Ira A. FULTON school of engineering

2006-2007 ANNUAL RESEARCH REPORT

INDUSTRIAL ENGINEERING
ARIZONA STATE UNIVERSITY

IE@ASU
Research at a Glance

Contents

Industrial Engineering 2007-2008 Research Report

The IE Department enjoys an outstanding national and international reputation for excellence with particular strengths in industrial statistics and quality engineering, applied operations research, production and supply-chain logistics, and enterprise information systems in challenging manufacturing and service environments. A world-renowned faculty mentors approximately 170 graduate students—a ratio conducive to extensive faculty/student interaction—and has oversight of more than $2 million in research grants. The IE program is ranked in the top 20 nationally by U.S. News & World Report and is among the top programs in the western United States.

Our IE student body is exceptional. Students often receive national, regional and local recognition for their achievements in academics, research, teaching and leadership. ASU students have received the Pritsker Dissertation Award from the Institute of Industrial Engineers (IIE), and, recently a doctoral student's dissertation proposal was selected for the Juran Fellowship, awarded for rigorous research on the topic of quality. Currently, more than 65 of our Ph.D. graduates hold faculty positions at institutions of higher learning around the world. These are testaments not only to our outstanding students, but also to the quality of education and mentorship provided by the dedicated faculty.

Degrees Awarded 2006-2007

Bachelors	Masters	Doctoral
32	29	15

Enrollment 2006-2007

Bachelors	Masters	Doctoral
155	76	91

Faculty News, Honors & Awards

First U.S.-Mexico binational aerospace workshop

Many resources need to be networked to create a globally competitive North American aerospace manufacturing industry. Industry leaders need to make connections with current and potential suppliers. Governments need to know the mutual benefits and opportunities so they can support industry growth. Universities need to solve problems in supplier development and develop programs that train a workforce with the necessary leadership and technical skills.

Dr. J. René Villalobos

To make a first step, the Department of Industrial Engineering at Arizona State University (ASU) established the basis for a long-term forum committed to the development of a binational aerospace industry. The first U.S.–Mexico Binational Aerospace Workshop for Supplier Development was held October 5th and 6th, 2006, in the city of Chihuahua, Mexico; it was organized in conjunction with co-sponsors Institute Technológico y de Estudious Superioures de Monterrey (ITESM) and the Secretariat of Industrial Development of the State of Chihuahua. The sponsoring universities arranged the two-day, special-invitation networking event for 130-plus attendees—governments, industrial developers, universities, and international and Mexican suppliers.

During the workshop, presenters discussed the logistics of aerospace industry development and breakout groups identified the current obstacles and strategic objectives for the binational aerospace industry. In addition, matchmaking sessions were arranged at the event to increase partnership. The workshop was successful and its primary objectives were fulfilled: 1) the basis was set for a long-term forum for continued discussion on a North American aerospace industry development, and 2) a steering committee was established to support the continued meetings between the suppliers, governments, and universities.

ASU and ITESM were already working to support the industry with highly-qualified engineers educated through a USAID-sponsored program on logistics. The customized graduate degree program for engineers was tailored to improve the global competitiveness of an integrated North American aerospace industry that would benefit the economy and welfare of North America. The program is training students through study in both Mexico and the United States and includes borderless internships that work on competitiveness improvement within an aerospace company sponsor.

Dr. Mary Anderson-Rowland

Dr. Anderson-Rowland honored for contribution to diversity in engineering

Throughout her career, Mary Anderson-Rowland has been honored for her dedication to promoting diversity in engineering and 2006 is proving no different. This year's honors include election to the American Society of Engineering Education (ASEE) board of directors, election as a fellow of the Society of Women Engineers (SWE), and receipt of the ASEE Minorities in Engineering Award.

Anderson-Rowland is an associate professor in the Fulton School of Engineering Department of Industrial Engineering and director of three academic scholarship programs - NACME (National Action Council for Minorities in Engineering), CIRC (Collaborative Interdisciplinary Research Community), and CIRC/METS (Maricopa Engineering Transition Scholars). She has also been instrumental in creating several engineering diversity initiatives including the Women in Science and Engineering program and the Minority Engineering Program.

With election to the ASEE board of directors, Anderson-Rowland serves as chair of the Professional Interest Council IV, which promotes and facilitates engineering education activities in areas related to teaching, research, entrepreneurship, diversity, graduate studies and technology.

Anderson-Rowland was honored with the 2006 ASEE Minorities in Engineering Award in recognition of her success in increasing student diversity and motivating underrepresented students. She is also involved in research and activities to increase the recruitment, enrollment and retention of women in engineering education programs.

Faculty Keynote Addresses

Dr. Dan L. Shunk delivered the keynote address at two international conferences in 2006. The first, "Getting Your Home Operations in Order - To Compete and Win in the Global Marketplace," was delivered at the Canadian Manufacturers and Exporters Annual Conference. The second, "The Roadmap to Achieve Distributed, Collaborative Commerce," was at the International Conference on Concurrent Enterprising in Milan, Italy. Both addresses have been published.

Dr. Douglas C. Montgomery delivered the keynote address at the International Statistical Institute Meeting in January of 2006. The title of his published address is "Statistics and the Transformation of Science, Business and Industry."

Institute Leadership

Dr. Ronald G. Askin was elected to serve as the Sr. Vice President for Continuing Education for the Institute of Industrial Engineers. In this position, Dr. Askin participates in setting strategic directions for IIE and on approving financial and operational plans. Dr. Askin is also serving as the Chair of the IIE Council of Fellows. Fellow is the highest membership rank of IIE.

Left to right: Dr. Dan L. Shunk and Dr. Douglas C. Montgomery and Dr. Ronald G. Askin, Chair

2006-2007 Sponsored Research

Production Systems & Logistics

"DDDAS-Dynamically Integrated Production Planning & Operational Control for the Distributed Enterprise," NSF, Ronald Askin

"Banner Throughput Collaborative: Operations Research," Banner Health, Jeffery Cochran

"Banner Health/ASU Partnership for ED Patient Safety," Banner Health, Jeffery Cochran

"ASAP Customization, Advanced Micro Devices," John Fowler, Gerald Mackulak

"The SRC Fellowship," SRC, John Fowler, Gerald Mackulak

"GOALI Collaborative Research: Matching Demand and Supply through Price and Lead Time Decisions," NSF-ENG Civil, Mechanical and Manufacturing Innovation (CMMI), Esma Gel

"Multi-Product Cycle Time & Throughput Evaluation," SRC, Gerald Mackulak, John Fowler

"Efficient Model Generation of AMHS Design Alternatives," Asyst Technologies, Gerald Mackulak, John Fowler

"Industrial Assessment Center Program," US Dept of Energy, Rene Villalobos

"Automated Generation of AVI Routines for Surface Mounted Assembly Systems," NSF, Rene Villalobos

"Logistics Capacity Study of the Guayamas-Tucson Corridor," ADOT, Rene Villalobos

"US-Mexico Partnership on Education & Technology Transfer for the Aerospace Industry Assn Liaison Office for University Cooperation in Dev," Rene Villalobos, John Fowler, Esma Gel

"Arizona State University Affiliation with the Center for Engineering Logistics & Distribution," NSF, Rene Villalobos, Ron Askin, Esma Gel

Operations Research

"Predicting and Prescribing Human Decision Making Under Uncertain and Complex Scenarios," AFOSR, Ronald Askin

"Multi-Product Cycle Time & Throughput Evaluation via Simulation on Demand," SRC, John Fowler, Teresa Wu

"Collaborative Research: Optimization of the Design & Operation Surgery Delivery Systems," NSF, John Fowler

"EPNES: Integrated MEMS & Advanced Technologies for the Next Generation Power Distribution System," NSF, Esma Gel

"Improving Airline Schedule Planning at Swift Aviation Group," Swift Aviation Group, Ahmet Keha

"Pricing & Profit Optimization for Financial Services," Response Analytics, Teresa Wu

Information & Management Systems

"Distributed Decision Support Framework for Adaptive Supply Chains," IBM, John Fowler, Teresa Wu

"CAREER: Design & Implementation of a Virtual Product Development Environment," NSF, Teresa Wu

"Fabrication Environmentally Conscious (Benign) Manufacturing into Engineering Education," UTEP, Teresa Wu

"A Complex Adaptive System Approach to QOS Assurance & Stateful Resource Mgt for Dependable Information Infrastructure," DOD-Air Force, Nong Ye

"Automatic Extraction & Coordination of Audit Data & Features for Intrusion & Damage Assessment," DOD-Air Force, Nong Ye

Industrial Statistics

"Collaborative Research: Hierarchical Modeling of Yield & Defectivity to Improve Factory Operations," SRC, Douglas Montgomery

"Collaborative Research: Monitoring Process & Product Quality Profiles," NSF, Douglas Montgomery

"Statistical Modeling of Customer Satisfaction Data," IBM, Douglas Montgomery

"SRP-PSERC Project 1997-2007," SRP, Douglas Montgomery

"Modeling & Analysis of Profiled Reliability Tests Using Computation-Intensive Statistical Methods," NSF, Rong Pan

"Self-Learning of Decision Rules for Process Control," NSF, George Runger

"Credit Risk Analytics," Desert Schools Fed Credit Union, George Runger

"Data Mining Pilot on Intel Factory Data," Intel, George Runger

"Danish Industrial PHD Fellowship," Danish Ministry of Science Tech & Innovation, George Runger

"Integration of Health Outcomes Information--A Partnership with Arizona Department of Environmental," George Runger

"Quality, Arizona Department of Environmental Quality," George Runger

"Feature Selection with Ensembles for Complex Systems," NSF, George Runger

Engineering Education & Undergraduate Research

"Collaborative Interdisciplinary Research Community (CIRC)," NSF, Mary Anderson-Rowland

"Collaborative Research: Maricopa Engineering Transition Scholars (METS)," NSF, Mary Anderson-Rowland

"Collaborative Interdisciplinary Research Community Maricopa Engineering Transition Scholars (CIRC/METS)," NSF, Mary Anderson-Rowland

"NACME Scholars Program," NACME, Mary Anderson-Rowland

"Academic & Professional Development for Upper-Division Computer Science, Engineering and Mathematics Students," NSF, Mary Anderson-Rowland

"Scholarships in Science, Technology, Engineering, and Mathematics (NSF S-STEM)," NSF, Mary Anderson-Rowland

"Using Mathematical Programming for Associative Classification," Fulton Undergraduate Research Initiative, Reina Dharmazi, Ahmet Keha

"A Divide-and-Merge Algorithm for Single Machine Weighted Number of Tardy Jobs," Fulton Undergraduate Research Initiative, Gina Dumkrieger, Ahmet Keha

"Comparative Analysis of M/M/1 and M/G/1 Queuing Models in Healthcare," Fulton Undergraduate Research Initiative, Garrett Bean, Jeffery Cochran

"Is There a Relationship Between a Negative Medical Incident and the Intervention, Implemented Over Time, to Limit It?," Fulton Undergraduate Research Initiative, Jeff Kenyon, Jeffery Cochran

Douglas Montgomery

Regents' Professor
Co-Director, Executive Committee on Statistics
Ph.D., 1969, Virginia Polytechnic Institute and State University
Statistical design of experiments, optimization and response surface methodology, empirical stochastic modeling and industrial statistics
Quality and Reliability Engineering Laboratory (Q&RE lab)

Dr. Montgomery is Regents' Professor of Industrial Engineering and Statistics and the ASU Foundation Professor of Engineering at Arizona State University. He received the Ph.D. in engineering from Virginia Polytechnic Institute and State University.

His research interests focus on designed experiments for product/process design and development, empirical model-building, and process monitoring and control. Dr. Montgomery is an author of 11 books that have appeared in over 30 English editions and numerous foreign language editions and over 190 archival journal papers. He has mentored 50 Ph.D. students and over 40 M.S. students. He is a recipient of the Shewhart Medal, the Brumbaugh Award, the Lloyd S. Nelson Award, the William G. Hunter Award, and the Shewell Award (twice) from the American Society for Quality. He is also a recipient of the Ellis R. Ott Award. He is a former editor of the *Journal of Quality Technology* and is the currently one of the Chief Editors of *Quality & Reliability Engineering International*. He serves on the editorial boards of several other professional journals. Dr. Montgomery is a Fellow of the American Statistical Association, a Fellow of the American Society for Quality, a Fellow of the Royal Statistical Society, a Fellow of the Institute of Industrial Engineers, an Elected Member of the International Statistical Institute, and an Elected Academician of the International Academy for Quality.

Recent Publications

Robinson, T.J., Wulff, S.S., Montgomery, D.C., and Khuri, A.I., "Robust Parameter Design using Generalized Linear Models," *Journal of Quality Technology*, 2006, 38, pp. 65-75.

Gupta, S., Montgomery, D. C., and Woodall, W. H., "Performance Evaluation of Two Methods for Online Monitoring of Linear calibration Profiles," *International Journal of Production Research*, 2006, 44, pp. 1927-1942.

Vadde, K.K., Syrotiuk, V. R., and Montgomery, D.C., "Optimizing Protocol Interaction using Response Surface Methodology," *IEEE Transactions on Mobile Computing*, 2006, 5, pp. 627-639.

Kowalski, S. M., Vining, G. G., Montgomery, D. C., and Borror, C. M., "Modifying a Central Composite Design to Model the Process Mean and Variance when there are Hard-to-Change factors," *Journal of the Royal Statistical Society C (Applied Statistics)*, 2006, 55, pp. 615-630.

Goldfarb, H. B., Borror, C. M., Montgomery, D. C., and Anderson-Cook, C. M., "Using Genetic Algorithms to Generate Mixture-Process Experimental Designs Involving Control and Noise Variables," *Journal of Quality Technology*, 2005, 37, pp. 60-74.

Leadership Activities

Editor, *Quality and Reliability Engineering International;* Editorial Advisor, *Journal and Probability and Statistical Science;* Editorial Board, *Quality Engineering;* Editorial Board, *Total Quality Management;* Editorial Board, *Journal of Quality Technology;* Editorial Board, *Journal of Applied Statistics;* Editorial Board, *International Journal of Production Research;* Editorial Board, *International Journal of Six Sigma.*

Ronald Askin

Professor and Chair
Ph.D., 1979, Georgia Institute of Technology
Design and operation of discrete manufacturing systems, production systems, decision analysis, applied operations research, facilities planning, industrial statistics and applied optimization

Ronald G. Askin is a Professor and Department Chair of Industrial Engineering at Arizona State University. He has authored or co-authored over 80 professional publications, primarily on the application of operations research and statistical methods to the design and analysis of production systems. His current research concentrates on developing integrated models for operational planning including facilities design, production planning, scheduling, material flow, and quality assurance. Other research interests include project management, team formation, and human decision making. Dr. Askin co-authored the texts *Modeling and Analysis of Manufacturing Systems* (1993) and *Design and Analysis of Lean Production Systems* (2002), both of which received the IIE Joint Publishers Book of the Year Award (1994 and 2003, respectively).

Dr. Askin is a Fellow of the Institute of Industrial Engineers (IIE), and an active member of the Institute for Operations Research and Management Science (INFORMS) and the Society of Manufacturing Engineers (SME). He currently serves as Chair of the Council of Fellows for IIE and on the IIE Board of Trustees.

Other awards he has received include the *IIE Transactions* on Design and Manufacturing Best Paper Award (twice as co-author), the Shingo Award for Excellence in Manufacturing Research, *IIE Transactions* Development and Applications Award (co-author), the ASEE/IIE Eugene L. Grant Award (co-author), and the National Science Foundation Presidential Young Investigator Award.

Recent Publications

Askin, R.G., and Chen, J., "Dynamic Task Assignment for Throughput Maximization with Worksharing," *European Journal of Operational Research*, 168(3), 2006, pp. 853-869.

Chen, J., and Askin, R.G., "Throughput Maximization in Serial Production Lines with Worksharing," *International Journal of Production Economics*, 99, 2006, pp. 88-101.

Krishnan, S., and Askin, R.G., "Effect of Information Sharing and Control Strategies on Supply Chain Performance," *International Journal of Simulation and Process Modeling*, 3/4, 2006, pp. 175-187.

Leadership Activities

Editorial Board, *International Journal of Industrial and Systems Engineering;* Special Issue Co-Editor, *International Journal of Production Economics;* Journals Committee, *Society of Manufacturing Engineering.*

John Fowler

Professor
Ph.D., 1990, Texas A&M University
Deterministic scheduling, discrete event simulation methodology, semiconductor manufacturing systems analysis, healthcare systems analysis and applied operations research
Modeling And Analysis For Seminiconductor Manufacturing Laboratory (MASM lab): ie.fulton.asu.edu/research/masm-lab

John W. Fowler is a professor in the operations research and production systems and logistics groups. Much of his research has focused on scheduling and simulation methodologies for application in semiconductor manufacturing. His research has been well supported by the National Science Foundation (Nsf), the Semiconductor Research Corp., International SEMATECH, as well as by several leading semiconductor manufacturers. Over the last two years, he has begun research on applications of scheduling, simulation, and other operations research techniques to health care and was recently awarded a grant from the National Science Foundation to investigate ways to schedule surgical delivery systems.

Dr. Fowler has co-authored over 60 journal articles in outlets including *Computers and Operations Research*, *Decision Sciences*, *European Journal of Operational Research*, *IEEE Transactions on Semiconductor Manufacturing*, *Journal of Scheduling*, and *Operations Research*. In addition, he has co-authored 11 book chapters and nearly 100 conference papers. He has advised or co-advised 20 Ph.D. students, 22 Master's students, and 3 undergraduate Honor's students.

Dr. Fowler is a Fellow of the Institute of Industrial Engineers (IIE), is a member of the Board of Directors of the Winter Simulation Conference, is Treasurer of Omega Rho (the IE Honor Society), and serves on the INFORMS Subdivisions Council. He is co-Program Chair of the 2008 Industrial Engineering Research Conference and Program Chair for the 2008 Winter Simulation Conference.

Recent Publications

Vardar, C., Gel, E.S., and Fowler, J.W., "A Framework for Evaluating Remote Diagnostics Investment Decisions for Semiconductor Equipment Suppliers," *European Journal of Operational Research*, Vol. 180, No. 3, 2007, pp. 1411–1426.

Laub, J., Fowler, J., and Keha, A., "Minimizing Makespan with Multiple Orders per Job in a Two Machine Flowshop," *European Journal of Operational Research*, Vol. 182, No. 1, 2007, pp. 63-79.

Chong, C.S., Lendermann, P., Gan, B.P., Duarte, B.M., Fowler, J.W., and Callarman, T.E., "Development and Analysis of a Customer Demand Driven Semiconductor Supply Chain Model using High Level Architecture (HLA)," *International Journal of Simulation and Process Modeling*, Vol. 2, Nos. 3-4, 2006, pp. 210-221.

Kim, B., Gel, E.S., Fowler, J.W., Carlyle, W.M., and Wallenius, J., "Evaluation of Nondominated Solution Sets for K-Objective Optimization Problems: An Exact Method and Approximations," *European Journal of Operational Research*, Vol. 173, No. 2, 2006, pp. 565-582.

Stray, J., Fowler, J.W., Carlyle, W.M., and Rastogi, A.P., "Enterprise-Wide Strategic and Logistics Planning for Semiconductor Manufacturing", *IEEE Transactions on Semiconductor Manufacturing*, Vol. 19, No. 2, 2006, pp. 259-268.

Leadership Activities

Area Editor–Manufacturing, *SCS Transactions on Simulation;* Area Editor–Planning & Scheduling, *Computers and Industrial Engineering;* Associate Editor, *IEEE Transactions on Electronics Packaging Manufacturing;* Associate Editor–Factory Modeling and Control, *IEEE Transactions on Semiconductor Manufacturing;* Editorial Board, *IIE Transactions;* Editorial Board, *Journal of the Chinese Institute of Industrial Engineers;* Editorial Board, *Journal of Simulation;* Guest Editor–eManufacturing in the Semiconductor Industry, *IEEE Transactions on Automation Science and Engineering.*

Gary Hogg

Professor
Ph.D., 1972, University of Texas at Austin
Applied statistics, process control, data mining, causal modeling and inference

Gary L. Hogg is currently a Professor of Industrial Engineering at Arizona State University. He holds an M.S. and Ph.D. from the University of Texas in Operations Research and B.S.M.E. from Texas A&M University.

His graduate training and subsequent research has been in the area of applying operations research, particularly simulation and optimization, to the design and control of production and service systems. He has taught a broad range of operations research and industrial engineering courses during his 35-plus year academic career, published widely, and conducted research for NSF, NASA, USAF, DOE, EPRI, DOT, DOD and the DOC. He has also served as a consultant to over twenty-five Fortune 500 corporations, but also, many smaller manufacturers. The bulk of his industrial experience is in high tech manufacturing, particularly aerospace and electronics.

He served as Program Head of IE, Interim Head of the IE Department and Asscociate Dean for Research and International Programs at Texas A&M. From 1995 through 2005 he served as the Chair of Industrial Engineering at Arizona State University. He is a Fellow of the Institute of Industrial Engineers and has served on the IIE Board of Trustees, Chair of the Council of Industrial Engineering Academic Department Heads, VP of Technical Societies, Director of the OR Division and President of the Arizona Chapter of IIE as well as the Brazos Valley Chapter (Texas).

He serves as Editorial Consultant to the National Research Council for Modeling and Simulation in Manufacturing and Defense Systems Acquisition, 2002; Contributing Editor for *McGraw-Hill Yearbook of Science and Technology*, 2002 through 2007 and the *Encyclopedia of Science and Technology*, 2005; and served as Area Editor for the *Journal of Computers in Industrial Engineering* from 2000 to 2007.

Recent Publications

Van den Briel, M. , Villalobos, J.R., Hogg, G.L. , Lindeman, T. and Mulé, A., "Development of Efficient Boarding Strategies at America West Airlines," *Interfaces*, Vol. 35, No. 3, May–June 2005, pp. 191–201.

Fowler, J.W., Hogg, G.L., and Mason, S.J., "Workload Control in the Semiconductor Industry," *Production Planning and Control*, Vol. 13, No. 7, 2002, pp. 568-578.

Fowler, J.W., Hogg, G.L., and Phillips, D.T., "Control of Multiproduct Bulk Server Diffusion/Oxidation Processes Part Two: Multiple Servers," *IIE Transactions on Scheduling and Logistics*, Vol. 32, No. 2, 2000, pp. 167-176.

Leadership Activities

Associate Editor–Probabalistic Models, *Computers & Industrial Engineering*

George Runger

Professor

Ph.D., 1982, University of Minnesota

Statistical learning, process control, and data mining for massive, multivariate data sets with applications in numerous disciplines

Quality and Reliability Engineering Laboratory (Q&RE lab)

George C. Runger, Ph.D., is a Professor in the department of Industrial Engineering at Arizona State University. His research is on real-time monitoring and control, data mining, and other data-analysis methods with a focus on large, complex, multivariate data streams. His work is funded by grants from the National Science Foundation and corporations. In addition to academic work, he was a senior engineer at IBM. He holds degrees in industrial engineering and statistics.

Recent Publications

Hwang, W., Runger, G.C., and Tuv, E., "Multivariate Statistical Process Control with Artificial Contrasts," *IIE Transactions: Special Issue on Data Mining,* 39(6), 2007, pp. 659-669.

Berrado, A. and Runger, G.C. "Using Metarules to Organize and Group Discovered Association Rules," *Data Mining and Knowledge Discovery,* 14(3), 2007, pp. 409-431.

Runger, G.C., Barton, R.R., Del Castillo, E., Woodall, W.H., "Optimal Monitoring of Multivariate Data for Fault Patterns," *Journal of Quality Technology,* 39(2), 2007, pp. 159-162.

Li, F., Runger, G.C., and Tuv, G.C., "Supervised Learning for Change-point Detection," *International Journal of Production Research: Special Issue on Data Mining*, 44(14-15), 2006, pp. 2853-2868.

Ramirez, B. and G.C. Runger (2006). "Quantitative Techniques to Evaluate Process Stability," *Quality Engineering*, 18(1), pp. 53-68.

Garcia, H., R. Villalobos, and G.C. Runger, "An Automated Feature Selection Method for Visual Inspection Systems," *IEEE Transactions on Automation Science and Engineering,* 3(40), 2006, pp. 394-406.

Leadership Activities

Department Editor, *Journal of Quality Technology;*
Associate Editor, *Journal of Mathematical and Management Sciences.*

Dan Shunk

Professor, AVNET Chair
Ph.D., 1976, Purdue University
Agile, enterprise and CIM systems, group technology, planning systems, economics of computer-integrated manufacturing (CIM), strategy and strategic role of technology
Supply Network Integration Laboratory (SNIL)

Dr. Shunk came from industry to ASU in 1984 as an associate professor of industrial engineering. From 1984 to 1994, he served as the CIM Systems Research Center Director. He is currently serving as the AVNET Chair of Supply Network Integration.

His principal research interests are in material, information, knowledge supply network integration, computer integrated manufacturing, electronic commerce progression, time compression, cultural acceptance of change and enterprise integration.

Shunk a senior member of the Institute of Industrial Engineers and a senior charter member of the Computer Aided Systems Association of the Society of Manufacturing Engineers. He is also a member of the Alpha Pi Mu and Tau Beta Pi honor societies. He currently serves on the editorial boards and the *International Journal of Flexible Automation and Integrated Manufacturing*, *International Journal of Logistics*, and the *International Journal of Product Development*.

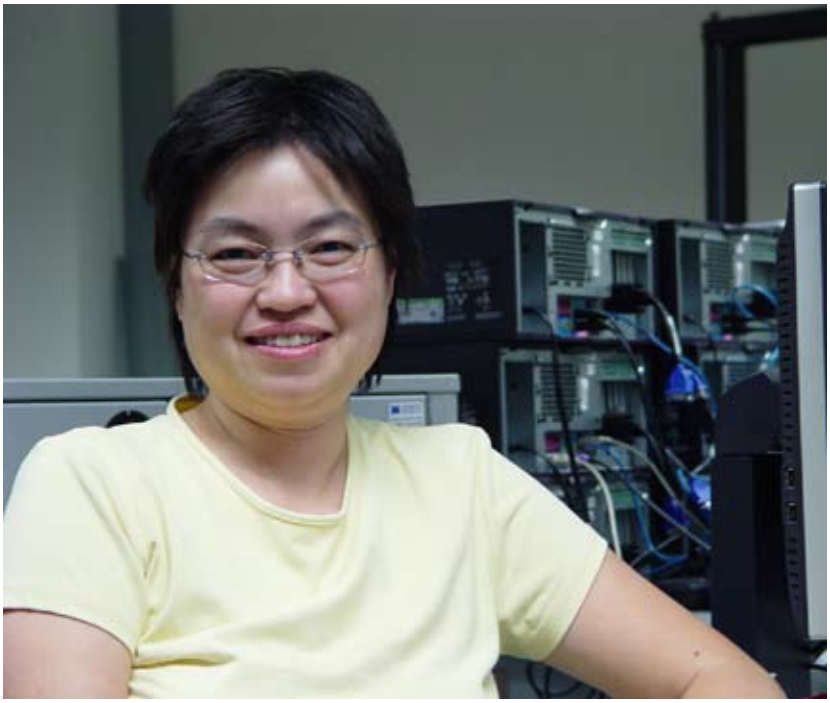
Recent Publications

Martinez-Olvera, C., and Shunk, D. "Comprehensive Framework for the Development of a Supply Chain Strategy," *International Journal of Production Research*, 2006, 44, No. 21, pp. 17.

Shunk, D., Carter, J., Hovis, J. and Talwar, A., "Electronics Industry Drivers of Intermediation and Disintermediation," *International Journal of Physical Distribution and Logistics Management*, Volume 37, No. 3, 2007, pp. 248-261.

Leadership Activities

Editorial Board, *International Journal of Flexible Automation and Integrated Manufacturing;* Editorial Board, *International Journal of Logistics;* Editorial Board, *International Journal of Product Development*.



Nong Ye

Professor

Ph.D., 1991, Purdue University

Information and systems assurance, data mining and modeling, quality optimization and control of system operations

Information and Systems Assurance Laboratory: *isa.eas.asu.edu*

Dr. Ye's past and current research activities–garnering over $9M external funding and have producing seventy-six journal papers, two books including *The Handbook of Data Mining*, and one U.S. patent–fall into the following two areas: data and modeling, and optimization and quality control of system operations.

Her research in data and modeling involves applications in computer and network data, cognitive behavior data, and biomedical data. Research in optimization and quality control of system operations involves computer and network systems, and manufacturing and supply chain enterprises.

Ye's interdisciplinary research is bringing industrial engineering theories and techniques into the scientific understanding and engineering of information systems. Applications of her research are establishing scientific understanding of information systems and the human brain, and developing engineering technologies for secure and dependable information systems.

Recent Publications

Xu, X. and Ye, N., "Minimization of job waiting time variance on identical parallel machines," *IEEE Transactions on Systems*, Man, and Cybernetics, Part C, Vol. 37, No. 5, 2007, pp. 917-927.

Ye, N., and Chen, Q., "Attack-norm separation for detecting attack-induced quality problems on computers and networks," *Quality and Reliability Engineering International*, Vol. 23, No. 5, 2007, pp. 545-553.

Ye, N., Li, X., Farley, T. and Xu, X., "Job scheduling methods for reducing waiting time variance," *Computers & Operations Research*, Vol. 34, No. 10, 2007, pp. 3069-3083.

Ye, N., Farley, T., Li, X., and Harish, B., "Batch scheduled admission control for computer and network systems," *Information, Knowledge, Systems Management*, Vol. 5, No. 4, 2005/2006, pp. 211-226.

Ye, N. and Farley, T., "Information sharing and control in homogeneous and heterogeneous supply networks," *International Journal of Modeling and Simulation*, Vol. 26, No. 2, 2006, pp. 160-168.

Li, X. and Ye, N., "A supervised clustering and classification algorithm for mining data with mixed variables," *IEEE Transactions on Systems, Man, and Cybernetics*, Part A, Vol. 36, No. 2, 2006, pp. 396-406.

Leadership Activities

Associate Editor, *IEEE Transactions on Reliability;* Associate Editor, *Information, Knowledge, Systems Management;* Editor, *IEEE Transactions on Systems, Man, and Cybernetics, Part A;* Editorial Board, *International Journal of Human-Computer Interaction;* Editorial Board, *Information, Knowledge, Systems Management.*

Mary Anderson-Rowland

Associate Professor
Ph.D., 1966, University of Iowa
Statistics and probability for quality control, academic scholarship programs for all engineering students with an emphasis on women and underrepresented minority students

Mary Anderson-Rowland is an associate professor in the Department of Industrial Engineering in the Ira A. Fulton School of Engineering at ASU. Anderson-Rowland received her B.A. in mathematics from Hope College in 1961, and her M.S. and Ph.D. in mathematics/statistics from the University of Iowa in 1963 and 1966, respectively.

Anderson-Rowland came to ASU in 1966 as a lecturer in mathematics and became the first woman faculty in engineering in 1974. She served as a statistical consultant to a variety of industry from 1973 until 1993, when she became the first woman appointed as an associate dean in the engineering school. She served as the associate dean of Student Affairs for 11 years. She is currently serving as the director of three academic scholarship programs and a fourth project for transfer students.

Anderson-Rowland was heavily involved in the creation of the Women in Engineering Program as well as the Minority Engineering Program. She serves as a mentor for women and underrepresented engineering students as well as supporting research that increases the recruitment, enrollment, and retention of engineering students with over 150 publications.

Anderson has been the recipient of six national awards and recognitions: American Society for Engineering Education, Fellow, 2001; Distinguished Engineering Educator Award, Society of Women Engineers, 2002; National Engineering Award, 2003, the highest award given by the American Association of Engineering Societies; SHPE National Educator of the Year Star Award, 2005; Minorities in Engineering National Award, American Society of Engineering Education, 2006; and Society of Women Engineers, Fellow, 2006.

Recent Publications

Anderson-Rowland, M.R., Bernstein, B.L. & Russo, N.F., "The Doctoral Program in Engineering and Computer Science: Is It the Same for Women and Men?" Proceedings of the 2007 WEPAN Conference, Orlando, Florida, June 2007, 14 pages, CD-ROM and www.wepan.org.

Anderson-Rowland, M.R. & VanIngen-Dunn, C., "Encouraging Transfer Students To Pursue a Bachelor's Degree in Engineering and Computer Science," Proceedings of the 2007 American Society for Engineering Education Annual Conference & Exposition, Honolulu, Hawaii, June 2007, 7 pages, CD-ROM and www.asee.org.

Anderson-Rowland, M.R., "A Comparison of the Academic Achievements and Retention Rates of Women and Men Engineering and Computer Science Students in an Academic Scholarship Program Designed for Underrepresented Minority Students," Proceedings of the 2007 WEPAN Conference, Orlando, Florida, June 2007, 11 pages, CD-ROM and www.wepan.org.

Leadership Activities

2007 WEPAN Proceedings Chair; 2006-2008 PIC IV Chair, Board of Directors, American Society of Engineering Education; 2005 Women in Engineering Division Chair, American Society of Engineering Education; Women in Engineering Recruitment and Retention Expert, National Academy of Engineering.

Esma S. Gel

Associate Professor
Ph.D., 1999, Northwestern University
Applied probability, stochastic processes, queuing theory, stochastic modeling and control of manufacturing systems

Esma Gel researches and teaches courses in the area of Operations Research, specifically focusing on production systems control and supply chain management.

Her research focuses on the use of applied probability techniques for management and design of production systems and supply chains. Some of her recent work has been on workforce agility and management, dynamic price and lead time quotation to manage congestion in make-to-order systems, queueing approximations for performance evaluation of manufacturing systems, and economic impact of inventory record inaccuracies in retail environments. Gel has presented her work in national and international conferences, and published in leading archival journals of her area. Her research has been funded by the National Science Foundation (NSF), as well as industrial partners such as Intel, IBM, and Infineon. Her latest grant from NSF involves the development of a framework for the integration of price, lead time, order selection, and inventory decisions to match supply with demand.

Gel is a member of the Institute for Operations Research and the Management Sciences (INFORMS), the Institute of Industrial Engineers, American Society of Engineering Education (ASEE), and the Operations Research Society of Turkey.

Recent Publications

Gel, E. S., W. J. Hopp, and M. P. Van Oyen, "Hierarchical cross-training in WIP-constrained environments," *IIE Transactions*, 2007, 39(2), pp. 125 – 143.

Armbruster, D. and E. S. Gel, "Bucket brigades revisited: Are they always effective?" *European Journal of Operational Research*, 2006, 172(1), pp. 213-229.

Gel, E. S., W. J. Hopp and M. P. Van Oyen, "Factors affecting the opportunity of worksharing as a dynamic line balancing mechanism," *IIE Transactions*, 2002, 34(10), pp. 847-863.

Wirojanagud, P., E. S. Gel, J. W. Fowler, and R. Cardy, "Modeling inherent worker differences for workforce planning," *International Journal of Production Research*, 2007, 45(3), pp. 525-553.

Vardar, C., E. S. Gel, J. W. Fowler, "A framework for evaluating remote diagnostics investment decisions for semiconductor equipment suppliers," *European Journal of Operational Research*, 2007, 180(3), pp. 1411-1426.

Carlyle, M. W., J. W. Fowler, E. S. Gel, B. Kim, "Quantitative comparison of approximate solution sets for bi-criteria optimization problems," *Decision Sciences*, 2003, 34 (1), pp. 63-82.

Leadership Activities

Associate Editor, *Journal of Flexible Services and Manufacturing*

Gerald Mackulak

Associate Professor
Ph.D., 1979, Purdue University
Simulation methodology, simulation output analysis, automated production systems, material handling design and analysis

Recent Publications

Lung, C.H., Urban, J.E., Mackulak, G.T., "Analogy-based domain analysis approach to software reuse," *Requirements Engineering*, May 2006, pp. 1-22.

Mackulak, G.T., Fowler, J., Park, S., McNeill, J., "A Three Phase Simulation Methodology for Generating Accurate and Precise Cycle Time-Throughput Curves," *International Journal of Simulation and Process Modeling*, Vol. 1, Nos. 1/2, 2005, pp. 36-47.

Diaz, S., Fowler J.W., Pfund, M.E., Mackulak, G.T., and Hickie, M., "Evaluating the Impacts of Reticle Requirements in Semiconductor Wafer Fabrication," *IEEE Transactions on Semiconductor Manufacturing*, Vol. 18, No. 4, 2005, pp.622-632.

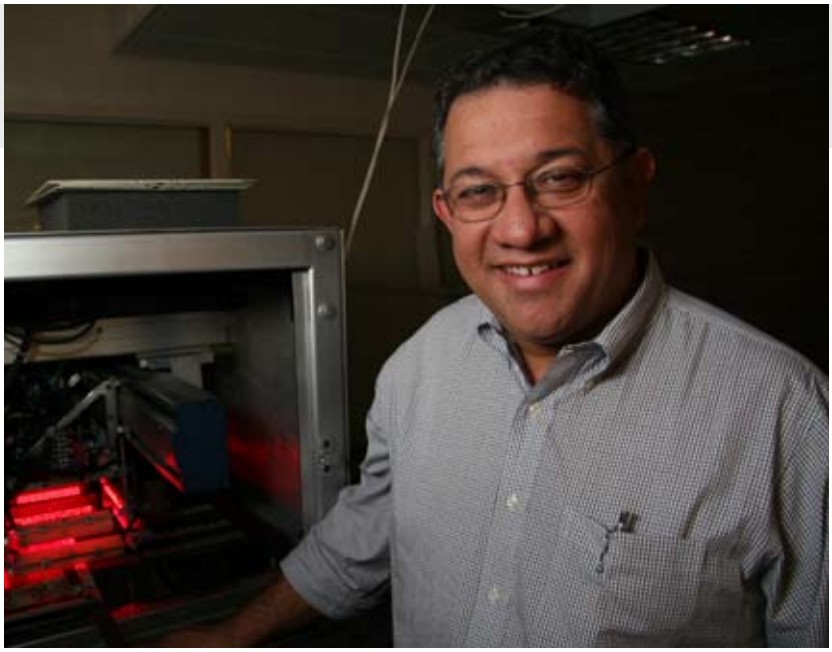
Leadership Activities

Associate Editor, *Transactions of the Society for Modeling and Simulation International;* Editorial Board, *International Journal of Simulation and Process Modeling;* General Chair 2011, Winter Simulation Conference.

Gerald Mackulak is currently participating in sponsored research from the SRC/International Semitech. His collaborative research project is investigating multi-product cycle time and throughput evaluation via simulation on demand, sponsored by Force II/SRC.

In previous years, he has participated in sponsored research from the Semiconductor Research Corporation, Anteon Corporation, Asyst, NSF, PRI Automation, the Federal Highway Commission, the McDonnell Douglas Corporation, the Hughes Missile Systems Company, the Institute for Manufacturing and Automation Research, the Allied-Signal Corporation, and Motorola.

Mackulak has written more than 75 journal and conference papers. He was recently a member of the editorial board of *International Journal of Simulation and Probability Modeling*; a past associate editor for *Simulation: Transactions of the Society for Modeling and Simulation International*, and in 2003 edited a special issue of the journal. He has received several Engineering Teaching Excellence Award nominations. He currently serves as the General Chair for the Winter Simulation Conference in 2011.



J. René Villalobos

Associate Professor
Ph.D., 1991, Texas A&M University
logistics, automated quality systems, manufacturing systems and applied operations research
International Logistics and Productivity Improvement Laboratory (ILPIL): ilpil.asu.edu

René Villalobos came to ASU in 1999 from the Mechanical and Industrial Engineering Department at the University of Texas at El Paso where he had been serving as an associate professor.

Prior to academia, Villalobos served as an industrial engineer for Packard Electric and a project engineer for Renault Company. Sponsors of Villalobos' research include the National Science Foundation, Texas Advanced Technology Program, the Arizona Dept. or Transportation, U.S. Army and private industry totaling an excess of $3 million dollars. He was the recipient of the 1993 IIE Doctoral Dissertation Award and a 1995 NSF Career Grant.

He is a member of Alpha Pi Mu, the Institute for Operations Research and the Management Science, and the American Society for Engineering Education. He is also a member of the Technical Advisory Board for *International Journal of Interactive Design and Manufacturing*.

Recent Publications

Montano, A, J.R. Villalobos, M.A. Gutierrez and L.R. Mar, "Performance of Serial Assembly Line Designs under Unequal Operator Speeds and Learning," *International Journal of Production Research*, Vol. 45 No 22, 2007, *in press*.

Garcia, H., Villalobos, R., and Runger, G., "Automated Feature Selection for Visual Inspection Systems," *IEEE Transactions on Automation Science and Engineering*, Vol. 3, No. 4, October 2006, pp. 394-406.

Van den Briel, M. , Villalobos, J.R., Hogg, G.L. , Lindeman, T. and Mulé, A., "Development of Efficient Boarding Strategies at America West Airlines," *Interfaces*, Vol. 35, No. 3, May–June 2005, pp. 191–201.

Villalobos, J.R., M. Arellano, A. Medina and Aguirre, F., "Vector Classification of SMD Images," *Journal of Manufacturing Systems*, Vol. 22, No. 4, 2003, pp. 265-282.

Villalobos, J.R., Munoz, L. and Gutierrez, M.A., "An Application of Fixed and Adaptive Multivariate SPC Charts for On-line Monitoring of SMD Assembly," *International Journal of Production Economics*, Vol. 95, No. 1, 2005, pp. 109-121.

Jing Li

Assistant Professor

Ph.D., 2007, University of Michigan

Applied statistics, process control, data mining, causal modeling and inference

Quality and Reliability Engineering Laboratory (Q&RE lab)

Jing Li

Assistant Professor

Ph.D., 2007, University of Michigan

Applied statistics, process control, data mining, causal modeling and inference

Quality and Reliability Engineering Laboratory (Q&RE lab)

Jing Li joined the Quality and Reliability Engineering research group in Fall 2007. Li's research interests include applied statistics, data mining, causal modeling and inference for process control. Her recent research focuses on modeling and analyzing massive high-dimensional datasets in complex systems for improving the quality of products and processes. Her work has been applied to manufacturing and public health problems.

She recently received an IERC Best Paper award for "Causation-Based T2 Decomposition for Multivariate Process Monitoring and Diagnosis," co-authored with Judy Jin and her advisor, Jan Shi, at the 2006 IIE

Teresa Wu came to the Ira A. Fulton School of Engineering in 2001. In 2003, she was the recipient of the National Science Foundation's Faculty Early Development (CAREER) Award. Her research interests include collaborative product development, supply chain management, distributed decision support and information systems. Wu's CAREER project is the "Design and Implementation of a Virtual Product Development Environment."

Li, J., and Shi, J., "Knowledge Discovery from Observational Data for Process Control using Causal Bayesian Networks," *IIE Transactions*, 39 (6), 2007, pp. 681 – 690.

Jin, R., Li, J., and Shi, J., "Quality Prediction and Control in Rolling Processes using Logistic Regression," *Transactions of NAMRI/SME* (North American Manufacturing Research Institution of Society of Manufacturing Engineers), 35, 2007, pp. 113-120.

Lin, G., Li, J., Hu, S. J., and Cai, W., "A Computational Response Surface Study of 3D Aluminum Hemming using Solid-to-Shell Mapping," *American Society of Mechanical Engineers* (ASME) *Transactions, Journal of Manufacturing Science and Engineering*, 129(2), 2007, pp. 360-368.

Li, J., Shi, J., and Chang, T.S., "On-line Seam Detection in Rolling Processes using Snake Projection and Discrete Wavelet Transform," accepted by *American Society of Mechanical Engineers* (ASME) *Transactions, Journal of Manufacturing Science and Engineering*, October 2007 to appear.

Control using Causal Bayesian Networks," *IIE Transactions*, 39 (6), 2007, pp. 681 – 690.

Jin, R., Li, J., and Shi, J., "Quality Prediction and Control in Rolling Processes using Logistic Regression," *Transactions of NAMRI/SME* (North American Manufacturing Research Institution of Society of Manufacturing Engineers), 35, 2007, pp. 113-120.

Lin, G., Li, J., Hu, S. J., and Cai, W., "A Computational Response Surface Study of 3D Aluminum Hemming using Solid-to-Shell Mapping," *American Society of Mechanical Engineers* (ASME) *Transactions, Journal of Manufacturing Science and Engineering*, 129(2), 2007, pp. 360-368.

Li, J., Shi, J., and Chang, T.S., "On-line Seam Detection in Rolling Processes using Snake Projection and Discrete Wavelet Transform," accepted by *American Society of Mechanical Engineers* (ASME) *Transactions, Journal of Manufacturing Science and Engineering*, October 2007 to appear.

Wu, T., Blackhurst, J., Chidambaram, V., "A Model for Inbound Supply Risk Analysis," *Computers in Industry*, Vol. 57, Issue 4, May 2006, pp. 350-365.

Parmar, D., Wu, T., Blackhurst, J., "MMR: An Algorithm for Clustering Categorical Data Using Rough Set Theory," *Data and Knowledge Engineering*, in print.

Kwon, T.J., Wu, T., "Cognitive Understanding of Remote Systems from the Perspectives of Online Laboratory Learning," *IEEE Computers in Education Journal*, 2007, to appear.

Leadership Activities

Editorial Board, *International Journal of Electronic Business Management*,

Computer and Standard Interface,

Guest Editor, *International Journal of Electronic Business Management Special Issue on Enabling Distributed Product Development*.

Li is a member of the Institute for Operations Research and the

Ahmet Keha

Assistant Professor
Ph.D., 2003, Georgia Institute of Technology
Computational and theoretical aspects of integer programming and combinatorial optimization, modern heuristics techniques, logistics and scheduling
Logistics, Optimization and Control Laboratory (LOC Lab)

Ahmet B. Keha joined the Ira A. Fulton School of Engineering in 2003, after receiving his Ph.D. from the Georgia Institute of Technology. His research interests include computational and theoretical aspects of integer programming and combinatorial optimization, application of integer programming, and modern heuristic techniques and scheduling.

Keha has presented papers at the INFORMS National Meetings, International Symposium on Mathematical Programming and Industrial Engineering Research Conferences. Some of the journals that he has published are *Operations Research*, the *European Journal of Operational Research*, and *Operations Research Letters*.

Recent Publications

Keha, A.B., deFarias, I.R., and Nemhauser, G.L. "A Branch-and-Cut Algorithm without Binary Variables for Nonconvex Piecewise Linear Optimization," *Operations Research*, 2006, 54, pp. 847-858.

McGarry, M. P., Reisslein, M., Maier, M., and Keha, A. "Bandwidth management for WDM EPONs," *Journal of Optical Networking*, 2006, 5, pp. 637-654.

Colak, A.B., and Keha, A.B. "A Divide-and-Merge Algorithm for a Single Machine Scheduling Problem," *Proceedings of IERC*, 2006, pp. 8.

Jing Li

Assistant Professor
Ph.D., 2007, University of Michigan
Applied statistics, process control, data mining, causal modeling and inference
Quality and Reliability Engineering Laboratory (Q&RE lab)

Jing Li joined the Quality and Reliability Engineering research group in Fall 2007. Li's research interests include applied statistics, data mining, causal modeling and inference for process control. Her recent research focuses on modeling and analyzing massive high-dimensional datasets in complex systems for improving the quality of products and processes. Her work has been applied to manufacturing and public health problems.

She recently received an IERC Best Paper award for "Causation-Based T2 Decomposition for Multivariate Process Monitoring and Diagnosis," co-authored with Judy Jin and her advisor, Jan Shi, at the 2006 IIE Conference.

Li is a member of the Institute for Operations Research and the Management Sciences (INFORMS) and the Institute of Industrial Engineers (IIE).

Recent Publications

Li, J., and Shi, J., "Knowledge Discovery from Observational Data for Process Control using Causal Bayesian Networks," *IIE Transactions*, 39 (6), 2007, pp. 681 – 690.

Jin, R., Li, J., and Shi, J., "Quality Prediction and Control in Rolling Processes using Logistic Regression," *Transactions of NAMRI/SME* (North American Manufacturing Research Institution of Society of Manufacturing Engineers), 35, 2007, pp. 113-120.

Lin, G., Li, J., Hu, S. J., and Cai, W., "A Computational Response Surface Study of 3D Aluminum Hemming using Solid-to-Shell Mapping," *American Society of Mechanical Engineers* (ASME) *Transactions, Journal of Manufacturing Science and Engineering*, 129(2), 2007, pp. 360-368.

Li, J., Shi, J., and Chang, T.S., "On-line Seam Detection in Rolling Processes using Snake Projection and Discrete Wavelet Transform," accepted by *American Society of Mechanical Engineers* (ASME) *Transactions, Journal of Manufacturing Science and Engineering*, October 2007 to appear.

Rong Pan

Assistant Professor
Ph.D., 2002, Pennsylvania State University
Industrial statistics, reliability analysis and time series modeling
Quality and Reliability Engineering Laboratory (Q&RE lab)

Rong Pan joined the Department of Industrial Engineering in the Ira A. Fulton School of Engineering in 2006. He received his B.S. in Materials Engineering from Shanghai Jiao Tong University, China, in 1995; his M.S. in Industrial Engineering from the College of Engineering of Florida A&M University and the Florida State University in 1999; and his Ph.D. in Industrial Engineering from the Pennsylvania State University in 2002. Before coming to ASU, Pan was an assistant professor of Industrial Engineering at the University of Texas at El Paso.

Pan's research interests include statistical quality control, reliability engineering, time series analysis and control, and supply chain management. Journals he has published in include *Journal of Quality Technology*, *Journal of Applied Statistics*, *International Journal of Production Research*, and *Quality and Reliability Engineering International*. His current research project, funded by the National Science Foundation (NSF), is on modeling and analysis of profiled reliability testing using computation-intensive statistical methods. His previous projects were funded by U.S. Department of Education (DoEd), Texas Department of Transportation (TxDOT) and GM.

Pan is a senior member of American Society of Quality (ASQ), and a member of the Institute for Operations Research and the Management Sciences (INFORMS), Institute of Industrial Engineering (IIE), and Institute of Supply Management (ISM). He is currently serving as an associate editor of *Journal of Quality Technology*.

Recent Publications

Pan, R., Solis, A. O., and Paul, B., "Demand-Supply Interaction and Production Capacity Planning for Short Life-Cycle Products," working paper, 2006.

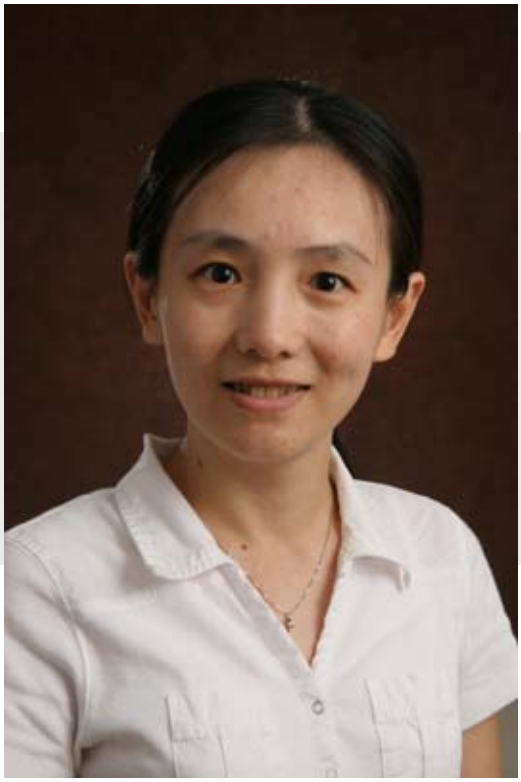
Pan, R., "A Bayesian Approach to General Repairable Systems with Failure Intensity Function Based Models," working paper, 2006.

Pan, R., "Bayesian Approaches to Process Monitoring and Process Adjustment," invited chapter to the book *Bayesian Monitoring, Control and Optimization,* edited by E. del Castillo and B.M. Colosimo, CRC Press, 2006.

Zhao, W., Pan, R., Aron, A. and Mettas, A., "Some Properties of Confidence Bounds on Reliability Estimation for Parts under Varying Stresses", *IEEE Transactions on Reliability*, 55(1), 2006, pp. 7-17.

Leadership Activities

Associate Editor, *Journal of Quality Technology*



Muhong Zhang

Assistant Professor
Ph.D., 2006, University of California—Berkeley
Integer programming, robust optimization, computational optimization, and network optimization

Dr. Zhang's past and present research work has been on developing techniques for robust optimization, transportation, and distribution in logistics, mixed-integer programming, comginatorial optimization, and network flows. Her work has been studying the two-stage robust network flow and design problem with demand uncertainty.

In the first stage, integer capacity decisions and flows on a subset of the arcs are determined. The recourse flow is determined in the second stage, after the realization of the uncertain demands. The robust network flow and design problem has many potential applications in telecommunication, hub location, production, and distribution logistics. Her research on two-stage robust network flow/design problem is for the general problem; currently, she is working on applications of this work to problems with special network structures.

Recent Publications

Atamtürk, A., and Zhang, M. "Two-Stage Robust Network Flow and Desing for Demand Uncertainty," *Operations Research*, 2005.

Gu, J., Hu, X., Jia, X., and Zhang, Muhong. "Routing Algorithm for Multicast under Multi-tree Model in Optical Networks." *Theoretical Computer Science*, Elsevier Science Publishers B.V., the Netherlands, 314(1-2)m, 2004, pp. 293-301.

Gu, J., Hu, X.D., Zhang, M., "Algorithms for multicast connection under multi-path routing model," *Information Processing Letters*, 84 (1), October 2002, pp. 31-39.

William Uttal

Emeritus Professor

Before my retirement, I was part of the department's human factors area, otherwise known as engineering psychology. Nowadays I am more of a psychologist than and engineer. Since my retirement in 1999, I have been spending my time writing a series of books.

I have completed twelve and am working on the thirteenth book, mostly concerned with exploring the basic assumptions and principles of scientific psychology. Two of these books were published in the last year—*The Immeasurable Mind* (2007, Prometheus Press) and *Human Factors in the Courtroom* (2006, Lawyers and Judges Publishing)—and two book manuscripts are completed and currently being reviewed by publishers, *Time Space and Number in Physics* and *Psychology and Distributed Neural Systems*. My latest critical writing is on a book tentatively entitled *Neuroscience in the Courtroom*.

This year I was a speaker at a national conference on brain imaging run by the ASU law school. In October, I am an invited keynote speaker at a similar conference run by the Delft University of Technology in the Netherlands. Next February I have been invited to speak at a conference on the philosophy of brain and mind at Guadalajara University in Mexico. Summers are spent on a visiting appointment at the Békésy Laboratory of Neurobiology at the University of Hawaii.

William Moor

Emeritus Professor

Since my December 2006 retirement, I have been working on three research projects, two of which are based on dissertation research of our graduates The first, based on the dissertation of Jon Ulrich, Ph.D., is exploring how varying arrow sizes relative to a proximal airplane silhouette's size affect subject performance. Our intent is to improve directional traffic sign design.

Second is a paper, based on the dissertation research of Randall Gibb, Ph.D, is about identifying which visual cues are most salient for glide path (GP) performance during an approach to landing by a pilot flying in both rich and impoverished visual conditions. Pilot performance suggested a three-phase perceptual process: assess, act, and react. Perceptual learning demonstrated that despite recognition of a black hole approach, pilots confidently flew dangerously low but did improve with practice implying that visual spatial disorientation education and training would be effective if accomplished in flight simulators.

I also am collaborating with colleagues at University of Oklahoma, Purdue University, University of Pittsburgh and University of Nebraska-Lincoln. We examine the achievement of parity of the sexes at the undergraduate level in industrial engineering, the data point to a combination of aspects of the discipline and the department culture as explanatory variables.

2006 Publications

Refereed Journal Articles

Askin, R.G., and Chen, Jiaqiong "Dynamic Task Assignment for Throughput Maximization with Worksharing," European Journal of Operational Research, 168(3), 2006, pp. 853-869.

Armbruster, D., and Gel, E.S. "Bucket Brigades Revisited: Are They Always Effective?" European Journal of Operational Research, 2006, 172, pp. 213-229.

Berrado, A., Hubele, N.F., and Gel, E.S. "An empirical investigation into the distribution of flatness measurements," Quality Engineering, 2006, 18(3).

Berrado, A., and Runger, G.C. "Using Metarules to Organize and GroOrganizing and Pruning the Discovered Association Rules Using Metarules," Data Mining and Knowledge Discovery, 2006, pp.20.

Bisgaard, S., and Kulahci, M. "Studying Input Output Relationships I," Quality Engineering, 2006, 18(2), pp. 273-281.

Bisgaard, S., and Kulahci, M. "Studying Input Output Relationships II," Quality Engineering, 2006, 18(3), pp. 405-410.

Bisgaard, S., and Kulahci, M. "The Application of Principal Component Analysis for Process Monitoring," Quality Engineering, 2006, 18, pp. 481-489.

Chen, H.N., and Cochran, J.K. "Effectiveness of Manufacturing Rules on Driving Daily Production Plans," Journal of Manufacturing Systems, 2006, 24:4, pp. 339-351.

Chen, Jiaqiong, and Askin, R.G. "Throughput Maximization in Serial Production Lines with Worksharing," International Journal of Production Economics, 99, 2006, pp. 88-101.

Chong, C.S., Lendermann, P., Gan, B.P., Duarte, B.M., Fowler, J.W., and Callarman, T.E. "Development and Analysis of a Customer Demand Driven Semiconductor Supply Chain Model using High Level Architecture (HLA)," International Journal of Simulation and Process Modeling, 2006, 2 (3-4), pp. 209-220.

Cochran, J.K., and Bharti, A. "A Multi-Stage Stochastic Methodology for Whole Hospital Bed Planning under Peak Loading," International Journal of Industrial and Systems Engineering, 2006, 1:1/2, pp. 8-36.

Cochran, J.K., and Ramanujam, B. "Carrier-Mode Logistics Optimization of Inbound Supply Chains for Electronics Manufacturing," International Journal of Production Economics, 2006, 103, pp. 826-840.

Cochran, J.K., and Kaylani, H. "Optimal Design of a Hybrid Push/Pull Serial Manufacturing System with Multiple Part Types," International Journal of Production Research, 2006, pp. 1-15.

Cochran, J.K., and Bharti, A. "Stochastic Bed Balancing of an Obstetrics Hospital," Health Care Management Science, 2006, 9:1, pp. 25-39.

Cochran, J.K., and Ramanujam, B. "Carrier-Mode Logistics Optimization of Inbound Supply Chains for Electronics Manufacturing," International Journal of Production Economics, 2006, pp. 1-29.

Delp, D., Si, J., and Fowler, J.W. "The Development of the Complete X-Factor Contribution Measurement for Improving Cycle Time and Cycle Time Variability," IEEE Transactions on Semiconductor Manufacturing, 2006, 13 (3), pp. 352-362.

Elias, R.J., Montgomery, D.C., and Kulahci, M. "An Overview of Statistical Forecasting Methodologies," International Journal of Production Research, 2006, 1, pp. 17-36.

Garcia, H., Villalobos, R., and Runger, G.C. "An Automated Feature Selection Method for Visual Inspection Systems," IEEE Transactions on Automation Science and Engineering, 2006, pp. 10.

Graves, S., Bisgaard, S., Kulahci, M., James, J., Marko, K., Ting, T., Van Gilder, J., Wu, C., and Zatorski, H. "Accelerated Testing for On-Board Diagnostics," Quality and Reliability Engineering International, 2006.

Gupta, J.N.D., Ruiz, R., Fowler, J.W., and Mason, S.J. "Operational Planning and Control of Semiconductor Wafer Production," Production Planning and Control, 2006, 17 (7), pp. 639–647.

Gupta, S., Montgomery, D.C., and Woodall, W.H. "Performance Evaluation of Two Methods for Online Monitoring of Linear calibration Profiles," International Journal of Production Research, 2006, 44, pp. 1927-1942.

Hu, J., Runger, G.C., and Tuv, E. "Tuned Artificial Contrasts to Detect Signals," International Journal of Production Research: Special Issue on Control Charts, 2006, pp. 15.

Keha, Ahmet B., deFarias, Ismael R., and Nemhauser, George L. "A Branch-and-Cut Algorithm without Binary Variables for Nonconvex Piecewise Linear Optimization," Operations Research, 2006, 54, pp. 847-858.

Kim, B., Gel, E.S., Fowler, J.W., Carlyle, W.M., and Wallenius, J. "Evaluation of Nondominated Solution Sets for K-Objective Optimization Problems: An Exact Method and Approximations," European Journal of Operational Research, 2006, 173 (2), pp. 565-582.

Kowalski, S.M., Vining, G.G., Montgomery, D.C., and Borror, C.M. "Modifying a Central Composite Design to Model the Process Mean and Variance when there are Hard-to-Change factors," Journal of the Royal Statistical Society C (Applied Statistics), 2006, 55, pp. 615-630.

Krishnan, S., and Askin, R.G. "Effect of Information Sharing and Control Strategies on Supply Chain Performance," International Journal of Simulation and Process Modeling, 3/4, 2006, pp. 175-187.

Kulahci, M., and Bisgaard, S. "A Generalization of the Alias Matrix," Journal of Applied Statistics, 2006, 33(4), pp. 387-395.

Kulahci, M. "Blocking Factorial Experiments," Quality and Reliability Engineering International, 2006.

Kulahci, M., Ramirez, J., and Tobias, R. "Split-Plot Fractional Designs: Is Minimum Aberration Enough?" Journal of Quality Technology, 2006, 38, pp. 56-64.

Kulahci, M., and Bisgaard, S. "The Partial Confounding and the Projection Properties of Plackett and Burman Designs," Journal of Quality Technology, 2006, 22, pp. 1-10.

Kumar, N., Kennedy, K., Gildersleeve, K., Abelson, R., Mastrangelo, C.M., and Montgomery, D.C. "A Review of Yield Modeling Techniques for Semiconductor Manufacturing," International Journal of Production Research, 2006, 44, pp. 5019-5036.

Lawson, C., and Montgomery, D.C. "Logistic Regression Analysis of Customer Satisfaction Data," Quality and Reliability Engineering International, 2006, 22, pp. 971-984.

Li, F., Runger, G.C., and Tuv, E "Supervised Learning for Change-point Detec

tion," International Journal of Production Research: Special Issue on Data Mining, 2006, 44, pp. 2853-2868.

Li, X., and Ye, Nong "Detection of Cyber Attacks from Network Traffic Data with Mixed Variables," IEEE Transactions on Systems, Man, and Cybernetics, Part A, 2006, 36, pp. 396-406.

Li, X., and Ye, Nong "A Supervised Clustering and Classification Algorithm for Mining Data with Mixed Variables," IEEE Transactions on Systems, Man, and Cybernetics, Part A, 2006, 36, pp. 396-406.

Lung, Chung-Horng, Urban, Joseph E., anMackulak, Gerald T. "Analogy-Based Domain Analysis Approach to Software Reuse," Requirements Engineering, May, 2006, pp. 1-22.

McGarry, M. P., Reisslein, M., Maier, M., and Keha, A. "Bandwidth management for WDM EPONs," Journal of Optical Networking, 2006, 5, pp. 637-654.

Park, Y., Montgomery, D.C., Fowler, J.W., and Borror, C.M. "Cost-Constrained G-Efficient Response Surface Designs for Cuboidal Regions," Quality and Reliability Engineering International, 2006, 22 (12), pp. 121-139.

Ramirez, B., and Runger, G.C. "Quantitative Techniques to Evaluate Process Stability," Quality Engineering, 2006, 15.

Robinson, T.J., Wulff, S.S., Montgomery, D.C., and Khuri, A.I. "Robust Parameter Design using Generalized Linear Models," Journal of Quality Technology, 2006, 38, pp. 65-75.

Skinner, K.R., Runger, G.C., and Montgomery, D.C. "Process Monitoring for Multiple Count Data Using a Deleted-Y Statistic," Quality Technology and Quantitative Management, 2006, 2, pp. 247-262.

Stray, J., Fowler, J.W., Carlyle, W.M., and Rastogi, A.P. "Enterprise-Wide Strategic and Logistics Planning for Semiconductor Manufacturing," IEEE Transactions on Semiconductor Manufacturing, 2006, 19 (2), pp. 259-268.

Vadde, K.K., Syrotiuk, V.R., and Montgomery, D.C. "Optimizing Protocol Interaction using Response Surface Methodology," IEEE Transactions on Mobile Computing, 2006, 5, pp. 627-639.

Wenbiao Zhao, Rong Pan, Alexander Aron, and Adamantios Mettas "Some Properties of Confidence Bounds on Reliability Estimation for Parts under Varying Stresses," IEEE Transactions on Reliability, 2006, 55, pp. 7-17.

Yang, Z., Ye, Nong, and Lai, Y.-C. "QoS Model of a Router with Feedback Control," Quality and Reliability Engineering International, 2006, 22, pp. 429-444.

Ye, Nong, and Farley, T. "Information Sharing and Control in Homogeneous and Heterogeneous Supply Networks," International Journal of Modeling and Simulation, 2006, 26, pp. 160-168.

Ye, Nong, Newman, C., and Farley, T. "A System-Fault-Risk Framework for Cyber Attack Classification," Information, Knowledge, Systems Management, 2006, 5, pp. 135-151.

Ye, Nong, Farley,, T., and Lakshminarasimhan, D.K. "An Attack-Norm Separation Approach for Detecting Cyber Attacks," Information Systems Frontiers, 2006, 8, pp. 163-177.

Ye, Nong, Parmar, D., and Borror, C.M. "A Hybrid SPC Method with the Chi-Square Distance Monitoring Procedure for Large-Scale, Complex Process Data," Quality and Reliability Engineering International, 2006, 22, pp. 393-402.

Ye, Nong, Harish, B., and Farley, T. "Attack Profiles to Derive Data Observables, Features, and Characteristics of Cyber Attacks," Information, Knowledge, Systems Management, 2006, 5, pp. 23-47.

Books & Chapters

Fowler, J.W., Moench, L., and Rose, O. "Scheduling and Simulation" in Handbook of Production Scheduling J.W. Herrmann 2006, Springer, pp. 109-134.

Goldfarb, H.B., and Montgomery, D.C. "Graphical Methods for Comparing Response Surface Designs for Experiments with Mixture Components," in Response Surface Methods and Related Topics, Andra I Khuri, 2006, Singapore, World Scientific, Publishing Co, pp. 472.

Martinez-Olvera, C., and Shunk, D. "Comprehensive Framework for the Development of a Supply Chain Strategy," International Journal of Production Research, 2006, 44, No. 21, pp. 17.

Montgomery, D.C., and Runger, G.C. Applied Statistics and Probability for Engineers, 2006, New York, John Wiley & Sons, 4th edition.

Montgomery, D.C., Peck, E.A., and Vining, G.G. Introduction to Linear Regression Analysis, 2006, New York, John Wiley & Sons, 4th edition.

Montgomery, D.C., and Jennings, C.L. "An Overview of Industrial Screening Experiments," in Screening: Methods for Experimentation in Industry, Drug discovery, and Genetics, Angela Dean and Susan Lewis, 2006, New York, Springer, pp. 326.

Pan, R. "Bayesian Approaches to Process Monitoring and Process Adjustment," in Bayesian Process Monitoring, Control and Optimization, Bianca M. Colosimo, Enrique del Castillo, 2006, Chapman & Hall/CRC, pp. 245-266.

Pfund, M.E., Mason, S.J., and Fowler, J.W. "Semiconductor Manufacturing Scheduling and Dispatching" in Handbook of Production Scheduling J.W. Herrmann 2006, Springer, pp. 213-242.

Utall, W.R. The Immesurable Mind. Prometheus Press, 2007.

Uttal, W.R. Human Factors in the Courtroom. Lawyers and Judges Publishing, 2006.

Conference Proceedings

Anderson-Rowland, M.R., Homsher, B., Lighty, J., Raper, J., and Vance, J.A "Characterization of Potential Women Engineering Administrators in Academia," Proceedings of the WEPAN Conference, 2006, pp. 15.

Anderson-Rowland, M.R. "Evaluating an Academic Scholarship Program For Engineering and Computer Science Transfer Students," ASEE/IEEE Frontiers in Education Conference, 2006, 36, pp. 6.

Anderson-Rowland, M.R. "Evaluation of a Program to Encourage Underrepresented Minority and Women Students to Become Interested in Research and to Attain Graduate Degrees," Proceedings of the WEPAN Conference, 2006, pp. 13.

Anderson-Rowland, M.R., and Newell, D.C. "Improving a NACME Class with an Emphasis on Detailed Time Management," Proceedings of the American society for Engineering Education Annual Conference & Exposition, 2006, 113, pp. 12.

Anderson-Rowland, M.R., VanIngen-Dunn, C., and Banks, D.L. "Improving a University/Community Partnership

Program with a Reduced Budget," Proceedings of the American Society for Engineering Education Annual Conference & Exposition, 2006, 113, pp. 7.

Anderson-Rowland, M.R., and Newell, D.C. "The Blurring of Academic, Cultural, and social Bordeers for Minority Engineering Students," ASEE/IEEE Frontiers in Education Conference, 2006, 36, pp. 7.

Askin, R.G., and Krishnan, Sa. "Selection of Inventory Control Points in Multistage Pull Systems," Proceedings of the INCOM'2006 Conference, St. Etienne, France, 2006, pp. 353-358. Republished in Information Control Problems in Manufacturing 2006, Dolgui, A., Morel, G., and Pereira, C. (eds.), Elsevier Ltd., 2006, pp. 335-340.

Bekki, J. E., Mackulak, G.T., and Fowler, J.W. "Indirect Cycle-Time Quantile Estimation for Non-FIFO Dispatching Policies," Proceedings of the Winter Simulation Conference, Monterey, CA, Dec. 3-6, 2006, pp. 1829-1835.

Burdick, T.L., and Cochran, J.K. "Collaborating to Address Capacity Constraints," HIMSS Conference & Exhibition, San Diego, CA, 2006, Paper 80, pp. 1-15.

Colak, A.B., and Keha, A.B. "A Divide-and-Merge Algorithm for a Single Machine Scheduling Problem," Proceedings of IERC, 2006, pp. 8.

Hu, J., Runger, G.C., and Tuv, E. "Self-Learning of Decision Rules for Statistical Process Control," Proceedings of the National Science Foundation Conference for Design, Manufacturing and Industrial Innovation, 2006, St. Louis, MS, pp. 8.

Hu, J., and Runger, G.C. "Time-Based Detection of Changes to Multivariate Patterns," Proceedings from INFORMS Artificial Intelligence and Data Mining Workshop, 2006, pp. 8.

Kaylani, H.A., and Cochran, J.K. "A Computational Approach to Optimizing Push/Pull Flow in an Aerospace Transmission Line," IASTED International Conference on Modeling and Simulation, Montreal, Canada, 2006, pp. 201-206.

Kulahci, M., and Bisgaard, S. "Challenges in Multivariate Control Charts with Autocorrelated Data," Proceedings to the 12th ISSAT International Conference on Reliability and Quality in Design, Chicago-IL, 2006.

Lin, Y.K., Pfund, M.E., Fowler, J.W., and Montgomery, D.C. "Classification of Parallel Machine Environments under Various Correlation Structures," 36th International Conference on Computers and Industrial Engineering, Taipei, Taiwan, R.O.C., June 20-23, 2006, pp. 1253-1261.

Mohandas, S., Henderson, M., Sinha, R., Shunk, D., and Keha, A.B. "Customer-Centric Order Management System – A Basic Framework," PICMET, 2006, pp. 8.

Montgomery, D.C., and Brombacher, A.C. "Carol J. Feltz and David Newton," editorial in Quality and Reliability Engineering International, 2006, 22, No. 2, pp. i.

Montgomery, D.C. "Analyzing and Improving Measurement Systems: A Key to Effective Decision-Making," editorial in Quality and Reliability Engineering International, 2006, 22, No. 3, pp. 237-238.

Montgomery, D.C. "Designed Experiments in Process Improvement," editorial in Quality and Reliability Engineering International, 2006, 22, No. 8, pp. 863-864.

Olivares-Benitez, L. E., Gonzalez-Velarde, J.L., and Keha, A.B. "Two-Echelon Supply Chain Design with Lead Time Choices," Proceedings of CLAIO (Latin-Iberoamerican Operations Research Conference), 2006, pp. 8.

Parmar, D., Wu, T., Fowler, J.W., Callarman, T. and Hargaden, V. "An Integrated Framework for Responsive Supply Chain Management," The 16th International Conference on Flexible Automation and Intelligent Manufacturing, Limerick, Ireland, June, 2006, pp. 859-866.

Urban, J.E., Anderson-Rowland, M.R., Banks, D.L., and Navabi, F. "Evaluating Self-Assessment and a Placement Examination for a First Course in Computer Science: How Do Women and Minority Students Fare?" Proceedings of the Ameerican Society for Engineering Education Annual Confeence & Exposition, 2006, 113, pp. 7.

Villalobos, J.R., and Martinez, H. "Development of a Virtual Inspection System for Solder Paste," Proceedings of the NSF Design, Service and Manufacturing Conference, 2006.

Villalobos, J. Rene, and Garcia, H. "Outliers Elimination for the Refinement of AVI Systems," Proceedings of the NSF Design, Service and Manufacturing Conference, 2006.

Wu, T., Fowler, J.W., Callarman, T. and Moorehead, A. "Multi-stage DEA as a Measurement of Progress in Environmentally Benign Manufacturing," The 16th International Conference on Flexible Automation and Intelligent Manufacturing, Limerick, Ireland, June, 2006, pp. 221-228.

2006-2007 Ph.D. Graduate Degrees Advised

Summer 2006

Yan Chen
Methodologies for Parameterization of Composite Dispatching Rules
Advisor: John Fowler, Michele Pfund
Placement: Assistant Professor, Macau University of Science and Technology

Russell Elias
Demand Model Management: A Model-Based Expert System for the Forecasting of Semi-Conductor Product
Advisor: Doug Montgomery
Placement: independent consultant

Mohammed Fennich
Stock Market Time-Series Behavior Predictability and Profitability
Advisor: Philip Wolfe

Pornsarun Wirojanagud
Modeling Inherent Worker Differences for Workplace Planning
Advisor: John Fowler, Esma Gel
Placement: independent consultant

Regents' Professor Douglas Montgomery with doctoral graduate Ashraf Almimi

Fall 2006

Jesus Jimenez
Simulation Modeling Levels to Support Integrated Capacity and AMHS Decision Making in Semiconductor Wafer Fabs
Advisor: John Fowler, Gerald Mackulak
Placement: Assistant Professor, Texas State University

Hari Balasubramanian
Parallel Machine Bicriteria Scheduling: Some Complexity Results and the Problem of Interfering
Advisor: John Fowler, Ahmet Keha
Placement: Mayo Clinic

Cem Vardar
A Simulation Optimization Approach to Design Field Service Systems with Remote Diagnostics
Advisor: John Fowler, Esma Gel
Placement: Intel Corp.

Jeffrey Laub
Scheduling Multiple Orders per Job to Minimize Makespan in Flowshops
Advisor: John Fowler
Placement: General Dynamics

Suraj Mohandas
Pricing with Efficient Frontiers
Advisors: Rajiv Sinha, Mark Henderson
Placement: Insight

Fang Li
Finding Heterogeneity in a Multivariate Process
Advisor: George Runger
Placement: American Express

Yang-Kuei Lin
Data Generation and Heuristics for Unrelated Parallel Machine Scheduling Problems
Advisors: John Fowler, Michele Pfund
Placement: CSX Transportation

Fall 2006 *(continued)*

Ashraf Almimi
Split-Plot Designs: Follow-Up Experiements [sic], Missing Observations, And Model Adequacy
Advisors: Murat Kulahci and Douglas Montgomery
Placement: NASA Postdoctoral Fellow

Spring 2007

Randall Gibb
Visual Perception in Aviation: Glide Path Performance During Impoverished Visual Conditions
Advisor: William Moor, Rong Pan
Placement: Air Force Academy, Colorado Springs

Jon Ulrich
Performance Effects of Varying Traffic Guidance Arrow Size In a Simulated Driving Environment
Advisor: William Moor, Stanley Parkinson
Placement: Faculty Associate, ASU Polytechnic

Summer 2007

Jing Hu
Change Detection with Supervised Learning
Advisor: George Runger
Placement: SRP

IE FACULTY

Mary R. Anderson-Rowland, Ph.D.
Statistics and probability for quality control, academic scholarship programs for all engineering students with an emphasis on women and underrepresented minority students.

Ronald G. Askin, Ph.D.
Design and operation of discrete manufacturing systems, production systems, decision analysis, applied operations research, facilities planning, industrial statistics and applied optimization.

Linda Chattin, Ph.D.
Discrete optimization, stochastic processes and probabilistic modeling, emergency service location.

John W. Fowler, Ph.D.
Deterministic scheduling, discrete event simulation methodology, semiconductor manufacturing systems analysis, applied operations research.

Esma S. Gel, Ph.D.
Applied probability, stochastic processes, queuing theory, stochastic modeling and control of manufacturing systems.

Gary L. Hogg, Ph.D.
Applied optimization, simulation, manufacturing planning and control.

Ahmet B. Keha, Ph.D.
Computational and theoretical aspects of integer programming and combinatorial optimization, modern heuristics techniques, logistics and scheduling.

Jing Li, Ph.D.
Applied statistics, process control, data mining, causal modeling and inference.

Gerald T. Mackulak, Ph.D.
Simulation methodology, simulation output analysis, automated production systems, material handling design and analysis.

Douglas C. Montgomery, Ph.D.
Statistical design of experiments, optimization and response surface methodology, empirical stochastic modeling and industrial statistics.

Rong Pan, Ph.D.
Industrial statistics, reliability analysis and time series modeling.

George C. Runger, Ph.D.
Statistical learning, process control and data mining for massive, multivariate data sets with numerous-discipline applications.

Dan L. Shunk, Ph.D.
Agile, enterprise and CIM systems, group technology, planning systems, economics of computer-integrated manufacturing, strategy and strategic role of technology.

William Thompson, Ph.D., P.E.
Lean production systems, engineering management and quality management.

J. René Villalobos, Ph.D.
Manufacturing systems, automated visual inspection, real time quality control and intelligent manufacturing systems.

Teresa Wu, Ph.D.
Information systems, supply chain management, multi-agent systems, data mining, Petri nets and Kalman filtering.

Nong Ye, Ph.D.
Information and systems assurance, security and dependability of computer and network systems, data mining and modeling, systems engineering and management.

Muhong Zhang, Ph.D.
Integer programming, robust optimization, computational optimization, and network optimization.

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