and Testing of Hypotheses	3	F		Lahiri
647	Multivariate Analysis	3	F		Amemiya
699	Research	Var	F,S,SS	Amemiya Athreya Cressie H. A. David H. T. David	Fuller Harville Hinz Kennedy Koehler

Lahiri
Marasinghe
Meeden
Meeker
Pollak
Rollins
Sacks

Shelley
Sposito
Stephenson
Stufken
Sukhatme
Vardeman

■ Graduate Students

An exchange program with Dortmund University, Dortmund, Germany, brought four statistics graduate students here for the 1990-91 academic year. They took regular courses and participated fully in Iowa STAT-ers and other campus activities. Next year three more students plan to come from Dortmund, while ISU statistics graduate student Michael Hartfield will spend the academic year at Dortmund. Preliminary contacts leading to the exchange program were made by Noel Cressie and Paul Hinz in their visits to Germany and by Franz Hering in his visits to ISU.

Todd Sanger served as president of the ISU Graduate Student Senate for the 1990-91 year.

Barbara Dombroski and Shelly Gregory were selected as fall semester 1990 recipients of ISU graduate teaching excellence awards. Karen Drinkwater was chosen as spring semester 1991 recipient.

Also in the spring a research excellence award was given to Scott Vander Wiel and the Dan Mowry statistical consulting excellence awards were given to Barbara Worth and Ann Russey.

Elizabeth McMichael received an ISU Committee for Women in Science and Engineering scholarship for fall semester 1990.

Jay Ver Hoef won one of two honorable mentions given in the awarding of the third annual Zaffarano Prize at Iowa State spring 1991. This prize is for the graduate student judged as showing the most potential for research. Ver Hoef is working on a joint Ph.D. in ecology and evolutionary biology and statistics; he has published five papers and has one under review.

Abdoulaye Adam served as president of the African Students Association. At the Africa Week '91 awards banquet held on March 23, Ibrahim Yansaneh was one of two ISU students honored for exceptional academic achievement.

The following graduate students held cooperative internships during the year: Alice Cramer, at Weyerhaeuser, Hot Springs, Arkansas, for summer and fall 1990; Dze-Hwei Lyan also there January through mid-August 1991; Lori Becker, at Weyerhaeuser, Tacoma, Washington, for one year beginning in August 1990; Georgene Kelly, at Mayo Clinic, Rochester, Minnesota, summer 1991.

Three other students took summer 1991 positions with industry: Ann Dyer, at Dow Chemical, Midland, Michigan; Bryan Olin, with CPC Fairfax, General Motors, in Kansas City, Kansas; and Todd Manke, at Pratt & Whitney, West Palm Beach, Florida.

Sarah Howard and Susan Holman brought data back from their 1990 summer internships at Mayo Clinic and used it in their creative component work. These students gained both consulting experience and academic progress from their internships.

David McDonald accepted a two-year research fellowship at the National Center for Atmospheric Research, Boulder, Colorado, starting February 1, 1991. Bryan Olin was awarded an IBM predoctoral graduate fellowship for the coming year.

During the year, 32 M.S. degrees in statistics, one in operations research, and 12 Ph.D. degrees in statistics, including two for co-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.

Iowa STAT-er president Paul Roback received a surprise gift for the STAT-ers at the Stat Lab spring breakfast. The four students from Dortmund University—(standing, L to R) Thomas Fischer, Julia Stein, Gerald Städtler, and Peter Müller—presented him with a ceremonial cake server for use at the birthday cake events held for STAT-ers sharing birth months. (Seated, L to R, are Roback, Karen Drinkwater, Todd Borchert, Susan Holman, and Fred Lorenz.)

M.S. Recipients

Munther Ali Al-Zaid (Summer 1990; Vincent A. Sposito) is an instructor in statistics at the Institute of Public Administration, Riyadh, Saudi Arabia.

Yi-Ju Chen (Spring 1991; Vincent A. Sposito) returned to Taipei, Taiwan.

Risana Tasnim Chowdhury (Fall 1990; Theodore B. Bailey).

Ching-Yi Chung (Spring 1991; Yasuo Amemiya) returned to Tainan, Taiwan, and is working as a researcher in the Ministry of Economic Affairs.

Mary Anne Dellva (Summer 1990; Paul N. Hinz) is an associate statistician in the Division of Biochemical Development and Technical Services, Eli Lilly & Co., Indianapolis, Indiana.

Djamal (Spring 1991; Herbert T. David) returned to the Central Bureau of Statistics, Jakarta, Indonesia, in December 1990.

Karen Drinkwater (Spring 1991; Paul N. Hinz) accepted a position in a new branch of Marion Merrell Dow, Inc., in Indianapolis, Indiana.

Shelly Lynn Gregory (Spring 1991; William Q. Meeker) has joined Shell Development's Westhollow Research Center, Houston, Texas, as a mathematician in the Systems Development Department.

Richard Griffiths (Spring 1991; Herbert T. David) is a mathematical statistician in the U.S. Bureau of the Census, Suitland, Maryland.

*Jeffrey Donald Helterbrand (Summer 1990; Wayne A. Fuller).

Susan L. Holman (Spring 1991; William Q. Meeker) has joined Eli Lilly and Company as a statistician working in the Statistical and Mathematical Services, Lilly Research Laboratories, Indianapolis, Indiana.

Taekyu Hwang (Spring 1991; Herbert T. David) is continuing studies toward a Ph.D. in statistics at the University of Iowa.

*Philip W. Iversen (Fall 1990; Mervyn Marasinghe).

*Seoung-Gon Ko (Spring 1991; Herbert T. David).

Chia-Lin Li (Summer 1990; William Q. Meeker) returned to Taiwan.

Dze-Hwei Lyan (Spring 1991; William Q. Meeker) is completing a statistics cooperative internship at Weyerhaeuser in Hot Springs, Arkansas.

Yvon Nininahazwe (Summer 1990; Paul N. Hinz) returned to the Biometrics Service, National Agricultural Research Institute of Burundi, in Bujumbura, Burundi.

*Bryan Olin (Spring 1991; John Stufken).

Sangun Park (Summer 1990; H. A. David) is continuing his studies for the Ph.D. degree in the Department of Statistics, University of Chicago.

Dwayne Pepper (Summer 1990; H. A. David) joined Intel Corporation, Chandler, Arizona, as a statistical consultant.

*Sallem Remadi (Summer 1990; Kenneth J. Koehler).

Jennifer Riddell (Spring 1991; W. Robert Stephenson) is working as a statistical analyst with Management Decision Systems, Atlanta, Georgia.

Paul J. Roback (Spring 1991; Frederick O. Lorenz) is joining Eli Lilly, Indianapolis, Indiana, as a clinical statistician.

*Todd M. Sanger (Spring 1991; Wayne A. Fuller).

Ru-Shuo Sheu (Fall 1990; Vincent A. Sposito) returned to Taipei, Taiwan, and joined the staff of the Hsin-Kong Insurance Company.

Diane Sly (Spring 1991; Carl Roberts) accepted a position as assistant statistician at Kellogg, Battle Creek, Michigan, for general consulting for sensory data, product development, and other areas.

Blake Alan Smith (Summer 1990; Kenneth J. Koehler) has joined the CNA Insurance Company in Chicago, Illinois.

Suharno (Summer 1990; Vincent A. Sposito) is a government officer in the Central Bureau of Statistics, Jakarta, Indonesia.

Amy Louise Hewitt Weaver (Summer 1990; Kenneth J. Koehler) is a biostatistician with the Mayo Clinic, Rochester, Minnesota.

Mark A. Wellman (M.S. in operations research, Spring 1991; Douglas D. Gemmill) joined the Procter & Gamble Company, Cincinnnati, Ohio, for market statistical research.

Barbara Worth (Spring 1991; Paul N. Hinz) is an associate statistician at Abbott Laboratories, Abbott Park, Illinois.

Abera Wouhib (Spring 1991; Roy D. Hickman) returned to the Central Statistical Authority of Ethiopia, in Addis Ababa, as senior statistician.

*Ibrahim Sorie Yansaneh (Summer 1990; Roy D. Hickman).

Ph.D. Recipients

Jonathan Biele (Summer 1990; Noel A. C. Cressie) is in the Department of Statistics at the Universidade de Campinas, IMECC, in Sao Paulo, Brazil.

Michael Ray Carley (joint Ph.D. in statistics and economics, Summer 1990; William J. Kennedy and Wallace Huffman) is working for the Iowa Power and Light Company, Des Moines, Iowa, as load research analyst, Department of Corporate and Economic Services.

Clarice Azevedo de Luna Freire (Summer 1990; Kenneth J. Koehler) is a professor in the Department of Statistics, Universidade Estadual de Campinas-IMECC, Sao Paulo, Brazil.

Patrick René Homblé (Summer 1990; Krishna B. Athreya and Wolfgang Kliemann) is an assistant professor in the Department of Statistics, University of Georgia.

Seung-Chun Li (Fall 1990; Glen Meeden) returned to Korea to teach statistics as an instructor at Sung Kyun Kwan University, Seoul.

Daniel Mundfrom (joint Ph.D. in statistics and professional studies in education, Spring 1991; Mack C. Shelley II and William G. Miller) is a temporary instructor in statistics at ISU for the summer term and has accepted a position as assistant professor in the College of Education, University of Arkansas-Little Rock, starting in August 1991 with principal responsibilities in the Center for Research on Teaching and Learning.

Sarah Margaret Nusser (Summer 1990; Kenneth J. Koehler) is a statistician in the Statistical Resources Section, Research & Development Division of Procter & Gamble's Miami Valley Laboratories, Cincinnati, Ohio.

Heon Jin Park (Fall 1990; Wayne A. Fuller) joined SAS, Inc., Cary, North Carolina, in August.

Stephen Lynn Rathbun (Summer 1990; Noel A. C. Cressie) is an assistant professor in the Department of Statistics, University of Georgia.

Sahadeb Sarkar (Summer 1990; Wayne A. Fuller) is an assistant professor in the Department of Statistics, Oklahoma State University.

Dongwan Shin (Summer 1990; Wayne A. Fuller) has a position in the Department of Statistics, University of Suwon, Hwasong-gun, Kyonggi-do, Korea.

Scott A. Vander Wiel (Spring 1991; Stephen B. Vardeman) is a member of the Technical Staff, AT&T Bell Laboratories, Murray Hill, New Jersey.

M.S. Candidates

Ahmad, Mahmood
Akbar, Aminul
   (operations research)
Al-Shiha, Abdoullah
Al-Zaid, Munther Ali A.
Andersen, Jeffrey
Ashman, Christine
Becker, Lori
Borchert, Todd
Bushaw, Sherry L.
Chen, Chun-Fu
Chen, Kehang
Chen, Yi-Ju
Cheng, Man-Lai Alice
Cho, Jihwan
Chowdhury, Risana
Chuang, Li-Fang
Chung, Ching-Yi
Cramer, Alice M.
Ding, Jianying Peng
Djamal (operations research)
Dodd, Kevin W.
Dombroski, Barbara
Drinkwater, Karen
Dubois, Dawn
Dyer, Ann
Emir, Birol
Fernandes, Gilenio Borges
Fischer, Thomas
Garcia, Cathalina
Geheb, Heidi
Gessner, Mary L.
Gilloon, Peter
Green, Marjorie A.
Gregory, Shelly
Griffiths, Richard R.
Harter, William H., Jr.
Hartfield, Michael
Hassan, Shawkat
   (operations research)
Hassanain, Khalifa M. A.
Hinkeldey, Anita M.
Holman, Susan L.
Howard, Sarah F.
Hu, Hui-Lin
Huang, Hui-Yi
Hwang, Taekyu
Joo, Hyum-Hee
Kang, Shin-Soo
Kao, Yu-Ling
Karabulut, Ihsan
Kelly, Georgene
Kim, Dae-Lyong
Kim, Sahmyeong
Kirchoff, Thomas
Ko, Seoung-Gon
Kreisberg, Mark S.
Lee, Kye-Don
Lee, Shu-Hua

Li, Young Jae
Lin, Kuo-Chin
Lin, Yi-Te
Lindstrom, Brian
Luk, Stella Chueck-Wah
Lyan, Dze-Hwei
Ma, Chuan-Chuan
Manke, Todd
Mattics, Steven
Mazas, Jose-Luis
McMichael, Elizabeth
Meyer, Richard C.
Milbrath, Rochelle L.
Moreno G., Carlos
Müller, Peter
Nininahazwe, Yvon
Novak, Christopher C.
Novak, Eric L.
Oh, Sang-Heon
Olin, Bryan D.
Paterno, Elizabeth M. S.
Paterno, Margarita
Putranto, Beta
Raymos, Lisanne R.
Reese, John T.
Riddell, Jennifer K.
Roback, Paul J.
Roelfs, Shonda D.
Ross, Philip H.
Rupe, Jason W.
   (operations research)
Rushing, Leroy N.
Schillmoeller, Laura
Sheu, Ru-Shuo
Shin, Chungyeol
Sly, Diane S.
Smith, Michael H.
Soumare, Harouna
Städtler, Gerald
Stein, Julia
Suharno
Tali, Dilek
Walczak, Daniel E.
Wall, Steven J.
Wang, Ouhong
Wellman, Mark
   (operations research)
Wenz, Paul F.
Whitney, Christine M.
Wilmarth, Steven
Worth, Barbara J.
Wouhib, Abera
Wu, Lie-Ling
Wu, Peitsang
   (operations research)
Yalçin, Ilker
Yen, Shu-Yuan
Yen, Yung-Li
Yu, Namkyu

Ph.D. Candidates

Adam, Abdoulaye
An, Baiching
Atuncar, Gregorio
Biele, Jonathan
Brescia, Victor P.
   (joint statistics-economics)
Bryan, Mark F. (in absentia)
Bushman, Brad J.
Carley, Michael R.
   (joint statistics-economics)
Chakak, Abderrahmane
Coffin, Marie A.
Cranford, B. Keith (in absentia)
Croos, Joseph H. R.
Deo, Rohit S.
Dunnigan, Gerri M.
Freire, Clarice A.
Fukuchi, Jun-ichiro
Garrigoux, Christian
   (joint statistics-industrial
   education and technology)
Han, Geun-Shik
Helterbrand, Jeffrey
Huang, Mu-Yeh
   (joint statistics-industrial
   engineering)
Iversen, Philip W.
Lee, Yung-Seop
Lei, Ding-Hwa Dean
Lemke, Klaus W.
   (joint statistics-industrial
   engineering)
Li, Seung-Chun
Liu, Chih-Yao
Liu, Jingyu
Lotfizadeh, Abdolhassan
Loughin, Thomas M.
Lu, Chi-hsien Joseph
McDonald, David G.
   (joint statistics-meteorology)

(in absentia)
Medak, Frederick M.
Mundfrom, Daniel (joint
   statistics-professional
   studies in education)
Navvabpour, Hamid
Nusser, Sarah
Papadopoulos, Savas
Park, Heon Jin
Pelkey, Jean E.
Rana, Abdul Wajid
Rathbun, Stephen L.
Remadi, Sallem
Robison-Cox, James
Rose, Daniel L.
Russey, Ann C.
Sabran, Muhamad
Sanger, Todd M.
Sarkar, Sahadeb
Shin, Dongwan
Sriplung, Kai-One
   (joint economics-
   statistics)
Takahashi, Hiroshi
   (joint animal science-
   statistics)
Tiro, Muhammad
Tollefson, Margot
Vander Wiel, Scott
Ver Hoef, Jay
   (joint botany-statistics)
Vidyashankar, Anand (joint
   mathematics-statistics)
Wallendorf, Michael
Wang, Chung-Ching Morgan
Wang, Kui-Jang William
Yansaneh, Ibrahim
Yoo, Seongmo
Yu, Yunn-Hwu
Zimmermann, Alan G.

▦ Mu Sigma Rho

The 20th annual Mu Sigma Rho lecture was presented by Elizabeth A. Martin, chief of the Center for Survey Methods Research, U. S. Bureau of the Census. Her lecture, entitled "Implications of Behavioral Research on Causes of Census Undercount," considered what the Census Bureau has learned about causes of undercount among certain population groups.

Mu Sigma Rho lecturer Elizabeth Martin.

Dr. Martin has more than 25 publications, including "Surveying Subjective Phenomena," the final report of the Panel on Survey Measurement of Subjective Phenomena, Committee on National Statistics, which she co-edited. Her visit on April 16-18 was co-sponsored by the Iowa STAT-ers, the ISU Department of Statistics, the undergraduate Statistics Club, five other departments, the Graduate College, the College of Business, RISE, and the ISU Committee on Lectures.

Nineteen new members were initiated into the Mu Sigma Rho honor society at the annual banquet, which preceded the lecture on April 16. The students were recognized for their scholarly achievements in statistics course work. Officers for the 1990-91 school year were Philip Iversen, president; Jim Robison-Cox, vice president; and Anita Hinkeldey, secretary-treasurer. W. Robert Stephenson served as faculty advisor.

▮ Iowa STAT-ers

The Iowa STAT-ers, the Department of Statistics graduate student organization, concluded another successful year featuring social and intellectual enrichment opportunities. This active group of about 75 students has gained recognition from graduate departments at ISU and from outside statistics departments for its various activities and its level of participation.

For instance, vice president Alan Zimmermann coordinated a bi-weekly Iowa STAT-ers seminar series that included talks by ISU faculty members and students and talks by others from business and academia. See p. 47 for details.

Todd Borchert and Susan Holman organized several social functions providing opportunities for interaction outside the hallways of Snedecor. This year's highlights included the Halloween Party (with prizes for best costume and pumpkin), the Moment Generating Function (a semi-formal gathering), and the Winter Party (with skits and music). Chris Whitney and Ibrahim Yansaneh, serving as the international student representatives, organized the Cultural Party,

Ken Koehler, faculty advisor to Iowa STAT-ers, introduces his youngest child, Sarah, to a Stat Lab tradition—the spring breakfast.

which this year focused on African cultures.

The STAT-er Clatter, our musical group, provided an additional outlet for STAT-ers. They performed at the Holiday Open House and the Winter Party and were featured in the spring at the third annual STAT-er recital. Yet another outlet explored by STAT-ers was the intramural sports scene where STAT-ers displayed their athletic abilities by winning championships in basketball, broomball, golf, badminton, racquetball, tennis, soccer, and wallyball. Todd Manke and Paul Wenz served as intramural coordinators.

This year's STAT-er cultural party focused on African cultures and international foods. Shown from L to R are Harouna Soumare, Kadiatu Yansaneh, and Abdoulaye Adam.

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Funds were raised for STAT-er activities through the sale of t-shirts, sweat-shirts, and birthday calendars.

Officers for the 1990-91 year were Paul Roback, president; Alan Zimmermann, vice president; Barbara Worth, treasurer; and Ann Russey, secretary. Todd Borchert was the student representative at statistics faculty meetings. Kenneth J. Koehler was faculty advisor to the student club.

Four Iowa STAT-ers have been serving as ISU Graduate Student Senate senators: Abdoublaye Adam, Todd Sanger—who is president of the senate, Diane Sly, and Alan Zimmermann.

Snedecor and Bancroft Awards

The 1991 George W. Snedecor Award was presented to Abdoulaye Adam as the most outstanding Ph.D. candidate in the Department of Statistics among students completing the doctoral preliminary examination during 1990. The award honors the founder and first director of the Statistical Laboratory. Adam received a bachelor's degree in mathematics and physics at the University of Niamey, Niger, West Africa, and a master's in statistics at Oklahoma State University. From 1979 until he came to ISU in 1988 he was chief of the Statistical Division, National Institute of Research in Agriculture of Niger.

The T. A. Bancroft award recognizes achievements in statistics by students who completed 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 1991 award was given to Sergio Horacio Lence, a doctoral candidate in agricultural economics with a statistics minor, from Buenos Aires, Argentina. The award honors Theodore A. Bancroft, director of the Statistical Laboratory and head of the Department of Statistics from 1950 to 1972. Lence completed undergraduate degrees in Argentina and an M.S. degree in agricultural economics at Iowa State in 1988. He returned to Argentina for a year to teach and work as a commodity market analyst for the Argentine Grain Board. While studying for his doctorate Lence was a research assistant in the Center for Agricultural and Rural Development; currently he is a postdoctoral research associate there.

Undergraduates

The department established the Department of Statistics/Eli Lilly Company Scholarship for an outstanding entering freshman student majoring in statistics. The scholarship is $1,000 for the first year of study at Iowa State University. The first award was made to Gregory Kinser of Emerson, Iowa, who will be an entering statistics major in the fall semester 1991. The scholarship has been introduced to increase the interest in and visibility of the undergraduate statistics major at Iowa State.

At the Scholarship Recognition Dinner, on April 23, Linda Marie Hornberger was recognized as ranking in the top 2 percent of seniors in the College of Liberal Arts and Sciences and also as the highest-ranking graduating senior in statistics.
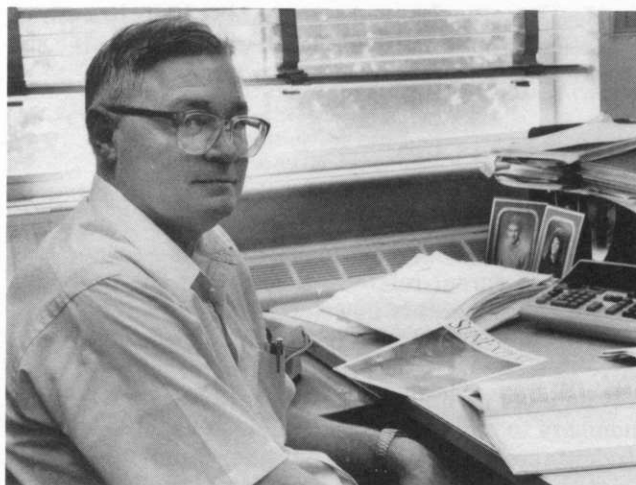
Richard Groenveld is coordinator of the department's undergraduate program. He also advises statistics majors and assigns and guides the graduate teaching assistants.

Eleven students received B.S. degrees in statistics and one received a B.S. degree in biometry during the period July 1, 1990, to June 30, 1991. 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.

Lynne Alethea Carber (Spring 1991) has accepted a position as an agricultural statistician with the National Agricultural Statistics Service in Boise, Idaho.

Chadd J. Crouse (Spring 1991) has joined the National Agricultural Statistics Service as agricultural statistician in Jackson, Mississippi.

Bryan Ducharme (Fall 1990) is continuing studies at Iowa State in computer science..

Linda Marie Brown Hornberger (Spring 1991) will continue studies at Iowa State University toward a graduate degree in botany.

Nancy Marie Houar (Summer 1990) is a data analyst at Mayo Clinic, Rochester, Minnesota.

*****Daniel James Parks** (Fall 1990) has been working in quality control at IBM in Rochester, Minnesota, under a co-op program in statistics January-August 1991 and is returning to ISU for graduate study in statistics in August.

Greg A. Pieper (Fall 1990) is a statistician in the State of Iowa Department of Human Rights, Des Moines, Iowa.

Laura Jean Roeder (Fall 1990) is a statistician in the State of Iowa Department of Human Rights, Des Moines.

Michael R. Sassman (Fall 1990) is an agricultural statistician in the Des Moines, Iowa, office of the National Agricultural Statistics Service.

Steven Ray Stockdale (biometry major; Spring 1991) has joined the National Agricultural Statistics Service, Des Moines, as an agricultural statistician.

Michael E. Tott (Fall 1990) is an actuarial trainee with the Lincoln National Life Insurance Company, Fort Wayne, Indiana.

Ramona Inta Wright (Fall 1990, with distinction) is an industrial engineer with United Parcel Service, Des Moines, Iowa.

Joel Brown, who graduated in May 1990, has taken a position with Communications Data Services, Inc., in Des Moines, as a computer programmer.

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.

This year's activities began with a pizza party in early October. The informal setting provided a good way for older members to get reacquainted and for new members to meet everyone. Later in October several students spoke to the club about their summer jobs and/or internships. Matt Gerdis spent from January through July 1990 in Hot Springs, Arkansas, on a cooperative internship with Weyerhaeuser. Dan Parks was at IBM in Rochester, Minnesota, in its summer internship program. Another summer intern was Mike Tott, who was an actuarial trainee with Lincoln National Corporation in Fort Wayne, Indiana. At the November meeting several current graduate students in statistics spoke to the club about graduate school.

During the spring semester, the first meeting was devoted to searching for a job. Services provided by the Liberal Arts and Sciences-Business Administration Placement Office were highlighted. The big event of the spring was a visit to IBM in Rochester, Minnesota, in April. Dan Parks (B.S. 12/90) arranged for a tour and presentations on how statistics is used at IBM.

Statistics Club officers for 1990-91 were Lynne Carber, president; Matt Gerdis, vice president; Laura Roeder (fall) and Dave Ramsey (spring), secretary; Laura Roeder (fall) and Ron Schewe (spring), treasurer. Lynne Carber was the recipient of the 1990-91 Statistics Club award. W. Robert Stephenson served as faculty adviser.

Seminars

The series of regular weekly noncredit seminars offered by the Statistical Laboratory and the Department of Statistics throughout the 1990-91 year was planned by Alicia Carriquiry and, for summer, Dean Isaacson.

Statistical Laboratory Seminars

Summer 1990

July 10　Nonlinear least squares estimators with differential rates of convergence. Sahadeb Sarkar.

11　Estimation for the autoregressive moving average model with a unit root. Dongwan Shin.

12　Applications of resampling methods to the estimation of ecological diversity. Clarice Freire.

Fall 1990

August 29　The undergraduate program in statistics at Iowa State University. Dean L. Isaacson

September 7　Assessing sources of error and calibrating error rates in computer matching, with application to census undercount. Thomas Belin, Department of Statistics, Harvard University, and U.S. Bureau of the Census

11　Some newer developments in asymptotic extreme value theory. Janos Galambos, Department of Mathematics, Temple University

12　Bonferroni-type inequalities and applications. Janos Galambos, Department of Mathematics, Temple University

19　Generalized ranking methods in survey sampling. Carl E. Sarndal, Department of Mathematics and Statistics, University of Montreal, and Statistics Canada

26　Censored distance-based intensity estimation of spatial point processes. Dale Zimmerman, Department of Statistics and Actuarial Science, University of Iowa

October 2　(joint with Department of Electrical Engineering) Segmentation of satellite-derived natural images. James Simpson, Scripps Satellite Oceanography Center, Scripps Institution of Oceanography, La Jolla, California

10　Stochastic simulation in the eighteenth and nineteenth centuries. Stephen Stigler, Department of Statistics, University of Chicago

17　Convergence of conditional expectations. Eimear Goggin, Department of Mathematics, Iowa State University

24　Constructing multivariate distributions with specific marginal distributions. Kenneth J. Koehler

31　Environmental conflicts and strategic behavior. Jason Shogren, Department of Economics/Center for Agricultural and Rural Development, Iowa State University

November 7　Variance component estimation from integrated likelihoods: An animal breeder's perspective. Daniel Gianola, Department of Animal Science, University of Illinois

14　Some admissible nonparametric tests. Seung-Chun Li

28　Alternative estimators of the parameters of the autoregressive process. Heon Jin Park

December 5　Optimal discrete adjustments for short production runs. Scott Vander Wiel

12　On a theorem by R. A. Fisher. Klaus Hinkelmann, Department of Statistics, Virginia Polytechnic Institute and State University

Spring 1991

January 16　(joint with Department of Electrical Engineering and Computer Engineering) Modeling and estimation in repairable systems reliability. Christian Hansen, Institute of Mathematical Statistics and Operations Research, the Technical University of Denmark

30　Comparing two groups of ranked objects by matching pairs. Jingyu Liu

31　Multidimensional blocking in experimental designs. Frances P. Stewart, Department of Statistics, University of Georgia

February 4　A new approach to spectral analysis and system identification of periodically excited systems. Peter Sherman, School of Mechanical Engineering, Purdue University

8　Estimation of the order restricted location parameters of two exponential distributions. Nabendu Pal, Department of Statistics, University of Southwestern Louisiana

13　Self-validating computations of probabilities for selected central and noncentral univariate probability functions. Morgan C. Wang

18　First order allocation. William Noble, Department of Statistics, Michigan State University

20　On noncausal autoregressions: Reversibility, identifiability, and estimation. F. Jay Breidt,

Summer 1991

Special Lectures and Seminars

Iowa STAT-ers Seminars

In Memoriam

Vera David, 1928 - 1991

Vera Reiss David died at Mary Greeley Medical Center, Ames, January 12, 1991. She was born in Prague, Czechoslovakia, on May 18, 1928, and left for England following Nazi occupation of Prague, then emigrated to Sydney, Australia, with her parents. Vera received a bachelor's degree in biochemistry at Sydney University in 1950 and married Herbert A. David in London, then worked there as a biochemist for three years while her husband completed his doctorate in statistics. Their son, Alexander, was born in 1954 after they moved back to Sydney. The family came to the U.S. in 1957 and to Ames in 1972. Vera received a master's degree in communications at the University of North Carolina-Chapel Hill in 1970.

Vera contributed much to the warmth and congeniality of Statistical Laboratory events. While her husband was director/head from 1972 to 1984, she was active in Statistics Women, which brought wives of statistics faculty and students together with women faculty and students. Under Vera's leadership, Statistics Women organized many departmentwide functions and instituted the Statistics Winter Party. On numerous occasions she opened her home to faculty and students, especially those from other countries, and welcomed alumni and other visitors with dinners and receptions.

Much of that time she was working on campus as an employee of the Ames Laboratory of the Department of Energy. She had also worked for WOI-TV and the Iowa State Department of Health. She retired as the Ames Lab's public information officer in February 1990 following a recurrence of colon cancer. Vera was active in Amnesty International and the Ames Jewish Congregation. Our deepest condolences go to her husband and her family.

A Vera David Fellowship is being set up to help support an outstanding female graduate student in statistics. Contributions may be made to the ISU Foundation, Memorial Union, Ames, Iowa 50011, and designated for the Vera David Fellowship in Statistics.