Annual Report 2011

Industrial and Manufacturing Systems Engineering

COLLEGE OF ENGINEERING

KANSAS STATE UNIVERSITY

Contents

Message from the Department Head

Dear Colleagues and Friends,

I am pleased to provide you with the 2011 annual report for the industrial and manufacturing systems engineering department at Kansas State University. Our faculty members are active researchers and engaged educators. This report includes a description of our faculty, programs and research. You will find evidence in these pages that our programs are strong and growing.

Our department employs 12 faculty members, 10 of whom have research assignments. During 2011, K-State IMSE faculty authored 33 journal articles, 21 articles in refereed conference proceedings and three book chapters. Collectively, they served in 38 editorial positions for a variety of academic journals. IMSE extramural grant expenditures in fiscal year 2011 exceeded $3.1 million. Of that total, more than $207,000 was for educational grants. Eighteen different Ph.D. students and 11 different M.S. students were supported on assistantships during the year.

In the fall, our programs enrolled 187 undergraduate, 82 graduate and 19 doctoral students. In the past five years, we have graduated, on average, 26 undergraduate and two or fewer doctoral students each year. To illustrate our growth, in 2011-2012 we will graduate more than 40 bachelor students and four Ph.D. students.

I believe the quality of our undergraduate education is strong. For the 29 bachelor students who graduated in 2010-2011, the average starting salary was $59,107. Year in and year out our students find internships and have salary offers that exceed the national average for industrial engineers. I believe this occurs because IMSE faculty members actively engage and challenge our students in their courses, and are accessible to students both during and outside of class.

Likewise, our graduate programs are well regarded and experiencing growth. This is particularly true for our online programs. Our master of science in operations research was first provided under contract to the U.S. Army but is now offered to students across the nation. The master of engineering management program was designed specifically with the working professional in mind and is now attracting international students. Both programs leverage our on-campus offerings and continue to attract additional students.

The IMSE department has been educating young engineers for more than a half century. The department initially grew from an emphasis on shop practice in the early years of K-State's engineering college. In 1937, the industrial arts department was established, and by 1954 the department was renamed industrial engineering and industrial arts. Kansas State University has been granting industrial engineering degrees since that time. Over the years, we have maintained an emphasis on hands-on, project-oriented research and education.

The department still has a strong emphasis on manufacturing processes and systems. But today, we increasingly emphasize the application of industrial engineering to service industries, especially health care systems.

In this issue we highlight the work of our newest faculty member, Jessica Heier Stamm. Dr. Heier Stamm joined our faculty in December 2010 after receiving her Ph.D. from Georgia Tech. In 2011 she was awarded the Transportation Science and Logistics Board's most outstanding dissertation prize in logistics at the INFORMS annual meeting. Her research is focused on improving public-impact supply chains. I'm sure you will enjoy reading about this important application of industrial engineering to improve the response to both disasters and ongoing public health challenges.

Please feel free to contact me about anything you read in this annual report. You may also want to check us out on the web: www.imse.ksu.edu

Regards,

Bradley A. Kramer

Bradley A. Kramer, Ph.D.
Ike and Letty Evans Engineering Chair
Professor and Head, IMSE
Director, Advanced Manufacturing Institute

FEATURE

Feature

Engineering humanitarian response efforts

The human and economic impacts of disasters are immense. According to a study by the Center for Research on the Epidemiology of Disasters (CRED), an average of 227.5 million people per year were affected by disasters between 2000 and 2009. Economic damages averaged $98.9 billion annually during that same period. Given the direct toll of such events, and the ripple effect that can be felt globally, finding ways to mitigate barriers to the most effective humanitarian relief is necessary to preserve life and quality of life, as well as minimize negative economic impacts.

When a disaster strikes, a natural human response is to act. Churches send volunteers to help rebuild. Massive quantities of food, clothing and medical supplies are shipped from countries around the world. Relief agencies set up make-shift hospitals to treat the injured. And millions upon millions of dollars are donated in response.

In the rush to respond, multiple agents work independently to provide relief as quickly as possible. Unfortunately, this uncoordinated effort often leads to suboptimal results. Critical questions can be overlooked. Where's the best location to place a hospital? What's the most efficient and equitable way to distribute supplies? How can monetary resources best be used? What synergies can be realized through coordinated planning?

The study of humanitarian logistics seeks to proactively improve the response to disasters by focusing on supply chain issues such as the type and quantity of resources available, methods of procurement and storage of supplies, tools of tracking and means of transportation to the stricken area, and cooperation between teams participating in the operation. Now, a Kansas State University assistant professor is taking humanitarian logistics beyond emergency preparedness and response, using both traditional and novel industrial engineering techniques to develop decision support systems for those responsible for responding to disasters.

"Every supply chain faces challenges in delivering the right quantity and type of product to the right place at the right time," said Jessica Heier Stamm, a faculty member with K-State's industrial and manufacturing systems engineering (IMSE) department. "However, designing and managing systems to deliver aid to those affected by natural disasters is especially difficult given additional challenges such as damaged infrastructure and constantly changing conditions."

One such factor frequently overlooked, but with significant impact, is the influence of multiple and decentralized decision makers, according to Heier Stamm.

"There are often a wide range of entities involved in these supply chains, including government, military, private, and non-governmental organizations and individuals," she explained. "While they all share a common goal – to help those affected by the disaster – each party operates based on its own objectives and levels of information, which may lead to duplication of efforts, waste, and in the worst cases, aid not reaching those who need it most.

About Dr. Heier Stamm

An industrial and manufacturing systems engineering department alumnus, Jessica Heier Stamm (2004) joined the IMSE faculty in December 2010 after receiving her Ph.D. from the Georgia Institute of Technology. A native of Quinter, Kansas, Heier Stamm teaches operations research and logistics engineering courses at both the undergraduate and graduate levels. She was recognized by the Engineers Week Foundation as a 2008 New Face of Engineering honoree, was the recipient of the Institute of Industrial Engineers Gilbreth Memorial Fellowship and NSF Graduate Research Fellowship, and was honored with the INFORMS Transportation Science and Logistics Society Dissertation Award.

Heier Stamm grew interested in humanitarian applications of industrial engineering and operations research during her undergraduate IE studies. Although she was drawn to the idea of making any system more efficient and effective, Heier Stamm became particularly excited when she realized the tools she was learning to manage inventory, transportation and resource allocation decisions in the commercial sector could also be applied to make a difference in the humanitarian sector. She also enjoys sharing her enthusiasm for these applications with students, noting there are still many challenges and opportunities in this area, which IEs are well-prepared to address.

"As we see increases in the number and impact of humanitarian crises, there also seems to be a greater understanding of the importance of improved supply chain systems to coordinate the efforts of many decentralized organizations," said Heier Stamm. "Success in humanitarian relief efforts is measured not only in lives saved but also in quality of life for survivors. As a result of my research, I hope approaches are developed and adopted within the international relief community which improve response efforts and minimize the short- and long-term human toll of disasters and public health threats."

"Traditional optimization approaches would advocate the adoption of a centralized decision maker to coordinate the entire response," Heier Stamm continued. "But in disaster scenarios this is frequently impractical or impossible. Through my research I am identifying novel approaches that enable decentralized systems to approximate the performance of centralized systems."

Optimizing care delivery

A current focus of study is the impact of decentralized decision making on access to cholera treatment in Haiti following the January 2010 earthquake. The disease was discovered in October 2010 and quickly spread across the country with more than 460,000 cases reported a year later. More than 110 organizations responded to this outbreak by establishing cholera treatment facilities.

"We found this decentralized approach resulted in the location of the vast majority of treatment facilities in a densely populated but relatively small geographic area," said Heier Stamm. "For people living outside this area, opportunities for treatment were very limited, especially given inadequate means of transportation and the urgency with which care is required after the onset of symptoms."

The goal of the research was to quantify the potential to improve access to care by modeling the desirable components of a centralized system while maintaining the same resources as the decentralized system. Among the centralized components were adequate access to treatment for all populations, equity in access and efficient use of resources.

"Balancing efficiency with equity is a major issue," Heier Stamm said. "In addition to the complexity that this introduces into the optimization models, there are social and political issues that must be taken into consideration.

"The goal of this research is not to mandate where organizations should place their treatment centers, but rather to quantify the differences between the actual decentralized response and the potential for improved accessibility."

Using integer programming models, Heier Stamm and IMSE graduate student Brian Moore were able to identify optimized locations for adequate and more equitable access to cholera care throughout Haiti. While treatment centers were still concentrated in more populous areas, a greater number were opened in suburban and rural areas.

"We find more equitable access can be achieved using the same resources that were available in the actual response. Furthermore, we have embedded our optimization models into a rolling horizon framework capable of supporting decisions about where to locate new treatment facilities over time as resource availability or disease patterns change," Heier Stamm said.

"The next step will be to identify incentives or other coordination mechanisms that will encourage independent organizations to locate facilities in a way that improves access. The approach we are developing is applicable not only to Haiti, but to other scenarios in which multiple agencies respond to infectious disease outbreaks or disasters."

Coordinating public health efforts

Public health efforts are another area in which Heier Stamm and others in the IMSE department are applying industrial engineering and operations research techniques.

IMSE associate professor Todd Easton has completed a study in the simulation of an epidemic in a small, rural Kansas town. While

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substantial research has been dedicated to simulating the spread of infectious diseases, these models have been focused on major urban centers. Individuals living in rural communities have drastically different interaction and travel patterns than those in urban settings. Using a generic simulation package, Easton was able to model the spread of an epidemic on a small rural town and test effectiveness of various mitigation strategies.

Additionally, work continues in the modeling of the progression of sepsis episodes through the human body at a cellular level by IMSE professors David Ben-Arieh and Chih-Hang (John) Wu. Working with the University of Kansas Medical School Hospital, the success of this research would prove especially useful for small, generally rural, hospitals not well equipped to deal with septic patients. Using an assessment tool, medical staff in these facilities could predict outcomes by comparing a series of simulated prognostic indicators with the actual patient's status. With this information medical staff could make better patient care decisions, including providing the time necessary to transport patients to a larger facility for care.

Heier Stamm's efforts in this area are directed at supply chain modeling to address challenges at the interface of human and animal health. According to the Centers for Disease Control and Prevention (CDC), nearly 75 percent of recently emerging infectious diseases affecting humans are diseases of animal origin and approximately 60 percent of all human pathogens are zoonotic (meaning they are transmissible between humans and animals). Examples include E. coli, West Nile virus, malaria and Lyme disease. In addition to life and quality of life considerations, the spread of zoonotic diseases can have considerable economic effects ranging from international trade restrictions to actual or perceived reductions in food quality and safety, and loss of a rural livelihood among individual producers or groups.

"There is a growing realization of the need to coordinate activities that protect and promote human, animal and environmental health, also known as One Health," said Heier Stamm. "Supply chain engineering can play an important role in prevention, response and mitigation. Additionally, coordination can lead to better decision making and use of scarce resources.

"Much like in a disaster situation, response to a zoonotic disease outbreak is decentralized. Not only are there multiple levels of decision makers – for instance local and state governments and various non-governmental organizations – but the focus of the response is directed at two different populations, human and animal."

Through her research, Heier Stamm hopes not only to demonstrate the value of a coordinated One Health approach, but also to determine what mechanisms can be used to coordinate the two systems, and how costs and benefits can be allocated among organizations to encourage collaboration.

IMSE undergraduate students are also engaged in application of their industrial engineering skills to humanitarian and public health systems. During the spring 2012 semester, Heier Stamm guided an IMSE senior design team's work on behalf of Heart to Heart International, an agency that seeks to improve global health through humanitarian initiatives that connect people and resources. Heart to Heart's operations include the receipt and subsequent distribution of pharmaceutical gifts-in-kind through their Global Distribution Center in Kansas City, Kansas. Through a custom order program, qualified organizations select the specific medicines and medical supplies needed to meet the ongoing medical needs of those impacted by disasters and poverty worldwide. The students evaluated receiving, order fulfillment and product distribution processes at the agency's warehouse.

Our project aims to support the agency's operations both during routine and crisis operations. We also hope to help the organization gain a better understanding of annual patterns in donations and demands so they can better plan for needed supplies."

More information about Dr. Heier Stamm's research, including maps showing decentralized and optimized cholera treatment facilities in Haiti, can be found at imse.ksu.edu.

FACULTY

Bradley A. Kramer
Department Head and Professor

Dr. Kramer is professor and head of the industrial and manufacturing systems engineering department, director of the Advanced Manufacturing Institute (AMI), and holds the Ike and Letty Evans Engineering Chair at Kansas State University. His current effort is focused on building efficient means for accelerating collaborative university and industry innovation. Dr. Kramer joined the faculty in 1985.

Education:
B.S. Kansas State University
M.S. Kansas State University
Ph.D. Kansas State University

David Ben-Arieh
Professor

Dr. Ben-Arieh concentrates mainly on applications of decision theory and operations research in the area of health care delivery systems and product development. He teaches courses in the area of production and inventory control and health care systems, and conducts research in these areas. His interests include DEA modeling, risk-mitigation techniques and information system modeling. His industrial experience includes working for AT&T Bell Laboratories, and consulting for the aerospace industry and health care organizations. Dr. Ben-Arieh joined the faculty in 1990.

Education:
B.S. Ben-Gurion University, Israel
M.S. Ben-Gurion University
Ph.D. Purdue University

Shing I. Chang
Associate Professor

Dr. Chang teaches courses related to quality engineering at both undergraduate and graduate levels. His main research interests include multivariate statistical process control for manufacturing and health care, nonlinear profile monitoring, neural networks and fuzzy set applications in quality engineering, and multivariate experimental designs. In addition, he coordinates assessments of student learning outcomes for ABET accreditation. Dr. Chang joined the department in 1991.

Education:
B.S. Tsing-Hua University, Taiwan
M.S. Arizona State University
Ph.D. Ohio State University

Timothy W. Deines
Instructor

Mr. Deines teaches manufacturing courses. His areas of research include manufacturing processes, composite manufacturing and machining, and energy manufacturing. He is a member of the Institute of Industrial Engineers (IIE) and Society of Manufacturing Engineers (SME). He was awarded the 2007 Making a Difference Award by the Kansas State University Women in Engineering and Science Program. Mr. Deines joined the IMSE department as an instructor in 2000.

Education:
B.S. Kansas State University

Faculty

Faculty

Kimberly Douglas-Mankin, P.E.
Associate Professor

Dr. Douglas-Mankin's research focuses on development and assessment of effective strategies for K-12 outreach, recruitment and retention of engineering and science students, particularly those who are under-served and under-represented in these fields. Dr. Douglas-Mankin is a licensed professional engineer. Her teaching and research focuses on management systems engineering, quality engineering, performance assessment, engineering economics and transportation engineering. She joined the faculty in 2003.

Education:
- B.S. Oklahoma State University
- M.S. Oklahoma State University
- Ph.D. Arizona State University

Todd Easton
Associate Professor

Dr. Easton performs research in discrete optimization with an emphasis in integer programming and graph theory. His current research in integer programming focuses on finding improved techniques to solve integer problems. In particular, he has developed fast techniques to perform exact simultaneous uplifting for sets of binary variables. His graph theory research develops algorithms and heuristics to solve computationally challenging problems. Most recently, he has been modeling and optimizing the response to the spread of an epidemic in rural Kansas. Dr. Easton joined the faculty in 2001.

Education:
- B.S. Brigham Young University
- M.S. Stanford University
- Ph.D. Georgia Institute of Technology

John R. English
Dean

Dr. English is dean of the College of Engineering, professor of industrial and manufacturing systems engineering, and holds the LeRoy C. and Aileen H. Paslay Chair in Engineering at Kansas State University. His research interests include quality control, reliability engineering and applied statistics. He has numerous journal articles in these areas. He is a registered professional engineer in the state of Arkansas and an IIE fellow. Dr. English joined the faculty in 2007.

Education:
- B.S. University of Arkansas
- M.S. University of Arkansas
- Ph.D. Oklahoma State University

Jessica Heier Stamm
Assistant Professor

Dr. Heier Stamm's research is focused on application of operations research and industrial engineering techniques to humanitarian relief and public health. She is specifically interested in design and analysis of systems with decentralized decision makers and development of methods that lead to decentralized solutions that approximate the performance of centrally optimal decision making. Her work also involves characterizing existing practices and decision-making processes in humanitarian supply chains. Dr. Heier Stamm is a member of the undergraduate committee. She joined the faculty in 2010.

Education:
- B.S. Kansas State University
- Ph.D. Georgia Institute of Technology

E. Stanley Lee
Professor

Dr. Lee's research interest is primarily in the optimization and systems analysis area such as intelligent and soft computing, uncertainty reasoning, support vector machines and neural-fuzzy computing, fuzzy logic, probabilistic approaches and evidence theory. Another aspect is the applications of these techniques to solve various engineering and social problems such as water resource management, alternative energy developments, pollution and environmental systems, and the efficiency of nonprofit and profit organizations. Dr. Lee teaches courses in optimization theory, queuing, operations research and production, and inventory control. Dr. Lee joined the faculty in 1966.

Education:
- B.S. Chung-Cheng Institute of Technology, Taiwan
- M.S. North Carolina State University
- Ph.D. Princeton University

Shuting Lei
Associate Professor

Dr. Lei's research interests include machining of difficult-to-machine materials such as structural ceramics, titanium alloys, superalloys and composites; laser-assisted machining of ceramics; femto-second laser micromachining; numerical modeling of manufacturing processes; and development of novel cutting tools. He teaches courses in manufacturing. Dr. Lei joined the faculty in 1999.

Education:
- B.S. Tsinghua University, China
- M.S. Tsinghua University, China
- Ph.D. Purdue University

Zhijian (ZJ) Pei
Professor

Dr. Pei's research interests include semiconductor wafer manufacturing processes, traditional and nontraditional machining processes, subsurface damage measurement in machined surfaces and energy manufacturing. He teaches manufacturing processes and systems, semiconductor manufacturing processes, product and process engineering, nontraditional machining processes, lean manufacturing and Six Sigma. Dr. Pei joined the faculty in 2000.

Education:
- B.S. Zhengzhou Institute of Technology, China
- M.S. Beijing Institute of Technology, China
- Ph.D. University of Illinois at Urbana-Champaign

Malgorzata J. Rys
Associate Professor

Dr. Rys' research interests include the human element in transportation systems, visibility and retro-reflectivity, rumble strips design and performance, roundabouts design and performance, modeling and simulation of natural disasters, transportation logistics, experimental design and benefit-cost analysis. She teaches courses in human factors engineering/ergonomics, design of experiments and engineering economy. Dr. Rys joined the faculty in 1989.

Education:
- B.S./M.S. Technical University of Wroclaw, Poland
- M.S. Kansas State University
- Ph.D. Kansas State University

Chih-Hang (John) Wu
Associate Professor

Dr. Wu's interests include mathematical programming, network optimization, applied operations research, transporation and air traffic systems, digital image processing, pattern recognition, material handling, robot control strategy, flexible manufacturing systems design, group technologies and machine loading. Dr. Wu joined the faculty in 1993.

Education:
- B.S. National Cheng Kung University, Taiwan
- M.S. Pennsylvania State University
- Ph.D. Pennsylvania State University

Adjunct Faculty

Faculty

Kelly Easton

Dr. Easton's area of focus is in operations research with an emphasis in discrete optimization. She was employed as a research associate at Barclays Global Investors, 1994–1996, where she developed nonlinear optimization models and a GUI for financial research. She is currently employed by The Sports Scheduling Group where she develops sports schedules for various college conference and professional leagues.

Education:

B.A. Johns Hopkins University
M.S. Stanford University
Ph.D. Georgia Institute of Technology

Graham Fisher

Dr. Fisher is currently director of intellectual property at MEMC Electronic Materials Inc. He joined MEMC in 1985 and has held various positions including chief scientist, director of operations technology, technical operations manager and applications engineering manager. His most recent research interests have centered on silicon materials and manufacturing science; developing robust, high-throughput manufacturing processes for silicon wafers for the semiconductor; and solar industries.

Education:

B.Sc. University of Salford, England
Ph.D. University of London, England

Young-Jou Lai

Dr. Lai is a senior forecast modeler of supply chain management at the Halliburton Company. He also serves as an associate editor of the International Journal of Revenue Management. His recent professional interests are in the area of forecasting, optimization, planning/scheduling, inventory control, and risk management with focus on modeling visualization, system development and automation in a global operational environment.

Education:

B.S. National Cheng Kung University, Taiwan
M.S. Kansas State University
Ph.D. Kansas State University

Jiangang Sun

Dr. Sun is a mechanical engineer in the nuclear engineering division at Argonne National Laboratory. His current research interests are in nondestructive evaluation (NDE) technologies including optical scanning, infrared thermal imaging, ultrasonic scanning and x-ray imaging for characterization of advanced materials and manufacturing processes. He has also conducted research in computational thermo-hydraulic analysis for nuclear reactor systems and in multiphase flow and heat transfer processes.

Education:

B.S. University of Science and Technology of China
M.S. University of Illinois at Urbana-Champaign
Ph.D. University of Illinois at Urbana-Champaign

Research • grants • Publications

Advanced manufacturing processes and systems

Advanced Manufacturing Institute

The Advanced Manufacturing Institute provides innovative engineering and business solutions for product and technology development. Comprised of experts in engineering, product design, manufacturing and business, AMI offers assistance with business planning and research, engineering, and economic development to help entrepreneurs and businesses be more competitive in the marketplace. In addition, AMI manages an intern program that allows students to gain real work experience and the opportunity to work with skilled professionals.

Laser-based manufacturing processes

The objective of this research is to develop laser-based manufacturing processes for various applications. Recent research includes laser-assisted machining (LAM) for difficult-to-machine materials such as ceramics and laser micromachining of various materials. Building on several years of experience in LAM of silicon nitride, we are applying LAM to a new bioceramic material, which is difficult to be shaped using conventional machining processes. We continue to collaborate with industry and university researchers to advance femtosecond laser micromachining research. With high-intensity, ultra-short pulses from a femtosecond laser, we are trying to develop new laser machining techniques to create features at both micro and nano scale. We have conducted micromachining for polyurea aerogel and demonstrated high-quality cuts for this highly porous polymer. A deep microhole drilling study has also been carried out. Currently we are working on femtosecond laser machining of solar cells. We are also pushing toward nanoscale machining in dielectrics. In addition to our experiment research, we are working to gain fundamental knowledge of the processes through numerical modeling and simulation.

Laser-scattering measurement of subsurface damage in machined surfaces

For semiconductor wafer manufacturing, subsurface damage induced by mechanical machining processes must be removed by subsequent processes. However, current subsurface damage characterization methods are mostly destructive, time consuming and expensive. There are no nondestructive evaluation methods that can provide subsurface damage information across the whole wafer. Lack of such tools has hindered further reduction in manufacturing costs of semiconductor wafers and integrated circuits. Collaborating with Dr. JG Sun at Argonne National Laboratory, we developed two laser-based techniques, an improved laser-scattering method and an innovative cross-polarization confocal-microscopy method to measure subsurface damage in silicon wafers nondestructively.

Machining of semiconductor wafers

Semiconductor devices are found almost everywhere—in computers, cell phones, televisions, automobiles and airplanes. More than 90 percent of the semiconductor devices in use today are built on silicon wafers. We are using finite-element analysis and theoretical modeling to develop grinding parameters for cost-effective silicon-wafer manufacturing. Progress in this research area will mean decreased cost of silicon wafers and semiconductor devices.

Manufacturing of biofuels

Growing concern over limited petroleum resources, environmental impacts and national security has stimulated broad interest in producing and utilizing biofuels (e.g., biodiesel and ethanol) from domestic biomass resources. Collaborat-

ing with faculty in the department of biological and agricultural engineering, we are working on manufacturing-related issues in producing biofuels from algae and cellulosic biomass.

Rotary ultrasonic machining of hard-to-machine materials

Using rotary ultrasonic machining, we develop new drilling methods for hard-to-machine materials such as advanced ceramics, titanium, stainless steel and composites. Many components made from these materials require drilling operations. However, these materials are notorious for their poor machinability, resulting in high cost and low efficiency with current drilling methods. Therefore, there is a critical need to develop more cost-effective drilling processes for these materials. Research in this area has been supported by NSF, Boeing, Sonic Mill and NBR Diamond Tool.

Profile analysis for multivariate statistical process control

Traditional statistical process control (SPC) focuses on monitoring one quality characteristic at a time. Recent research on SPC has expanded its role to monitor multiple quality characteristics simultaneously. A special case in multivariate SPC is the profile analysis in which a quality characteristic is measured over time or space. Most current research tackles this problem by forming a quality characteristic vector containing all measured points in a profile. We have been working on dimension-reduction techniques to further simply the difficulty of SPC implementation. Specifically, wavelet filtering is applied to separate a profile into two distinct channels. The approximate channel contains the information on profile shape changes, while the detail channel bears the information of amplitudes of a profile. We then apply a cubic B-Spline function to fit the signals from the approximate channel. Dimension reduction is then achieved by considering only a handful of control points in the B-Spline function. We have been working on applying this framework on composite manufacturing. For example, measures from various temperature sensors mounted inside an autoclave provide several similar temperature profiles over time. The proposed method would be able to provide a way to monitor production changes from batch to batch. We have also been applying profile analysis on bioinformatics applications. For example, the profile analysis approach is proposed to a cancer research that groups lipids' outputs on skin layers of experimental white mice according to the lipids' chemical properties such as LysoPC, PC, ePC, LysoPE and PE. Instead of treating each test result under a group as one independent entity, the proposed method treats all tests under one group as one profile. Variations from experimental white mice under the same treatment can be clustered together, while inter-treatment profiles can be compared according to their B-Spline functions.

Grants

- "Attosecond Optical Technology Based on Recollision and Gating," U.S. Department of Defense, $5,520,833, Co-PI **Shuting Lei**, Z. Chang and C.L. Cocke, May 2007 – April 2012.
- "CAREER: Fundamental Research on Silicon Wafer Fine Grinding To Foster a Quantum Leap inManufacturing of Silicon Wafers," National Science Foundation, $514,855 (including two workshop supplements, two RET supplements, four REU supplements, one IREE Supplement, and one book-writing supplement), **ZJ Pei**, Feb. 2004 – Jan. 2012.
- "Collaborative Research: Fundamental Research on Titanium Drilling with Rotary Ultrasonic Machining," National Science Foundation, $311,363 (including one RET supplement and four REU supplements), Co-PI **ZJ Pei** and J.G. Sun, July 2009 – June 2012.
- "Collaborative Research: Mathematical Modeling and Experiemental Study of Femotosecond Laser Machining of High-Aspect Ratio Microstructures (HARMs)," National Science Foundation, $117,999, Co-PI **Shuting Lei** and Z. Chang, $117,999, Feb. 2009 – Aug. 2011.
- "Defect-Free and Roburst Microstructuring Using Femtosecond Axicon-Lens-Focused Beams (FAB) with Application Focus in Thin-Film Solar Cell Manufacturing," National Science Foundation, $288,422, **Shuting Lei**, Sept. 2011 – Aug. 2014.
- "Kansas Bioprocessing Science and Engineering Center," National Science Foundation PFI Grant IIP 0917984 and partners, $702,339, PI **Bradley Kramer**, March 2010 – Feb. 2013.
- "Kansas Opportunity Innovation Network," U.S. EDA and partners, $1,440,000, PI **Bradley Kramer**, Aug. 2010 – Sept. 2013.
- "Kansas Technology Enterprise Corporation Center of Excellence Grant Agreement," Kansas Technology Enterprise Corporation, $468,566, PI **Bradley Kramer**, July 2010 – June 2011.
- "Phase IV & V: Farm-Scale, Phosphorus-Recovery Master Agreement Construction, Start-Up and Monitoring (P08-0102)," Kansas Environmental Management Associates, LLC, $120,984, PI **Bradley Kramer**, Jan. 2007 – Jan. 2011.
- "Ultrasonic Vibration-Assisted Pelleting of Cellulosic Biomass for Biofuel Manufacturing," National Science Foundation, $483,572 (including two REU supplements), Co-PI **ZJ Pei** and D.H. Wang, Sept. 2010 – Aug. 2013.

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- Zhang, P.F., Feng, Q., **Pei, Z.J.**, and Zhang, W.W., 2011, "Non-traditional drilling of SiC-based ceramic matrix composites: a literature review," International Journal of Machining and Machinability of Materials, Vol. 10, No. 3, pp. 235-259.

- Zhang, P.F., **Pei, Z.J.**, Wang, D.H., Wu, X.R., Cong, W.L., Zhang, M., and Deines, T.W., 2011, "Ultrasonic vibration-assisted pelleting of cellulosic biomass for biofuel manufacturing," Journal of Manufacturing Science and Engineering, Vol. 133, No. 1, pp. 011012-1 – 011012-7.

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- Cong, W.L., Feng, F., **Pei, ZJ**, **Deines, T.W.**, and Treadwell, C., 2011, "Experimental study on cutting temperature in rotary ultrasonic machining," Proceedings of NAMRI/SME, Vol. 39, 2011.

- Cong, W.L., Feng, F., **Pei, ZJ**, **Deines, T.W.**, and Treadwell, C., 2011, "Dry machining of carbon fiber-reinforced plastic composite by rotary ultrasonic machining: effects of machining variables," Proceedings of the ASME 2011 International Manufacturing Science and Engineering Conference (MSEC 2011), June 13-17, 2011, Corvallis, Oregon, USA.

- Li, Z.C., **Pei, ZJ**, and Funkenbusch, P.D., 2011, "Machining processes for sapphire wafers: a literature review," Journal of Engineering Manufacture (Proceedings of the Institution of Mechanical Engineers, Part B), Vol. 225, No. 7, pp. 975-989. DOI: 10.1177/2041297510393667.

- Liu, Z.P., Sun, J.G., and **Pei, ZJ**, 2011, "Cross-polarization confocal imaging of subsurface flaws in silicon nitride," International Journal of Applied Ceramic Technology, Vol. 8, No. 2, pp. 411-422.

- Kulkarni, S.S., Haynes, M., Reimers, L., Achanta, K.R., and **Lei, S.**, "An investigation into machinability of sintered nanocrystalline hydroxyapatite," Proceedings of the ASME 2011 International Manufacturing Science and Engineering Conference, June 13-17, Corvallis, Oregon, USA, 7p (2011).

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- Zhang, Q., Zhang, P.F., **Pei, ZJ**, and Pei, L., 2011, "An experimental investigation on cellulosic biofuel manufacturing: effects of biomass particle size on sugar yield," Proceedings of the ASME 2011 International Mechanical Engineering Congress and Exposition, Denver, Colorado, November 11-17, 2011, IMECE 2011-62721.

- Zhang, P.F., and **Pei, ZJ**, 2011, "Cost estimates of cellulosic ethanol manufacturing: a literature review," Proceedings of the ASME 2011 International Manufacturing Science and Engineering Conference (MSEC 2011), June 13-17, 2011, Corvallis, Oregon, USA.

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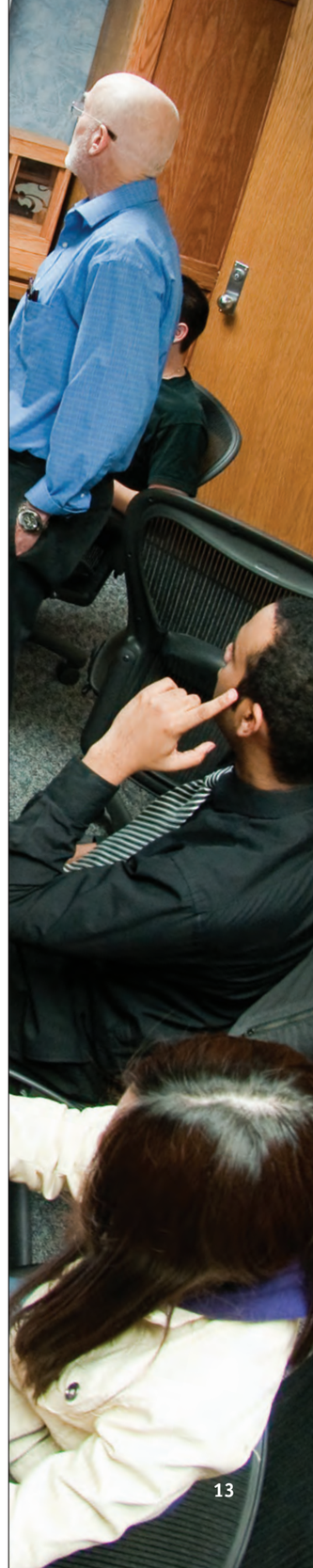
- Zhang, P.F., Zhang, Q., **Pei, ZJ**, and Pei, L., 2011, "Ultrasonic vibration-assisted pelleting in manufacturing of cellulosic biofuels: an investigation on biomass particle size," Proceedings of the ASME 2011 International Mechanical Engineering Congress and Exposition, Denver, Colorado, November 11-17, 2011, IMECE 2011-64172.

Book chapters

- **Ben-Arieh, D.**, and Choubey, A., Platform Formation Under Stochastic Demand, in Evolutionary Computing In Advanced Manufacturing, M K Tiwari and J Harding (Eds.), Wiley-Scrivener Publishing LLC, (2011).

- **Ben-Arieh, D.**, The Platform Formation Problem, in Mass Customization: Engineering and Managing Global Operations, Springer Series in Advanced Manufacturing, Fogliatto F.S. and da Silveira G. J.C. (Eds.), Springer, 105 – 122, (2011).



Engineering Education

Ft. Leavenworth TRAC program

This partnership with the U.S. Army offers the master of science degree in operations research to both military and civilian personnel stationed at Fort Leavenworth, Kansas.

NSF CAREER proposal writing workshops

Since 2004, IMSE professor ZJ Pei has organized workshops sponsored by the National Science Foundation to help young faculty members develop funded research programs.

STEM recruitment and retention

This development and assessment of effective strategies for K-12 outreach, recruitment and retention for students in STEM majors has a particular focus on efforts directed at students who are under-served and under-represented in these fields.

Grants

- "Defect Free and Roburst Microstructuring Using Femtosecond Axicon-Lens-Focused Beams (FAB) with Application Focus in Thin-Film Solar Cell Manufacturing –REU," National Science Foundation, $14,208, **Shuting Lei**, Sept. 2011 – Aug. 2014.
- "K-State STEP: Increasing the Number and Diversity of Students Graduating in STEM Fields Proposal," National Science Foundation, DUE-0525556, $1,962,943, **Kimberly Douglas-Mankin**, Oct. 2009 – Sept. 2011.
- "Operational Process for EPA Radiation and Indoor Environments: Laboratory Environmental Professional Student Intern Program," U.S. Environmental Protection Agency, $222,500, **Kimberly Douglas-Mankin** with Brian R. Hanson and Bruce C. Snead, 2006-Present.
- "Part-Time M.S. Program in Industrial Engineering – Spring 2011," U.S. Department of Defense, $56,311, **Todd Easton**, Jan. – May 2011.
- "Student Participation in the 2009 NSF Civil, Mechanical and Manufacturing Innovation Grantees and Research Conference; June 22–25, 2009; Honolulu, Hawaii," National Science Foundation, $225,782, **ZJ Pei**, Nov. 2008 – April 2011.
- "Ultrasonic Vibration-Assisted Pelleting of Cellulosic Biomass for Biofuel Manufacturing—REU," National Science Foundation, $13,000, Co-PI **ZJ Pei** and D.H. Wang, Sept. 2010 – Aug. 2013.
- "Ultrasonic Vibration-Assisted Pelleting of Cellulosic Biomass for Biofuel Manufacturing—RET," National Science Foundation, $10,000, Co-PI **ZJ Pei** and D.H. Wang, Sept. 2010 – Aug. 2013.
- "Workshop/Collaborative Research: 2012 NSF CAREER Proposal Writing Workshop; University of Nevada, Reno, March 26-27, 2012," National Science Foundation, $20,970, **ZJ Pei**, Oct. 2011 – Sept. 2012.
- "Workshop/Collaborative Research: 2011 NSF CAREER Proposal Writing Workshop; University of Connecticut; Storrs, Connecticut; April 4-5, 2011," National Science Foundation, $24,998, **ZJ Pei**, Feb. 2011 – Jan. 2012.
- "Workshop/Collaborative Research: 2010 NSF CAREER Proposal Writing Workshop; September 1-2, 2010; University of Nebraska-Lincoln," National Science Foundation, $24,827, **ZJ Pei**, May 2010 – April 2011.
- "Workshop/Collaborative Research: 2009 NSF CAREER Proposal Writing Workshop; George Mason University; Arlington, Virginia; March 12–13, 2009," National Science Foundation, $22,958, **ZJ Pei**, Aug. 2008 – July 2011.
- "Workshop/Collaborative Research: 2008 NSF CAREER Proposal Writing Workshop; March 27 and 28, 2008; Northwestern University; Evanston, Illinois," National Science Foundation, $23,758, **ZJ Pei**, Feb. 2008 – Jan. 2010.
- "Workshop: 2007 NSF CAREER Proposal Writing Workshop, August 22 and 23, 2007, University of Alaska," National Science Foundation, $48,535, Co-PI **ZJ Pei** and J. Twomey, June 2007 – May 2011.

Ergonomics/Human Factors

Guidelines for installations of centerline rumble strips

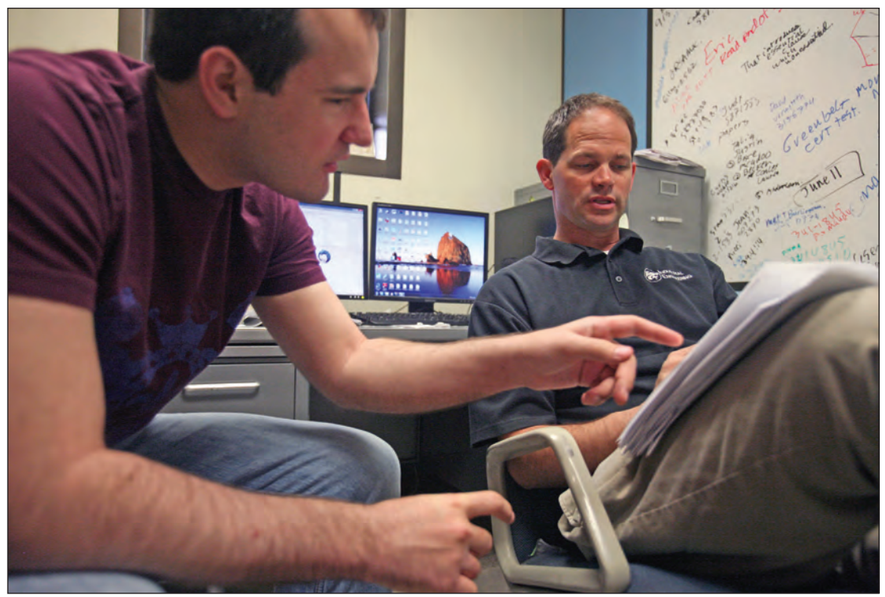
In the United States, roadway departure crashes correspond to approximately 40% of all traffic crashes, and their associated estimated annual cost is about $100 billion. Centerline rumble strips (CLRS) are raised or indented patterns installed mainly on two-lane undivided highways, utilized to alert drivers they are crossing the center of the travel lane by producing noise and vibration when crossed by vehicles' tires. It is estimated that CLRS can reduce approximately 25% of cross-over crashes. However, states' department of transportation (DOTs) have reported some potential disadvantages in the usage of CLRS, such as levels of exterior noise created by the patterns, decrease in visibility of the pavement markings installed over CLRS and their influence on operational use of the travel lane. Understating how CLRS affect these factors is vital for improving current and future applications of CLRS, which will contribute to saving lives. The primary goal of this research is to provide guidance on future installations of CLRS for policy makers, based on current good practices and specific investigations of exterior noise, retroreflectivity and operational use of the travel lane.

A review of overhead guide-sign lighting policy

It has been almost 10 years since a study sponsored by the FHWA determined the minimum luminance requirements for overhead guide signs. Since that time, three major developments have taken place:

1. A number of new retro-reflective sign sheeting types are on the market.
2. Classification of retro-reflective sign sheeting types has significantly changed.
3. There is now a federal mandate for maintaining minimum retro-reflectivity.

States have until 2012 to implement and continue using an assessment or management method to maintain traffic sign retro-reflectivity at or above the minimum levels. Also, overhead signs that need to be illuminated should be done in the most cost-effective manner, taking advantage of newer lighting systems that use less energy than most of the older systems and bulbs. The objective of this project is to determine the most cost-effective method to maintain the minimum retro-reflectivity levels for overhead guide signs that will satisfy FHWA requirements and be consistent with minimizing life-cycle costs.



Ergonomics/human factors

Grants

- "A Review of KDOT Overhead Guide Sign Lighting Policy," Kansas Department of Transportation, $63,882, **Malgorzata Rys** with A. Rys and E. Russell, Nov. 2010 – June 2012.
- "Graduate Student Support," University Transportation Center, Kansas State University, $10,000, **Malgorzata Rys**, Jan. 2010 – May 2011.
- "Keeping Vehicles on the Roadway in Rural Areas: Analysis of Run-Off-the-Road Crashes," University Transportation Center, Kansas State University, $119,972, **Malgorzata Rys** with S. Dissanayake, E. Russell, and R. Stokes, Nov. 2009 – May 2011.
- "Study of KDOT Policy on Lane and Shoulder Minimum Width for Application of CLRS," Kansas Department of Transportation, $59,000, **Malgorzata Rys** with E. Russell, July 2009 – June 2011.

Journal publications

- Karkle, D.E. **Rys, M.J.**, and E.R. Russell, "Centerline Rumble Strips: A Study of External Noise," Journal of Transportation Engineering, Vol.137, No.5, 2011.
- Karkle, D.E., **Rys, M.J.**, and E. Russell, "State-of-the-Art: Centerline Rumble Strips Usage in the United States," Journal of Transportation Research Forum, Vol. 50, No. 1, 2011.

Publications in peer-reviewed transactions and proceedings

- Ahearn, S. and **Rys, M.J.**, "Applying Ergonomic Principles to Dental Scalers," Proceedings from the 16th Annual International Conference on Industrial Engineering Theory, Applications and Practice, ISBN #97819346601-3-3, Stuttgart, Germany, September 2011.
- Gund, A. and **Rys, M.J.**, "A Review of Overhead Guide Sign Lighting Policy," Proceedings from the 16th Annual International Conference on Industrial Engineering Theory, Applications and Practice, ISBN #97819346601-3-3, Stuttgart, Germany, September 2011.

Research reports

- **Rys, M.J.**, Karkle, D.E., and Russell, E.E., "Study of KDOT Policy on Lane and Shoulder Minimum Width for Application of CLRS," Final Report, K-TRAN Project No: KSU-10-7, November 2011.

Health care initiatives

Modeling the spread of disease

Now in its fifth year, our health care focus continues to grow with numerous projects including the modeling of the progression of different sepsis episodes (e.g., systemic inflammatory response (SIR), sepsis, severe sepsis and then septic shock) in the human body at a cellular level using system dynamics, agent-based simulation and evolutionary games. The aim is to model the human immune and inflammatory responses at an aggregate level using advanced parallel simulation mechanisms, thus allowing acute care providers or care managers to predict the outcomes or risk of a patient during an episode of care by comparing a series of simulated prognostic indicators with actual patient's status. This could help an intensive care unit (ICU) to make best use of its resources to focus on patients who are at a higher risk of developing sepsis shocks. The current effort is conducted with a close collaboration with the University of Kansas Medical School Hospital.

Analyzing the effectiveness of health clinics

Another project uses data envelopment analysis (DEA) methodology to assess the effectiveness of safety-net clinics in the state of Kansas. This research focuses on assessing the effectiveness, core competencies and weaknesses of individual clinics regardless of size, location or community served. This research develops a new methodology to conduct the DEA analysis on entities with sparse data as is after the practical case.

Grants

- "Improved Deployment of the Tele-Tracking Bedboard Monitoring System," Children's Mercy Hospital (Kansas City), $23,680, Co-PI **David Ben-Arieh** and **Chih-Hang (John) Wu**, May 2010 – Feb. 2011.
- "Measuring Impact of Field-Based Analytics Education," U.S. Department of Veterans Affairs, $62,282, **David Ben-Arieh**, **Shing Chang**, and **Kimberly Douglas-Mankin**, Sept. 2011 – July 2012.
- "Operating Room IT Evaluation," U.S. Department of Veterans Affairs, $63,882, **David Ben-Arieh** and **Malgorzata Rys**, Sept. 2011 – Nov. 2012.
- "Patient-Flow Analysis and Improvement," Kansas City VA Medical Center, $120,000, Co-PI **David Ben-Arieh** and **Chih-Hang (John) Wu**, Jan. 2010 to Dec. 2011.
- "Readiness for Reliability in Sterile Processing Department (SPD)," U.S. Department of Veterans Affairs, $61,698, **David Ben-Arieh**, **Shing Chang**, and **Kimberly Douglas-Mankin**, Sept. 2011 – July 2012.

Journal publications

- Joshi, A. and **Rys, M.J.**, "Study on the Effect of Different Arrival Patterns on Emergency Department's Capacity Using Discrete Event Simulation," International Journal of Industrial Engineering – Theory, Practice and Application, Vol.18, No. 1, 2011.
- **Ben-Arieh, D.**, **Wu C-H.**, "Reducing Patient Waiting Time at an Ambulatory Surgical Center," in Management Engineering for Effective Healthcare Delivery: Principles and Applications, Kolker A. and Story P (Eds.), IGI Global, pp. 246-260, (2011).
- **Wu, C.H.**, **Ben-Arieh, D.**, and Shi Z., An Autonomous Multi-Agent Simulation Model for Acute Inflammatory Response," International Journal of Artificial Life Research Vol. 2, no.2, 105-121, April-June (2011).

Operations Research

Artificial life and applied soft computing

An interdisciplinary research area, artificial life intends to combine various disciplines such as artificial intelligence, neural network, fuzzy sets, psychology and humanistic aspects to study or to model the living systems or human-level artificial systems or machines that exhibit intelligent autonomous behavioral characteristics of human or living systems. At the same time, IGI-Global published a journal on artificial life research.

Fuzzy neural network, known as fuzzy adaptive network (FAN), and support vector machines are used to model not-well-defined, vague or humanistic systems such as thermal comfort, human fatigue, presidential elections, financial credit ratings, soft-pad grinding in manufacturing, cell formation in cellular manufacturing, etc.

Decision making: decentralized and fuzzy

Many problems arising in both the public and private sectors involve numerous individual decision makers, each with their own objectives and levels of information, who utilize resources within a common system. In general, decentralized decision making can perform poorly in comparison to systems where a centralized planner makes choices. However, central control can be costly and unrealistic in many practical settings. Traditional optimization approaches that adopt a centralized perspective are therefore not sufficient for these scenarios. By combining tools from optimization and algorithmic game theory to analyze such systems, methods are sought that lead to decentralized solutions that approximate the performance of centrally optimal decision making but are practical to implement. This work will contribute to the fundamental understanding of decentralized systems in general and, in particular, systems arising in public-impact scenarios such as humanitarian response and public health.

Multilevel optimization plays an important role in decentralized planning for organizations in which decision makers are arranged at hierarchical levels, and is a very useful tool for large organizations such as government policy, economic systems, transportation networks, etc. Since the problem is basically fuzzy and not well defined, fuzzy approach appears to be ideally suited to improve the basic multilevel approaches. A book has been published in this area: Fuzzy and Multi-Level Decision Making: Interactive Computational Approach, Springer-Verlag, London (2001). Another book to solve the multi-level problem based on evolutionary concepts is in the development stage.

Discrete optimization

We are currently performing research in discrete optimization with an emphasis in integer programming and graph theory. This integer programming research focuses on finding improved techniques to solve integer problems. Our graph theory research develops algorithms and heuristics to solve computationally challenging problems.

The bulk of our recent integer programming research uses feasible integer points to generate valid inequalities and facet-defining inequalities. This technique has led to numerous new results in integer programming, including development of the algorithm to simultaneously lift sets of general integer variables, a new way to perform sequential lifting, polynomial time methods to simultaneously life numerous inequalities into a cover inequality and discovering a new class of facet-defining inequalities called three-set inequalities for the knapsack polytope.

Fuzzy systems analysis and optimization

The definitions of convex and concave functions for crisp systems are too restrictive to apply to fuzzy or more general systems. Several new concepts in this area have been proposed. These new concepts can be used to promote more concise optimization theories, which can be applied to more general fuzzy systems, parallel to the Karush-Kuhn-Tucker theory for classical systems.

Data envelope analysis (DEA), based on linear programming, has proven to be a highly useful tool for comparing and improving the efficiencies of non-profit and very large organizations such as hospitals and educational institutions. But, the basic systems of such nonprofit organizations are vague and not well defined. Thus, a fuzzy approach can help to overcome some of the problems in applying DEA. A book in this area will be published by IGI-Global, entitled Fuzzy Data Envelopment Analysis: Technologies, Concepts and Applications.

Public-impact supply chains

While many of the earliest applications of operations research and industrial engineering were in the public sector, many opportunities remain to improve the supply chains that deliver goods and services to those impacted by disasters and ongoing public health challenges. Problems arising in these areas often require new modeling ideas, because the constraints and objectives of such problems differ from seemingly similar private sector counterparts. As a result, solving these problems advances our understanding of theory as well as practice. Recent and ongoing efforts in this area focus on empirical studies of the supply chain practices of private companies, government agencies and non-governmental organizations involved in disaster response. Investigation of both successful and unsuccessful public-impact supply chains will advance understanding of the gaps between the theory of supply chain management and actual practice, and develop a deeper knowledge of how decisions are made in these contexts. This research will contribute to supply chain systems for humanitarian response and public health that are more efficient, effective and equitable in addressing critical needs.

Ultra-precision, non-contact surface strain measurements

The main objective of this multi-department (civil, mechanical and industrial engineering) research effort is the development of ultra-precision, non-contact measurement techniques to measure dynamic changes on surface strains in a variety of real-world applications, including bridge inspection, pre-stress concrete elements manufacturing, semiconductor water surface strains measuring and metallic structure dynamic stress. Previous research efforts have shown that by recognizing the tiny shifts of the fringes or speckle patterns reflected by the measured surfaces, precise surface strain changes can be calculated mathematically using sophisticated digital-imaging processing algorithms and their corresponding domain transformations.

Grants

- "Developing a Scheduling Software Package for Digestive Health Specialists," Digestive Health Specialists, $3,000, **Todd Easton**, Jan. – Sept. 2011.
- "Developing a Scheduling Software Package for Westside High School," Westside High School, $18,000, **Todd Easton**, March 2010 – June 2011.
- "Quantifying the Effect of Prestressing Steel and Concrete Variables on the Transfer Length in Pretensioned Concrete Crossties," U.S. Department of Transportation/Federal Railroad Administration, $247,299, **Chih-Hang (John) Wu** with B.T. Beck and R.J. Peterman, May 2011 – Oct. 2013.

Operations Research

Journal publications

- Cheng, C.-B., **Lai, Y.-J.**, and Chan, K., "Solving a Reverse Auction Problem by Bi-Level Distributed Programming and Genetic Algorithm," International Journal of Revenue Management, Vol. 5, Nos. 2/3, pp. 234-260.
- **Easton T.**, K. Carlyle, J. Anderson, and M. James (2011), "Simulating the Spread of an Epidemic in a Small Rural Kansas Town," International Journal of Artificial Life Research, 2 (2) 95-104.
- Kim, G., and **Wu, C.-H.**, "A Pegging Algorithm for Separable Continuous Nonlinear Knapsack Problems with Box Constraints," Engineering Optimization, DOI: 10.1080/0305215X.2011.646263, (Nov. 2011).
- **Lee, E.S.**, Tan, Q., He, Q., and Shi, Z.Z., "An Improved FCMBP on Evolutionary Programming," Computers and Fuzzy Clustering Method-Based Mathematics with Applications, 61, pp. 1129-1144 (2011).
- **Lee, E.S.**, Syau, and Sugianto, "Continuity and Semicontinuity of Fuzzy Mappings," Computers and Mathematics with Applications, 61, pp. 1122-1128 (2011).
- **Lee, E.S.**, Hung, W.-L., and Yang, M.-S., "Cell Formation Using Fuzzy Relational Clustering Algorithm," Mathematical and Computer Modelling," 53, pp. 1776-1787 (2011).
- **Lee, E.S.**, Hwang, C.-M., Yang, M.-S., and Hung, W.-L., "Similarity, Inclusion and Entropy Measures between Type-2 Fuzzy Sets Based on the Sugeno Integral," Mathematical & Computer Modelling, 53, pp. 1788-1797 (2011).
- **Lee, E.S.**, Guu, S.-M., and Wu, Y.-K., "Multi-Objective Optimization with a Max-T-Norm Fuzzy Relational Equation Constraint," Computers & Mathematics with Applics, 61, pp. 1559-1566 (2011).
- **Lee, E.S.**, Yuan, X.-H., and Liu, Z.-L., "Center-of-Gravity Fuzzy Systems Based on Normal Fuzzy Implications," Computers & Math. With Applics., 61, pp. 2879-2898 (2011).
- **Lee, E.S.**, Yu, J., and Yang, M.S., "Sample-Weighted Clustering Methods," Computers & Math. With Applics., 62, pp. 2200-2208 (2011).
- **Lee, E.S.**, Hung, W. L., and Chang, Y. C., "Weight Selection in W-K-Means Algorithm with an Application in Color Image Segmentation," Computers & Math. With Applics., 62, pp. 668-767 (2011).
- **Lee, E.S.**, Hung, W.L., and Chuang, S. C., "Balanced Bootstrap Resampling Method for Neural Model Selection," Computers & Math. With Applics., 62, pp. 4576-4581 (2011).
- **Lee, E.S.**, Li, J., Yuan, X., and Xu, D., "Setting Due Dates to Minimize the Total Weighted Possibilistic Mean Value of the Weighted Earliness-Tardiness Costs on a Single Machine," Computers & Math. With Applics., 62, pp4126-4139 (2011).
- Zhao, W., Larson, K., Peterman, R.J., Beck, T., and **Wu, C.-H.** "Development of a Laser-Speckle Imaging Device to Determine the Transfer Length in Pre-tensioned Concrete Members," PCI Journal, pp. 135-143, (Winter/2012).

Publications in peer-reviewed transactions and proceedings

- **Lee, E.S.**, Naadimuthu, and Kapur, "A Modified Computational Dynamic Programming Approach to a Production and Inventory Control Problem," Proceedings of the Southeast Decision Sciences Institute Conference, Savannah, GA, February 23-25 (2011).

Book chapters

- **Ben-Arieh, D.** and **Easton T.**, "Product Design Compromise Using Consensus Models," Herrera-Viedma E. ,García-Lapresta L, Kacprzyk J., Fedrizz M., Nurmi H., and Zadrozny S., (Eds.), in "Consensual Processes: Studies in Fuzzines and Soft Computing, Vol. 267, ", pp. 405-423, Springer Verlag, (2011).

Professional Leadership

David Ben-Arieh
- Editorial board, Journal of Health Systems
- Editorial board, International Journal of Information and Operations Management Education
- American Association of Telemedicine, special interest group on human factors
- Society of Health Systems, Body of Knowledge group
- Member, IFIP Work Group 5.1— Information Technology in the Product Realization Process
- Member, IFIP Work Group 5.3—CAD/CAM and Information Systems

Shing Chang
- Editorial board, International Journal of Information and Decision Sciences (IJIDS)
- Editorial board, International Journal of Experimental Design and Process Optimisation (IJEDPO)

Kimberly Douglas-Mankin
- Editor, The Journal of Women and Minorities in Science and Engineering
- National Science Foundation STEP PI Meeting, advisory committee
- Louisiana Tech NSF ADVANCE, external advisory board
- Iowa State STEM Student Enrollment and Engagement Through Connections (SEEC), external advisory board
- WEPAN, awards committee

Todd Easton
- Guest editor, International Journal of Artificial Life Research

John English
- Member, Arkansas Academy of Industrial Engineering
- Juror, National Council for Engineering Examinations and Surveyors
- Board of directors, Reliability and Maintainability Symposium
- Board of directors, KSUIC
- Member, IIE, honors and awards committee
- Board of directors, Kansas Foundation for Engineers

Bradley Kramer
- Vice-chair, board of directors, IDEA Center

E. Stanley Lee
- Editor, associate editor, or on the editorial board of the following journals:
  - International Journal of Artificial Life Research
  - International Journal of Operations Research
  - International Journal of Modeling and Simulation
  - Fuzzy Optimization and Decision Making
  - Mathematical Sciences Research Hot-Line
  - Computer and Mathematics with Applications
  - Indian Journal of Management and Systems
  - Journal of Engineering Chemistry and Metallurgy
  - The Journal of Fuzzy Systems Association, Taiwan
  - Journal of Nonlinear Differential Equations: Theory, Methods, and Applications
  - Journal of the Chinese Institute of Industrial Engineers
  - International Journal of Fuzzy Systems
  - The Chinese Journal of Process Engineering
  - Journal of Uncertain Systems (JUS)
  - Optimization and Engineering
  - Journal of Intelligent Information Management

Professional Leadership

- Annals of Fuzzy Sets, Fuzzy Logic and Fuzzy Systems
- Applied Computational Intelligence and Soft Computing
- Advances in Computational Research
- International Journal of Mechatronics and Manufacturing Systems
- International Journal of Manufacturing, Materials and Mechanical Engineering

■ Honorary professor, Chinese Academy of Sciences, People's Republic of China

Shuting Lei

■ International editorial review board, International Journal of Manufacturing, Materials and Mechanical Engineering
■ Member, NAMRI/SME, scientific committee
■ Editorial board member, Journal of International Scholarly Research Network (ISRN) Ceramics

ZJ Pei

■ Associate editor, Journal of Manufacturing Processes
■ Associate technical editor, Machining Science and Technology
■ Editorial board, International Journal of Engineering Business Management
■ Editorial board, International Journal of Machine Tools and Manufacture
■ Editorial board, International Journal of Machining and Machinability of Materials
■ Editorial board, Journal of Machining and Forming Technologies
■ Editorial board, Open Mechanical Engineering Journal
■ Editorial board, Recent Patents on Mechanical Engineering
■ Organizer, 2011 NSF CAREER proposal writing workshop
■ Chair, ASME MED Manufacturing Processes, technical committee

Malgorzata Rys

■ Editorial board, International Journal of Industrial Engineering – Theory, Applications and Practice

Undergraduate Studies

Undergraduate

Undergraduate enrollment in the industrial and manufacturing systems engineering department continues to grow. In 2011, we had a total enrollment of nearly 190 undergraduate students, a 50 percent increase over our 2007 enrollment. Women make up approximately 25 percent of our undergraduates. During the spring and fall 2011 commencement ceremonies, 42 BSIE degrees were granted. Graduates of our program are in strong demand in Kansas, the Midwest region and across the nation. Companies that recruited our graduates last year include Accenture, Altec Industries, Inc., Burlington Northern-Santa Fe Railway, Caterpillar, Cessna, Exxon Mobile, Halliburton, Honeywell, Hormel Food and J.B. Hunt. Average annual starting salary for our graduates is nearly $60,000.

We emphasize team work and group projects in our learning experience to help our students develop the skills necessary for success in today's work environment. Our program gives students the opportunity to work on a real-world problem for an senior design organization. In MSDA (manufacturing systems design and analysis), students create and run their own business, from product design and production to marketing, sales and distribution. Additionally, most of our graduates complete two internships by the time they graduate. From these experiences, our graduates enter the work force ready to contribute and succeed.

Students may choose an area of specialization in engineering management, ergonomics, manufacturing engineering or operations research. Additionally, high-performing students can earn a bachelor's and master's degree concurrently. Graduates typically complete both degrees in about one calendar year beyond the time it would take to complete the bachelor's alone. Students accepted in this program earn a broader and deeper appreciation for industrial engineering through advanced-level coursework. They also significantly enhance their technical skill set through active engagement in research. Starting salaries for graduates of this program have been approximately 20% more than that of B.S. graduates.

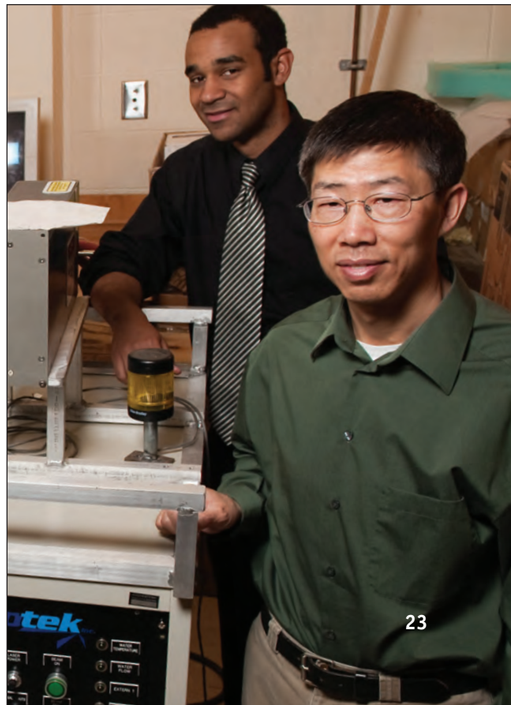
Awards

In 2011, one of our students received the Material Handling Education Foundation Scholarship. Since its inception in 1976, 31 K-State IMSE students out of the approximately 700 total recipients have been awarded this scholarship. That means some 4.4 percent of all awards given nationally were received by students from our department.

For the 2011-2012 academic year, scholarships totaling nearly $90,000 were awarded to 36 outstanding IMSE students.

IIE student chapter

The department has an active student chapter of the Institute of Industrial Engineers. The faculty adviser is Margaret J. Rys. IIE officers organized a number of activities promoting academic and social interaction among the members. The chapter hosted student/faculty picnics, mentor day, a financial workshop, and a tailgate party with the Oklahoma State University IIE student chapter and the Kansas City IIE senior chapter; sponsored displays at K-State Open House; and participated in the Technical Paper Conference. For the fourth consecutive year, the chapter received the Gold Award in the IIE national chapter recognition competition.



Graduate Studies

graduate

Graduate program

The industrial and manufacturing systems engineering department is committed to excellence in scholarly research and graduate teaching. Our graduate classes typically enroll 20 or fewer students each. Graduate students are individually known by the IMSE faculty and will work directly with one of our faculty members to conduct their research projects.

We have an active graduate student council that advocates on behalf of our graduate students and arranges for social gatherings such as picnics and celebrating the Chinese New year and Diwali.

We offer four graduate degrees: the master of science in industrial engineering (MSIE), the master of science in operations research (MSOR), the master of engineering management (MEM), and a doctor of philosophy in industrial engineering. (The MEM degree is offered exclusively as a distance program, while the MSOR is availabe both on campus and online to better serve our students.)

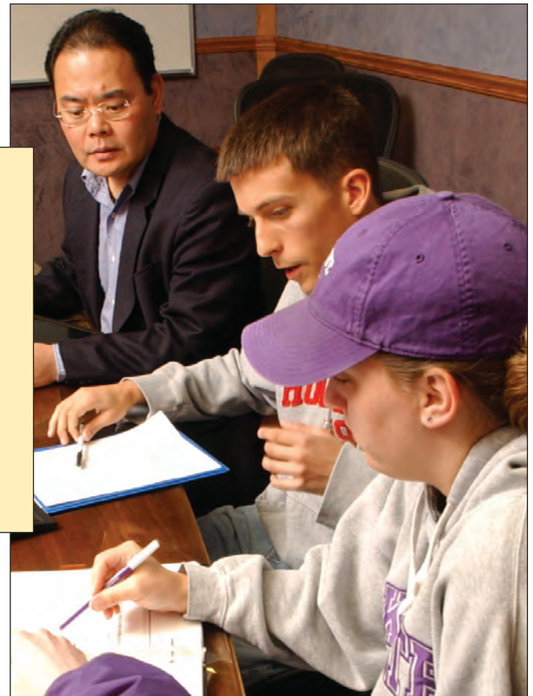
MSIE program teaches students the mathematical, scientific and analysis skills to solve complex business problems in manufacturing, health care, transportation, financial organizations, communications, government, military and many other organizations. The MSOR program focuses on the application of mathematical models to analyze complex problems and develop optimum solutions. The MEM program is geared toward management of engineering or highly technical organizations as well as money, people and equipment.

Admission requirements

Applicants for our graduate degrees must possess a bachelor's degree in engineering with at least a 3.0 grade point average or equivalent from an accredited institution. Students not possessing a degree in engineering must have a background that includes the equivalent of core undergraduate engineering and mathematics courses. International students must have an Internet-based TOEFL of 79 or higher. GRE scores are required for all of our graduate degree applicants, except MEM students whose undergraduate degrees are from an ABET-accredited, United States-based institutions.

Areas of concentration

The IMSE department offers a rich variety of projects in the areas of operations research, ergonomics, manufacturing processes, production, health systems, uncertainty representation and intelligent reasoning, as well as quality engineering. In addition to basic research, our curriculum emphasizes collaborative and interdisciplinary research, collaboration with industrial partners, and development and modeling of various industrial processes. Please refer to the research section to get a feel for our current research on to get a feel for our current research.



Where to apply

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Kansas State University
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Fax: 785.532.3738
Email: imse@ksu.edu
www.imse.ksu.edu

Application materials

- Online application: *www.k-state.edu/grad/application*
- Application fee
- Official transcripts
- TOEFL* and GRE scores
- Affidavit of financial support*
- Statement of objectives
- Three letters of recommendation

** required for international students only*

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