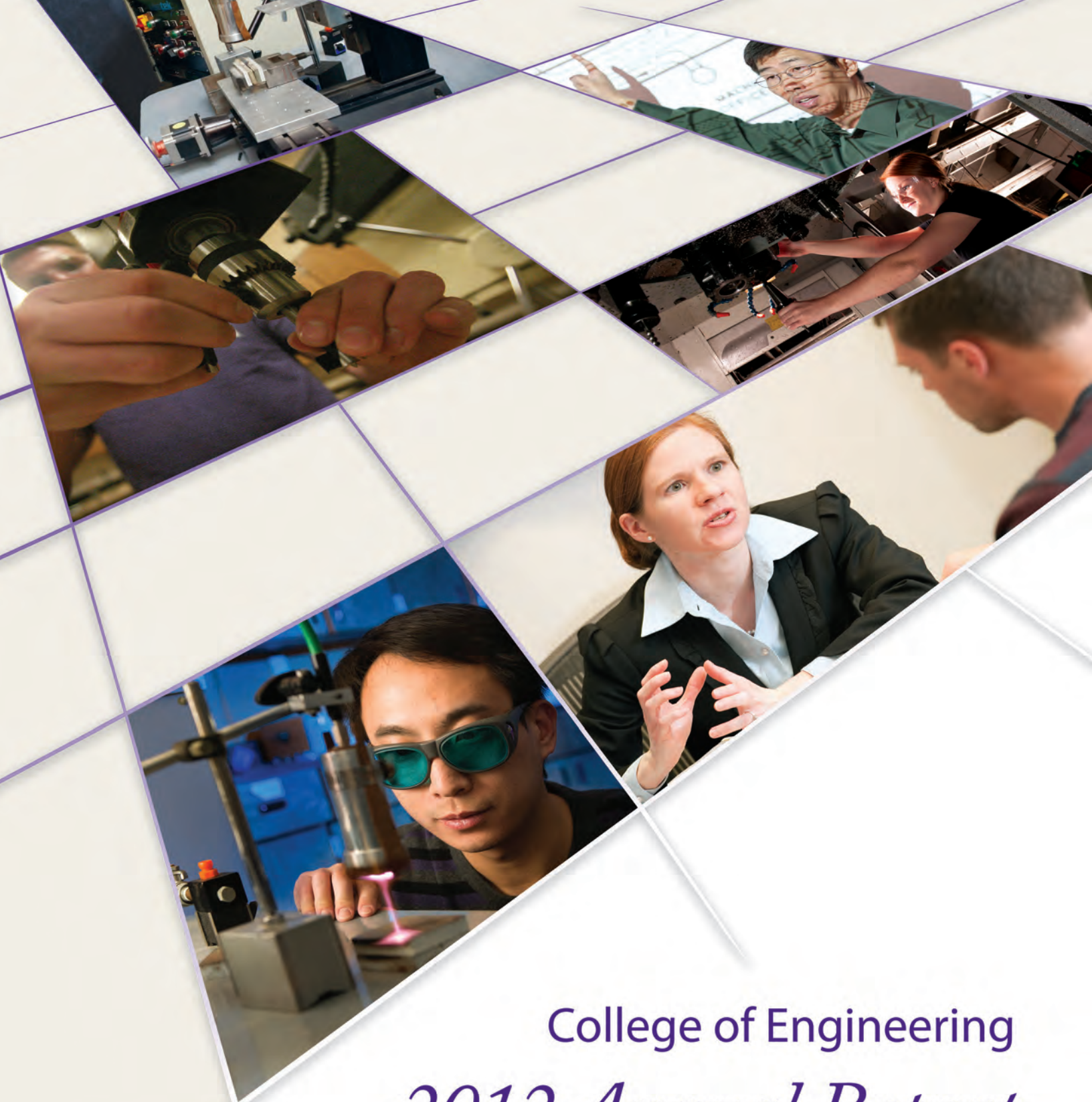


College of Engineering

2012 Annual Report

Industrial and Manufacturing Systems Engineering

KANSAS STATE UNIVERSITY

Contents

Message from the department head

Dear Colleagues and Friends,

It's been another exciting and successful year for the industrial and manufacturing systems engineering department at Kansas State University. I'm pleased to share with you information about our work and achievements.

For me, 2012 was a year of steady progress. As a department, we made strides to ensure our continued success educating industrial engineers – including successful ABET re-accreditation of our undergraduate program and establishment of the IMSE Academy, an alumni group dedicated to supporting the goals of the department.

It was also a year of new opportunity. As part of a major donation to the university, IMSE alum Carl Ice and his wife, Mary, endowed a logistics professorship in the department. This generous gift will allow us to expand our capabilities in logistics research and education.

Also in 2012, IMSE professor ZJ Pei accepted an NSF program director position in the advanced manufacturing cluster. While this two-year assignment takes him away from the K-State campus, the opportunity to make new connections with other researchers and organizations interested in manufacturing research is sure to be of great benefit to him and the university.

We continue to make progress in growing our department. In 2012, our programs enrolled 191 undergraduate, 69 master's and 17 doctoral students. In the past five years, we have graduated, on average, 26 undergraduates each year. To illustrate our growth, in 2012, bachelor's degrees were conferred on 43 graduates.

Our faculty members continue to be active researchers and engaged professionally. During 2012, K-State IMSE faculty authored 35 journal articles, 16 articles in refereed conference proceedings and three book chapters. Collectively, they served in 46 editorial positions for a variety of academic journals. IMSE extramural grant expenditures in fiscal year 2012 exceeded $3.16 million. Of that total, more than $322,000 was for educational grants. Eighteen different Ph.D. students and eight different M.S. students were supported on assistantships during the year.

In this report, we highlight the work of Shuting Lei. Dr. Lei has been a member of the IMSE faculty since 1999 and primarily teaches courses in manufacturing. His research area is primarily focused on using a laser to develop cost-effective and high-quality micromachining processes for advanced materials, such as ceramics and thin films. His work is contributing to a greater understanding of the use of lasers in manufacturing and may lead to significant practical applications in various industries.

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.
Professor and IMSE Department Head
Ike and Letty Evans Engineering Chair
Director, Advanced Manufacturing Institute

Manufacturing: an IE approach

While the term advanced manufacturing may be a relatively new buzzword, for Shuting Lei, a professor in Kansas State University's industrial and manufacturing systems engineering department, it's more a christening for the work throughout his career. A mechanical engineer by training, Lei has been applying industrial engineering techniques, and computer and numerical modeling to optimize machining processes for advanced materials used in varied industries.

There is growing recognition among economists, politicians and the general public alike of the importance of a strong manufacturing sector. It is considered of fundamental importance to the economic strength and national security of the nation. Additionally, manufacturing—more than any other industry—is recognized for its contributions to research discoveries, inventions and innovations.

Underscoring the significance of manufacturing, and particularly advanced manufacturing, has been recent efforts such as the Advanced Manufacturing Partnership, the National Network for Manufacturing Innovation and the Interagency Advanced Manufacturing National Program Office. These government-endorsed efforts work to partner with industry, coordinate efforts between government offices and fund manufacturing innovation institutes.

"This is an exciting time to be involved in the manufacturing sector," Lei said. "The convergence of attention and resources by industry and governmental entities could lead to significant advances that could renew the United States' leadership position in manufacturing."

Laser-focused

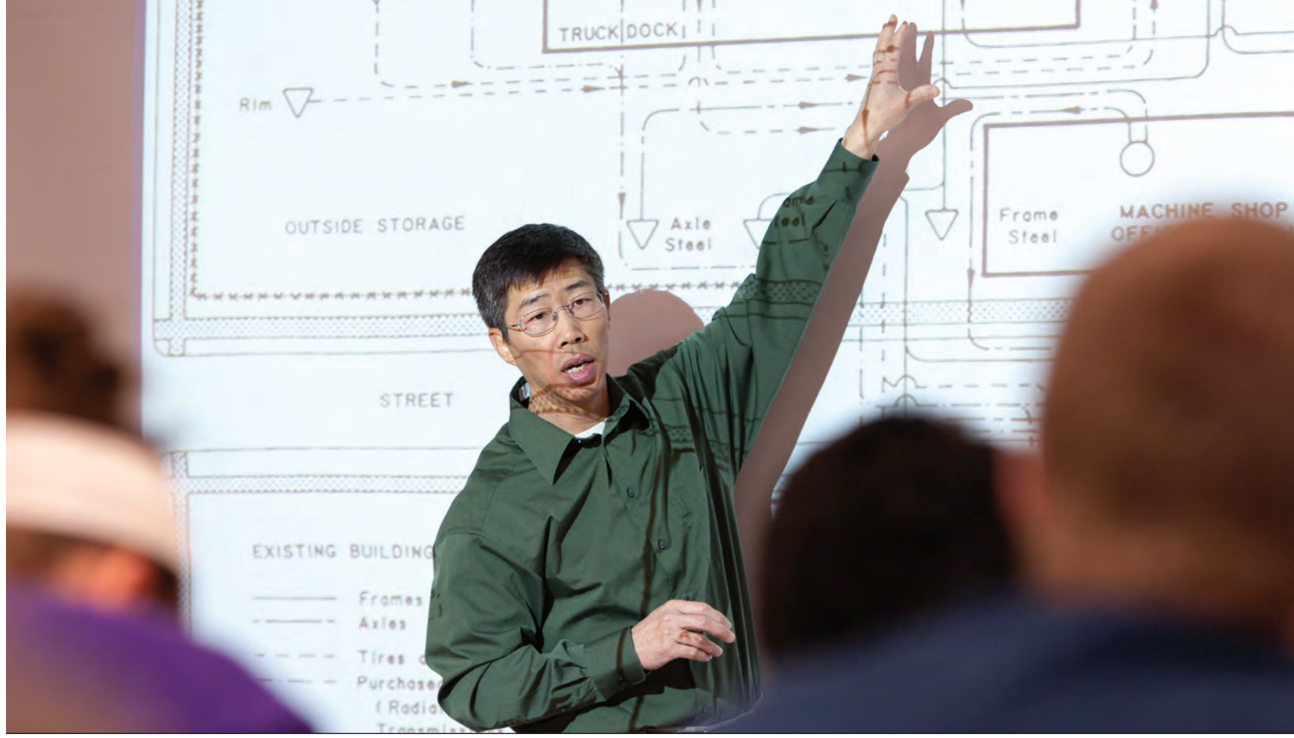
The focus of Lei's research is to machine advanced materials such as ceramics and thin films. These materials have applications in the aerospace, automotive, electronics and energy industries. However, current processes for machining these materials are expensive and cause significant degradation in material strength. In many cases, these issues have limited widespread use of these materials.

Lei's goal is to develop innovative laser-assisted machining techniques and femtosecond laser micromaching processes that make machining of these materials cost effective and lead to greater adoption of these materials by various industries.

Lei's early research was conducted on laser-assisted machining (LAM) and laser-assisted milling (LAMill) of silicon nitride ceramic. Silicon nitride ceramics are used in a variety of applications including automobile engine parts, bearings found in machines as diverse as wind turbines and skateboards, and as an insulator in manufacturing integrated circuits in electronics. They are lightweight and desirable for their ability to withstand high temperatures and resistance to corrosion. However, when machined, silicon nitride ceramic is prone to surface and subsurface cracks and causes significant tool wear due to the hardness of the material.

To overcome these obstacles, researchers have demonstrated use of a laser to soften the material. However, experiments have shown that material temperature determines surface quality of the machined workpiece. In his research, Lei used experiments and numerical modeling and simulation with finite-element analysis and distinct-element simulation to develop, validate and use models to predict optimal operating conditions for LAM.

Because milling is an intermittent cut that involves frequent impact between the cutter and the material, it is more likely to cause tool fracture and serious edge chipping to the material being milled. In his research funded by the National Science Foundation, Lei evaluated the machinability of silicon nitride by LAMill. He found proper application with a laser enabled the materials to be cut by milling without breaking the cutting tip and produced a very good surface finish. However, the success of LAMill was greatly dependent on the material's temperature, which affected both tool wear and exit edge chipping. By controlling this variable, as well as the exit angle, it was determined laser heating significantly improves the machinability of silicon nitride ceramics.



Quickening the pulse

Where his early research used continuous laser technology, Lei's current efforts involve use of the femtosecond laser—a device that creates a burst of laser energy at an extremely fast rate. These ultra-fast pulses are very precise and can remove materials at a molecular level without damaging adjacent areas. Because of this, the femtosecond laser is considered an ideal tool for precision micromachining.

In one of Lei's NSF projects, the objective was to develop an efficient method to drill high-quality, high-aspect ratio microholes. Examples of their use are in the automotive and aerospace industries where microholes are drilled into engines to aide with cooling, efficiency and noise reduction.

A key problem in laser drilling is the taper that naturally occurs in laser-drilled holes. Usually the entry point is larger than the exit point. Taper limits how deep a laser-drilled hole can be. Additionally, removed material can be deposited on the sides of the holes affecting roundness and cylindricity.

Lei's experiment involved using a hollow-core fiber as a simple spatial filter to transmit the laser beam to the target position. The main objective was to explore how the operating parameters affect the laser-fiber coupling efficiency and the ablation rate for the material to be microdrilled.

Lei found it is feasible to drill deep microholes using the femtosecond laser delivered through a hollow-core fiber. A high material removal rate could be achieved with high-pulse energy, a short-pulse duration and a focusing lens with long focal length. However, it was concluded that optimization of the operating conditions is needed to obtain a maximum ablation rate while meeting the quality requirement for microholes such as size, roundness and cylindricity.

The solar industry is another area that may benefit from use of the femtosecond laser. Currently indium tin oxide (ITO) is widely used as a contact layer in the fabrication of thin-film solar cells. Patterning or scribing of the ITO layer is one of the steps to define individual cells and interconnect adjacent cells electrically. This is done by removing part of the ITO, creating grooves in the material. The better the quality and more narrow the grooves, the greater the solar cell power conversion efficiency.

In his research funded by the United States Department of Defense and National Science Foundation, Lei studied roles of laser-pulse duration, laser fluence and laser-scanning speed in femtosecond laser patterning of the ITO layer. Of particular interest was determination of whether optimal levels of these variables, either singularly or in combination, existed for creation of high-quality, extremely narrow groves of a few microns wide.

Lei and his colleagues were able to demonstrate that such grooves were attainable within prescribed parameters. By controlling the laser energy and scanning speed, a high-quality narrow groove was achieved with negligible damage to the glass substrate.

"This proposed scribing process could lead to a significant increase in conversion efficiency for thin-film solar panels," Lei said. "Together with the potential of significantly reducing cost through roll-to-roll mass production, this project may contribute to the nation's clean energy future."

While practical applications of his research are significant, Lei never loses sight of the broader implications.

"While my research aims to use the laser as a tool to solve selected challenging problems in manufacturing processes, in doing so it also advances our scientific understanding of the field and contributes to the revival of manufacturing in the United States," Lei said. "This not only has a positive impact on the country, but also to society and our environment."

About Dr. Lei

Education

B.S. and M.S., Tsinghua University, China
Ph.D. Purdue University

Teaching

Computer-aided manufacturing
Industrial facilities layout and design
Manufacturing processes engineering
Tribology in manufacturing
Theory and practice of manufacturing processes
Research method in industrial engineering

Recent funded projects

- Defect-Free and Robust Microstructuring Using Femtosecond and Axicon-Lens-Focused Beam (FAB) with Application Focus in Thin-Film Solar Cell Manufacturing, PI, NSF, $288,442, 91/1/2011 – 8/31/2014.
- Collaborative Research: Mathematical Modeling and Experimental Investigation of Femtosecond Laser Machining of High-Aspect Ratio Microstructures (HARMs), PI, NSF, $117,999 (project total $199,998), 9/1/08-8/31/10.
- Attosecond Optical Technology Based on Recollision and Gating, Co-PI (5/1/07 – 8/8/10), PI (8/9/10 – 9/27/12), DoD MURI (Multidisciplinary University Research Initiative) grant, $6,250,000, 5/1/07 – 9/27/12.

Recent publications

- Bian, Q.,Yu, Y.,Zhao, B., Chang, Z., and Lei, S., 2013, "Femtosecond laser ablation of indium tin-oxide narrow grooves for thin-film solar cells," Optics & Laser Technology, Vol. 45, pp. 395–401.
- Shen, X., Yang, B., and Lei, S., 2012, "Microstructural Modeling and Dynamic Process Simulation of Laser-Assisted Machining of Silicon Nitride Ceramics with Distinct-Element Method," Journal of Manufacturing Science and Engineering, Transactions of the ASME, Vol. 134, No. 2, 021011.
- Sha Tao, Benxin Wu, and Shuting Lei, 2012, "A comparative study of the interaction between microhole sidewall and the plasma generated by nanosecond and femtosecond laser ablation of deep microholes," Journal of Manufacturing Processes, Vol. 14, No. 3, pp. 233-242.
- Xinwei Shen, Qiumei Bian, Zenghu Chang, Shuting Lei, and Benxin Wu, 2012, "A study on laser-fiber coupling efficiency and ablation rate in femtosecond laser deep microdrilling," International Journal of Mechatronics and Manufacturing Systems , Vol. 5, No. 3/4, pp. 280-293.
- Tao, S., Wu, B., and Lei, S., 2011, "Study of Laser Beam Propagation in Microholes and the Effect on Femtosecond Laser Micromachining," Journal of Applied Physics, Vol. 109, 123506 (6 pages).

Select professional service

- Editorial board, International Journal of Manufacturing, Materials, and Mechanical Engineering
- Editorial board, Journal of ISRN Ceramics, an international scholarly research network journal
- Member, NAMRI/SME Scientific Committee

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

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

Faculty

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; femtosecond 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

Pengfei (Patrick) Zhang

Research Assistant Professor

Dr. Zhang's research interest include the manufacturing and processing of health care-related materials and devices; precision machining of composite metals and ceramics using ultrasonic vibration-assisted processes; and mechanical, thermal and biological processing of biomass for biofuel manufacturing. He has taught courses in manufacturing processes and computer operating systems. Dr. Zhang joined the faculty in 2012.

Education: B.S. Beijing Institute of Technology, China
M.S. Beijing Institute of Technology, China
Ph.D. Kansas State University

Adjunct 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 areas of forecasting, optimization, planning/scheduling, inventory control and risk management with a 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

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 in our 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 also 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 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

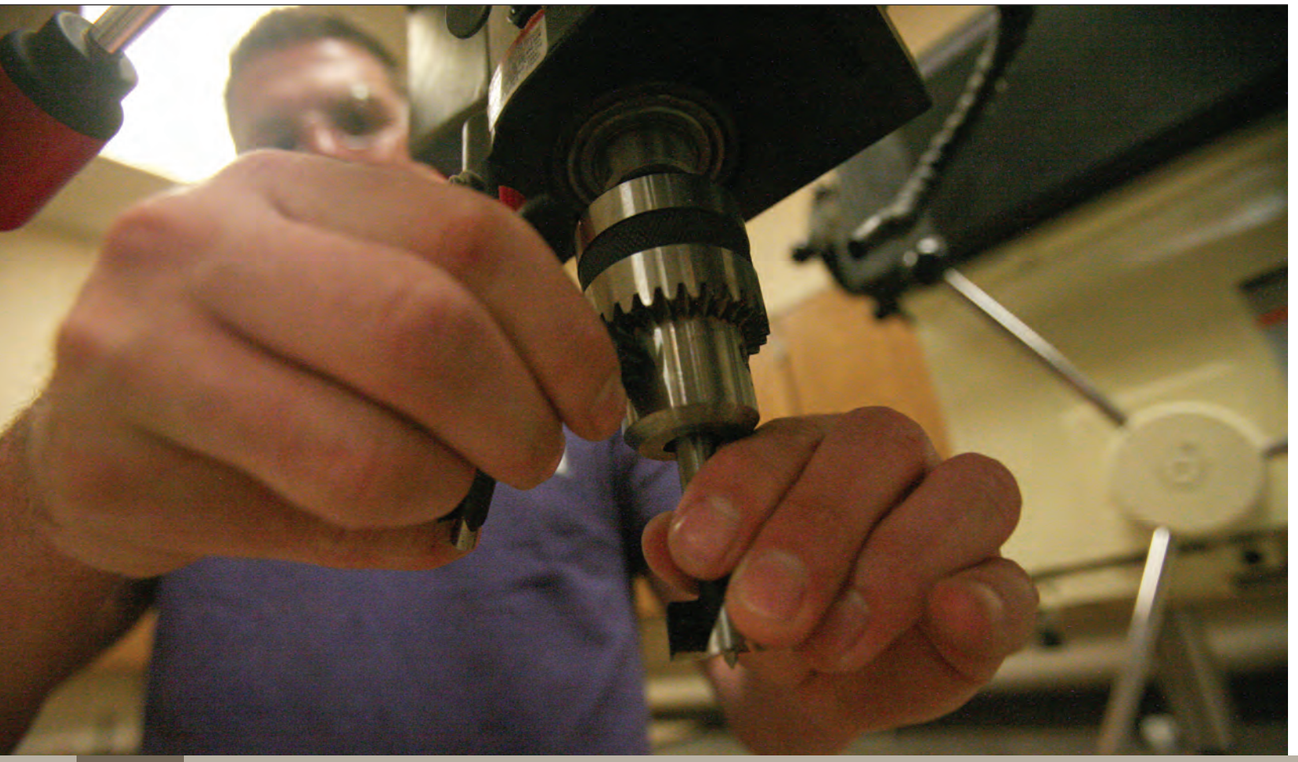
Growing concern over limited petroleum resources, environmental impacts and national security has stimulated broad interest in producing and utilizing biofuels (e.g., biodiesel and ethanol) from domestic biomass resources. Collaborating with faculty in the department of biological and agricultural engineering, 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 in manufacturing 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.
- "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.
- "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.

Journal Publications

- Ahmed, Y., Cong, W.L., Stanco, M.R., Xu, Z.G., **Pei, ZJ**, Treadwell, C., Zhu, Y.L., Li, Z.C., 2012, "Rotary ultrasonic machining of alumina dental ceramics: a preliminary experimental study on surface and subsurface damages," Journal of Manufacturing Science and Engineering, Vol. 134, No. 6, pp. 064501-1 – 064501-5.
- Bhandavat, R., **Pei, ZJ**, Singh, G., 2012, "Polymer-derived ceramics as anode material for rechargeable Li-ion batteries: a review," Nanomaterials and Energy, Vol. 1, No. 6, pp. 324-337. http://dx.doi.org/10.1680/nme.12.00030.
- **Chang, S.I.**, Tsai, T.R., Lin, D.K.G, Chou, S.H., and Lin, Y.S., 2012, "Statistical Process Control for Monitoring Nonlinear Profiles: A Six Sigma Project on Curing Process," Quality Engineering, 24, 2, 251-263.
- Cong, W.L., Feng, Q., **Pei, Z.J.**, **Deines, T.W.**, and Treadwell, C., 2012, "Edge chipping in rotary ultrasonic machining of silicon," International Journal of Manufacturing Research, Vol. 7, No. 3, pp. 311-329.
- Cong, W.L., Feng, Q., **Pei, ZJ**, **Deines, T.W.**, and Treadwell, C., 2012, "Rotary ultrasonic machining of carbon fiber-reinforced plastic composites: using cutting fluid versus cold air as coolant," Journal of Composite Materials, Vol. 46, No. 14, pp. 1745-1753.
- Cong, W.L., **Pei, ZJ**, Feng, Q., **Deines, T.W.**, and Treadwell, C., 2012, "Rotary ultrasonic machining of CFRP: a comparison with twist drilling," Journal of Reinforced Plastics and Composite, Vol. 31, No. 5, pp. 313-321.
- Cong, W.L., **Pei, ZJ**, **Deines, T.W.**, Srivastava, A., Riley, L., and Treadwell, C., 2012, "Rotary ultrasonic machining of CFRP composites: a study on power consumption," Ultrasonics, Vol. 52, No. 8, pp. 1030-1037. http://dx.doi.org/10.1016/j.bbr.2011.03.031.
- Fan, K.Q., **Zhang, P.F.**, and **Pei, ZJ**, 2012, "Ultrasonic vibration–assisted pelleting of wheat straw: a predictive model for pellet density using response surface methodology," Biofuels, Vol. 3, No. 3, pp. 259-267.
- Fan, K.Q., Zhang, P.F., and **Pei, ZJ**, 2012, "An assessment model for collecting and transporting cellulosic biomass," Renewable Energy, Vol. 50, pp. 786-794.
- Feng, Q., Cong, W.L., **Pei, ZJ**, and Ren, C.Z., 2012, "Rotary ultrasonic machining of carbon fiber-reinforced polymer: feasibility study," Machining Science and Technology, Vol. 16, No. 3, pp. 380-398.
- Liu, D.F., Cong, W.L., **Pei, ZJ**, and Tang, Y.J., 2012, "A cutting-force model for rotary ultrasonic machining of brittle materials," International Journal of Machine Tools and Manufacture, Vol. 52, No. 1, pp. 77-84.
- Shen, X., Yang, B., and **Lei, S.**, 2012, "Microstructural modeling and dynamic process simulation of laser-assisted machining of silicon nitride ceramics with distinct-element method," Journal of Manufacturing Science and Engineering, Transactions of the ASME, Vol. 134, No. 2, paper # 021011.
- Shen, X., Bian, Q., Chang, Z., **Lei, S.**, and Wu, B., 2012, "A study on laser-fiber coupling efficiency and ablation rate in femtosecond laser deep microdrilling," International Journal of Mechatronics and Manufacturing Systems , Vol. 5, No. 3/4, pp. 280-293.
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- Ma, J., **Lei, S.**, and Lu, H., 2012, "3D numerical investigation of effect of milling process parameters on high-speed milling of Ti-Al6-V4," Proceedings of the ASME 2012 International Mechanical Engineering Congress & Exposition, IMECE 2012, November 9-15, 2012, Houston, Texas, 5p.
- Ma, J., Yong, Y., and **Lei, S.**, 2012, "3D FEM investigation of the effects of nose radius and edge radius on turning of AISI 4140," Proceedings of the ASME 2012 International Mechanical Engineering Congress & Exposition, IMECE 2012, November 9-15, 2012, Houston, Texas, 5p.
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- Wu, H., **Zhang, P.F.**, Zhang, Q., and **Pei, ZJ**, 2012, "Effects of water soaking on biomass particle size in cellulosic biofuel manufacturing," Proceedings of the ASME 2012 International Manufacturing Science and Engineering Conference (MSEC), Notre Dame, IN, June 4-8, 2012, MSEC 2012-7227.
- Zhang, Q., **Zhang, P.F.**, Pritchett, G., **Pei, ZJ**, Zhang, M., Song, X., and **Deines, T.W.**, 2012, "Ultrasonic-vibration-assisted pelleting for cellulosic ethanol manufacturing: effects of particle size and moisture content on power consumption," Proceedings of the ASME 2012 International Manufacturing Science and Engineering Conference (MSEC), Notre Dame, IN, June 4-8, 2012, MSEC 2012-7211.
- Zhang, Q., **Zhang, P.F.**, Pritchett, G., **Pei, ZJ**, Zhang, M., Song, X., and **Deines, T.W.**, 2012, "Ultrasonic-vibration-assisted pelleting for cellulosic biofuel manufacturing: investigation on power consumption with design of experiment," Proceedings of the ASME 2012 International Manufacturing Science and Engineering Conference (MSEC), Notre Dame, IN, June 4-8, 2012, MSEC 2012-7212.
- Zhang, Q., **Zhang, P.F.**, Zhang, Song, X., **Pei, ZJ**, and Siddiqui, O., 2012, "Sugar yield comparison of wheat straw processed by two pelleting methods for cellulosic biofuel manufacturing," Proceedings of the ASME 2012 International Manufacturing Science and Engineering Conference (MSEC), Notre Dame, IN, June 4-8, 2012, MSEC 2012-7228.

Book Chapters

- Feng, Q., Ren, C.Z., and **Pei, ZJ**, 2012, "Ultrasonic-vibration-assisted (UV-A) machining of composites," an invited book chapter in Machining Technology of Composite Materials: Principles and Practice, edited by H. Hocheng, Woodhead Publishing Limited, Cambridge, UK, pp. 185-201.

Engineering Education

Ft. Leavenworth TRAC Program

Partnership with the U.S. Army to offer 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

Development and assessment of effective strategies for K-12 outreach, recruitment and retention for students in STEM majors. 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. 2013.
- "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 2012," U.S. Department of Defense, $60,003, **Todd Easton**, Jan. – May 2012.
- "Part-Time M.S. Program in Industrial Engineering – Summer 2012," U.S. Department of Defense, $64,516, **Todd Easton**, June – July 2012.
- "Part-Time M.S. Program in Industrial Engineering – Fall 2012," U.S. Department of Defense, $676,675, **Todd Easton**, Aug. – Dec., 2012.
- "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.

Publications in Peer-Reviewed Transactions and Proceedings

- Bauer, D., **Heier Stamm, J. L.**, and Strawderman, L., 2012, "A Review of Capstone Course Designs Used in Industrial Engineering Programs," Proceedings of the 2012 American Society for Engineering Education Conference.

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 that 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 usage of CLRS, such as the 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 on 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 minimum luminance requirements for overhead guide signs. Since that time, three major developments have taken place:

- There are a number of new retro-reflective sign sheeting types on the market.
- The classification of retro-reflective sign sheeting types has significantly changed.
- 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.

Grants

- "A Study to Mitigate Rural and Urban High-Speed Horizontal Curve Crashes in Kansas." Kansas Department of Transportation, $79,000, **M.J. Rys** with E. Russell, August 15, 2012 – December 14, 2013.
- "A Review of KDOT Overhead Guide Sign Lighting Policy," Kansas Department of Transportation, $89,000, **M.J. Rys** with A. Rys and E. Russell, Nov. 2010 – June 2013.

Publications in Peer-Reviewed Transactions and Proceedings

- Karkle, D., and **Rys, M.J.**, "Drivers' Operational Use of the Travel Lane with Rumble Strips," Proceedings from the 1st Industrial and System Engineering World Conference, Washington, D.C., September 2012.

Research Reports

- **Rys, M.J.**, Karkle, D., and Russell, E., "Use of Centerline Rumble Strips to Improve Safety on Two-Lane Highways," U.S Department of Transportation, Research and Innovative Technology Administration (RITA), UTC Spotlight, University Transportation Centers Program, http://utc.dot.gov/publications/spotlight/2012_04/html/spotlight_1204.html, April 2012.

Health care initiatives

Modeling the Spread of Disease

Now in its fifth year, the health care focus continues to grow with numerous projects including 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

- "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, $43,993, **David Ben-Arieh** and **Malgorzata Rys**, Oct. 2011 – April 2012.
- "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.

Publications in Peer-Reviewed Transactions and Proceedings

- Shi, Z., **Wu, J.**, **Ben-Arieh, D.**, "Modeling and Simulation of Sepsis: Explore the Therapeutic Agents in Intensive Care Unit," INFORMS, Phoenix AZ, May 17, 2012.
- Shi, Z., **Wu, J.**, **Ben-Arieh, D.**, "Acute inflammatory response and perturbation analysis of pro-inflammatory and anti-inflammatory cytokines," IERC, Orlando, FL, May 19, 2012, IIE Doctoral Colloquium, Poster Presentation.

Book Chapters

- **Ben-Arieh, D., Wu, C-H.**, "Reducing patient waiting time at an ambulatory surgical center," Management Engineering for Effective Healthcare Delivery: Principles and Applications, Kolker A. and Story P (Eds.), IGI Global, pp. 246-260, 2012.

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 lift 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 the 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

- "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.
- "Measurement and Evaluation of H1N1 Response Systems towards Driving Improvements in Effectiveness and Efficiency," Emory Preparedness and Emergency Response Research Center (PERRC) Pilot Grant, $20,000, **J. L. Heier Stamm** with J. Swann and N. Serban, Feb. 2011 – Sept. 2012.
- "Optimizing Access to Humanitarian Services in Decentralized, Stochastic, Dynamic Systems," Kansas State University Mentoring Fellowship, $6,000, **J. L. Heier Stamm**, July 2012 – June 2013.
- "BRIGE: Understanding and Managing Humanitarian Logistics Systems through Advances in Optimization and Game Theory," National Science Foundation, $174,998, **J. L. Heier Stamm**, Sept. 2012 – Aug. 2014.
- "Optimizing Crane Usage at Spirit AeroSystems," PI**: T. Easton**, Spirit AeroSystems, $30,000, Jan. 2012 - Dec. 2012.

Journal Publications

- **Ben-Arieh, D.**, and Gullipalli D-K, 2012, "Data Envelopment Analysis of Clinics with Sparse Data: Fuzzy Clustering Approach," Computers and Industrial Engineering, 63, no. 1, pp. 13-21.
- **Lee, E.S.**, Shih, H. S., and Chuang, S.H., 2012, "A forecasting decision on the sales volume of printers in Taiwan: An exploitation of the analytic network process," Computers & Mathematics with Applications, vol. 64, pp. 1545-1556.
- **Easton, T.** and Lee, J., 2012, "Quaternary Hyperplane Branching with Internally Generated Cutting Planes for Solving Integer Programs," The International Journal of Operations Research, vol. 14, no. 3, pp. 366-385.
- Hopkins M., Pahwa, A., **Easton, T.**, 2012, "Intelligent Dispatch for Distributed Renewable Resources," IEEE Transaction on Smart Grid, vol. 3, no. 2, pp. 1047-1054.

Publications in Peer-Reviewed Transactions and Proceedings

- Moore, B., and **Heier Stamm, J. L.**, 2012, "Impact of Decentralized Decision Making on Access to Public Health Facilities." Proceedings of the 2012 Industrial and Systems Engineering Research Conference, G. Lim and J. W. Herrmann, eds.

Book Chapters

- **Lee, E.S.**, "Humanistic Fuzzy Systems," in On Fuzziness - A Homage to Lotfi A. Zadeh, (edited by Rudolf Seising, Enric Trillas, Claudio Moraga and Settimo Termini), Volume 216 of the series of books entitled " Studies in Fuzziness and Soft Computing", Springer, New York, pp145-150, 2012.

David Ben-Arieh

- Editorial board member, Journal of Health Systems
- Editorial board, International Journal of Information and Operations Management Education
- Editorial board, International Journal of Telemedicine and Medical Informatics (IJTMI)
- Vice-chair elect, Human Factor Special Interest Group, American Telemedicine Association

Shing Chang

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

Kimberly Douglas-Mankin

- Editor, The Journal of Women and Minorities in Science and Engineering
- Advisory committee member, National Science Foundation STEP PI meeting
- External advisory board member, Louisiana Tech NSF ADVANCE
- External advisory board member, Iowa State STEM Student Enrollment and Engagement Through Connections (SEEC)
- 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
- Member, board of directors, Reliability and Maintainability Symposium
- Member, board of directors, NISTAC
- Member, IIE Honors and Awards Committee
- Member, board of directors, Kansas Foundation for Engineers

Jessica Heier Stamm

- Junior vice president of programs, INFORMS Section on Public Programs, Service and Needs

Service and recognition

Bradley Kramer

- Vice-chair, IDEA Center Board of Directors

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
  - Annals of Fuzzy Sets, Fuzzy Logic and Fuzzy Systems
  - Applied Computational Intelligence and Soft Computing
  - Advances in Computational Research
  - British Journal of Applied Science and Technology
  - Bioninfo Publications Journals
  - Scholarly Research Exchange
  - The Open Industrial and Manufacturing Engineering Journal
  - International Journal of Computer Science and Application
  - International Journal of Enhanced Research in Science
  - World Journal of Pharmaceutical Research
  - Applied Cell Biology
- Honorary Professor, Chinese Academy of Sciences, People's Republic of China

Shuting Lei

- Editorial board, International Journal of Manufacturing, Materials and Mechanical Engineering
- Member, NAMRI/SME Scientific Committee

- Editorial board member, Journal of ISRN Ceramics, an International Scholarly Research Network (ISRN) journal

ZJ Pei

- Associate editor, Journal of Manufacturing Processes
- Associate technical editor, Machining Science and Technology
- Editorial board member, International Journal of Engineering Business Management
- Editorial board member, International Journal of Machine Tools and Manufacture
- Editorial board member, International Journal of Machining and Machinability of Materials
- Editorial board member, Journal of Machining and Forming Technologies
- Editorial board member, Open Mechanical Engineering Journal
- Editorial board member, Recent Patents on Mechanical Engineering
- Editorial board member, ISRN Ceramics
- Organizer, 2012 NSF CAREER Proposal Writing Workshop
- Chair, ASME MED Manufacturing Processes Technical Committee
- Member, SME NAMRI Scientific Committee

Malgorzata Rys

- Member, advisory committee for First Industrial and Systems Engineering World Conference

Undergraduate studies

Overview

Undergraduate enrollment in the industrial and manufacturing systems engineering department continues to grow. In 2012, our enrollment grew to 191 undergraduate students, a 25 percent increase in five short years. Nearly 30 percent of our undergraduates are women. During the spring and fall 2012 commencement ceremonies, 43 BSIE degrees were granted.

Graduates of our program are in strong demand in Kansas, the Midwest region and across the nation. A few of the companies that have recently recruited our graduates are Deloitte Consulting, Exxon Mobile, Cessna, J.B. Hunt, General Mills, Blue Cross Blue Shield, PepsiCo/Frito-Lay and Spirit AeroSystems. The average annual starting salary for our graduates is more than $60,000.

We emphasize teamwork and group projects in our learning experience to help our students develop the skills necessary for success in today's work environment. Our Senior Design course gives students the opportunity to work on a real world problem for an organization. In MSDA (Manufacturing Systems Design and Analysis), students create and run their own business. This experience spans all aspects of the enterprise, from product design and production to marketing, sales and distribution.

Students have 15 hours of professional and industrial engineering electives that enable them to focus their education into areas of interest. Students may choose an area of specialization in engineering management, ergonomics, manufacturing engineering or operations research. Additionally, high-performing students can earn their bachelor's and master's degree concurrently. These graduates typically complete both degrees in about one calendar year beyond the time it would take to complete the bachelor's alone.

Awards

In 2012, one of our students received the Material Handling Education Foundation Scholarship. Since its inception in 1976, 32 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 2012-2013 academic year, scholarships totaling nearly $114,000 were awarded to 39 outstanding IMSE students.

Clubs

The department has active student chapters of the Institute of Industrial Engineers (IIE) and Society of Manufacturing Engineers (SME). Each group hosts a number of academic and social events for members. Activities include workshops, regional and national conferences, open house displays, student/faculty picnics and intramurals.

K-State's IIE chapter has received the Gold Award in the national chapter recognition completion for five consecutive years. SME regularly tours manufacturing facilities and annually takes a trip to a major manufacturing exhibition in Chicago. Additionally, many IMSE students are involved in college and university-wide organizations such as Steel Ring, Engineering Ambassadors and the Student Governing Association.

Graduate studies

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 master's degrees in operations research and in engineering management are available via distance learning to better serve our students.

The 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 the 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 accredited institutions. 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 institution.

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.

Contact information

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