REPORT OF RESEARCH AND SCHOLARLY ACTIVITIES

ACADEMIC YEARS 2008-2010

Department of Industrial and Systems Engineering

College of Engineering
# Report of Research and Scholarly Activities
## Academic Years 2008 – 2010

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DEPARTMENT OF INDUSTRIAL AND SYSTEMS ENGINEERING

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Department of Industrial and Systems Engineering

- Ranked 31st by the National Research Council.
- Offers five degrees — BSIE, MSIE, MSMFG, MSEM and Ph.D. with more than 250 students.
- 11 Full-time Faculty and over 40 Ph.D. candidates.
- Established the first Global Executive Track Ph.D. in Industrial Engineering for managers and executives.
- New certificate programs in Systems Engineering, Engineering Management and Black Belt Six Sigma.
- Established healthcare systems engineering research thrust and plays leading role in U.S. Department of Veterans Affairs.
- Funding per professor among the highest in the College of Engineering at Wayne State University.
- More than $1.6 million annual research expenditures with sponsorship from NSF, Ford Motor Company, Veterans Health Administration, Siemens and General Dynamics Land Systems.

For more information visit ise.eng.wayne.edu
Tenured and Tenure-track Faculty

Kenneth Chelst, Professor
Ph.D., Massachusetts Institute of Technology, 1975

Research interests include structured decision making in engineering management and the impact of globalization on the engineering and manufacturing management functions.

- Member of IIE, INFORMS, ORS and ASEE
- Played a lead role in the development of the Engineering Management Masters Program, which emphasizes team projects and providing the corporate sponsor with immediate return on educational investment dollars
- Consults with Urban Science Applications Inc., a world-wide leader in the planning of new car dealership networks

Ratna Babu Chinnam, Associate Professor
Ph.D., Texas Tech University, 1994


- Has collaborated with Ford, General Dynamics, and Chrysler and consulted for such companies as Sirius Satellite Radio and ECD.
- Founding co-director of the Global Executive Ph.D. Track at Wayne State, the first such engineering track in the U.S.
- Member, INFORMS, NAMRI

R. Darin Ellis, Associate Professor
Ph.D., Pennsylvania State University, 1994

Research is focused on human-robot interaction including application of augmented reality to robotic interfaces, user-centered design and evaluation of robot controls and displays, operator mental workload assessment and operator-in-the-loop system performance measurement. Applications of this work include remote inspection via teleoperated robots (DoD), robotic assisted surgery (DMC), and operation of space-based robotic manipulators (NASA).

- Member of INCOSE, HFES and IIE
- Associate editor, IEEE Trans Sys Man Cybernetics Part A
- Associate editor, Gerontechnology
Kyoung-Yun Kim, Assistant Professor  
Ph.D., University of Pittsburgh, 2003  
Research interests include assembly design; collaborative product development; computational intelligence and informatics for product design and development; sustainable and renewable energy product design; and design and manufacturing of soft products.
- Has published more than 40 journal papers and conference papers and numerous technical reports and presentations.
- Received top cited article award (2005-2010) from Journal CAD and 2003 IIE Transactions Best Paper Award
- Co-Director of Product Development and Systems Engineering Consortium (PDSEC)
- Planning site director for the NSF Industry and University Cooperative Research Center (I/UCRC) for e-Design.
- Member, IIE, ATA & ASME

Leslie Monplaisir, Associate Professor and Chair  
Ph.D., Missouri University of Science & Technology, 1995  
- Lead researcher and director of the Product Development and Systems Engineering Consortium (PDSEC) at WSU.
- Received Outstanding Faculty Award, College of Engineering, Wayne State University, April 2007.
- Has authored more than 70 publications in research with funded research from NSF, Ford, Sun Microsystems, Tardec and PTC
- Senior member of IIE, INFORMS and SME
Tenured and Tenure-track Faculty continued

E. Alper Murat, Assistant Professor
Ph.D., McGill University, 2006
Research interests include application of optimization modeling and simulation techniques and data mining in the fields of supply chain management, logistics and transportation, product development, quality, reliability and healthcare.
- Worked with Ford Motor Company, General Dynamics, Henry Ford Health Care Systems and Veterans Engineering Resource Center (VERC) on various applications of operations research and simulation tools and techniques
- Principal investigator of research projects funded by VA, VAVERC VISN-11, US Department of Transportation, Department of Homeland Security, General Dynamics, and Ford Motor Company.
- Has authored numerous peer-reviewed journal articles which appeared in such journals as European Journal of Operations Research, Computers and Operations Research and Information Sciences
- Member of SME, CORS, IIE, INFORMS and DSI

Nanua Singh, Professor
Ph.D., University of Rajasthan, India, 1981
Research interests include cellular manufacturing systems: design, planning and control.
- Member of IIE and SME
- Active in research as an academician supervising over 20 Ph.D.s, and writing/presenting close to 130 research papers in International Journals and conferences
- Editor-in-chief of International Journal of Six Sigma and Competitive Advantage

Gary Wasserman, Associate Professor
Ph.D., Georgia Institute of Technology, 1986
Research interests span the areas of reliability and quality assurance, with special interests in the development and implementation of new methods for improving product reliability. They also include industrial and systems engineering, information and computer science, operations research and statistics, and chemical engineering.
- Member of ASQ, ASA, IIE and SRE
- Certified in both quality and reliability by the ASQ
Kai Yang, Professor
Ph.D., University of Michigan, 1990

Research interests include statistical methods in quality and reliability engineering, lean product development, healthcare system engineering, and engineering design methodologies.

- ISE’s leader in established healthcare system engineering research thrust and plays leading role in VA’s Veteran Engineering Resource Center
- Book, Design for Six Sigma: A Roadmap for Product Development is an influential book that provides a framework to integrate both innovation methods, and traditional statistical quality assurance methods into the product development process.
- Outstanding Achievement Award, International Society of Agile Manufacturing, 2009
- IERC Best Paper Award — Quality and Reliability: Adaptive Sequential Experimentation Methodology for Response Surface Optimization, A. Alaeddini, K. Yang, and A. Murat, 2010
- Member of ASA, IEEE, ASQ, IIE and INFORMS

Qingyu Yang, Assistant Professor
Ph.D., University of Iowa, 2008

Research interests include healthcare system engineering, information technology, modeling and simulation of complex systems, distributed sensor system, and applied statistics.

- Best Paper Award — from Industrial Engineering Research Conference for the paper Separation of Individual Operation Signals from Mixed Sensor Measurements
- Organizer/chair of the session, “Health Management of Complex Systems,” Annual INFORMS Conference, Austin, TX, Nov. 7-10, 2010
- Organizer/Chair of the session, “Advanced Multivariate Data Analysis,” Annual INFORMS Conference, San Diego, CA, Oct. 11-14, 2009
- Member of IIE and INFORMS
Affiliate Faculty

Celestine Aguwa, Visiting Professor
Ph.D., University of Pittsburgh, 2000
Research in healthcare systems engineering, quality and systems/process, reliability, design optimization, computer aided engineering, lean product development.
- Member of SME, IIE, AIA, NIA & HFES
- Beta Sigma Fraternity — University of Nigeria
- Journal Reviewer for: Journal of Manufacturing Systems (JMSY); Journal of Engineering Design

Julia C. Gluesing, Associate Professor – Research
Ph.D., Wayne State University, 1995
Research interests include the science of collaboration and team science in health care and in global product development, with particular emphasis on multidisciplinary and multicultural teams. Applying the perspectives and methods of anthropology and social network analysis to uncover cultural patterns and patterns of interaction that facilitate or hinder collaboration, with the goal of accelerating innovation.
- Co-director, Evaluation Division, Michigan Alliance for Clinical and Translation Research
- Co-director, Global Executive Track Ph.D. in Industrial Engineering, ISE
- Co-organizer and program committee member, Collaborative Innovation and Networks Conference, co-sponsored by WSU ISE, MIT Center for Collective Intelligence and Savannah College of Art and Design, October 7–9, 2010
- Carolyn Dexter Award, Best International Paper, Academy of Management Annual Meeting, Montreal, Canada, August, 2010
- Reviewer, Human and Social Dynamics Program, National Science Foundation, Washington, D.C., May 2008

Dean Pichette, Senior Lecturer
M.S., Wayne State University, 1995
Teaching interests include systems engineering, project/program management, engineering economics & lifestyle costing, Introduction to Design
- Co-author for MINDSET (high school math textbook) Critical Path Method chapter
- Author for Value Added Decision Making (Master’s level engineering decision and risk textbook) Ethical Decisions Chapter
- Member, ISE Lecture Capture Task Force
- ISE Undergraduate Program Committee
- College of Engineering Climate Working Group
Frank Plonka, Professor of Research  
Ph.D., University of Michigan, 1974

Research interests include improving the dimensional quality of stamped sheet metal automobile body subassemblies and workforce development. Additional research interests include creating pathways for sustaining jobs in the United States and North America by leveraging the intellectual capacity of the workforce through continual skill development and continuous improvement.

- Member of the Leadership Project Oversight Committee for the Engineering Management Masters Program (EMMP)
- Principal Investigator for Auto Body Consortium for the 2mm Program, the Near Zero Stamping Program and the Center for Automotive Research for the Digital Body Development System
- Served as Interim Academic Dean of the Greenfield Coalition funded by the National Science Foundation to help create the curriculum for the next generation of Manufacturing Engineers at Focus:Hope

Kenneth Riopelle, Research Professor  
Ph.D., University of Michigan, 1983

Research interests include accelerating the diffusion of innovations in globally, networked organizations, which was funded by a National Science Foundation, the study of collaborative innovation networks or COINs and the science of team science using co-author and co-citation analysis as a method to visualize, measure and understand scientific collaboration.

- Faculty lead for Engineering Management Masters Program (EMMP) Leadership Projects
- Director, Evaluation Division, Michigan Alliance for Clinical and Translational Research
- Co-organizer and program committee member, Collaborative Innovation Networks Conference, co-sponsored by WSU ISE, MIT Center for Collective Intelligence and Savannah College of Art and Design, October 7-9, 2010
- Member of the Health Care Industry Academic Panel for the Douglas A. Fraser Center for Workplace Issues
The Project MINDSET (Mathematics INstruction using Decision Science and Engineering Tools) curriculum is designed to answer the dreaded question even before it can be voiced. In contrast to the high school instruction we all experienced, Project MINDSET starts with a realistic context. It then moves on to the mathematics needed to formulate and explore the problem. Although the mathematics of Project MINDSET is within the technical grasp of senior-level math teachers, it will be challenging to teach. The approach is foreign to the way the vast majority of high school teachers have experienced and viewed mathematics: as a tool to find the single correct answer to a problem. They will be required to think and act differently in the classroom. It is this change in perspective, a new mathematics MINDSET, which we explore after reviewing the project’s status.

Project MINDSET is a $3 million NSF-funded project designed to develop, implement and evaluate a two-semester course for high school seniors based on the mathematics of operations research and industrial engineering. The three partner universities are North Carolina State University (Robert Young, Karen Keene and Karen Norwood), Wayne State University (Kenneth Chelst and Thomas Edwards) and University of North Carolina-Charlotte (David Pugalee). The course is designed to address the following well-documented performance gaps and motivational issues in high school mathematics in the United States:

- improve multi-step problem solving,
- improve ability to results in context, and
- increase motivation and positive attitude toward mathematics.

In a traditional approach, class begins with a review of the previous night’s homework assignment. Next a new mathematical procedure is introduced and explained in detail. Typically, several examples are worked out at the board, usually by the teacher. Finally, students are given several similar examples to practice in class as the teacher monitors their work. Sometimes in lieu of these practice examples, students are invited to begin the homework assignment for that night.

Only after sufficient proficiency with the mathematical procedures is developed is there any consideration of practical application. When applications do appear, they tend to be examples that are artificially created for the purpose of further practice with the set of procedures that have just been learned. If developing of computational proficiency takes longer than expected, the application problems are either skimmed over or skipped entirely.

Most often, the word problems contain just enough information to solve them. Not surprisingly, most students show no real interest in them, probably because problem-solving has been reduced to finding the one and only correct answer and moving on. Notice that in this approach, students take a more or less passive role in their learning, and there is little room for student discussion of key ideas. Small wonder, then, that so many students come away from their study of mathematics with a strange (to us) view of the goal of mathematical problem-solving as “solving artificial word problems rather than realistic world problems” (Mathematical Sciences Education Board, 1990, p. 4).

In contrast, the new MINDSET we are proposing is applications-based and problem-driven.
Instruction on any given day begins with a real-world application with which most, if not all, of the students can identify. The mathematics is then developed within the context of the problem situation. There are ample opportunities for student discussion as the class struggles to understand the problem and develop a path to a solution. Once the problem is solved, student discussion continues, but now it is centered on interpreting the solution. Such discussions will also include some sensitivity analysis. How robust is the solution in the face of a change in one of the parameters of the problem? Is this the only solution for this problem?

We believe that school mathematics instruction that embraces our new MINDSET will evoke fundamental differences in the ways in which high school students view mathematics.

When mathematics is taught using a traditional approach, students tend to view mathematics as a set of procedures to be applied to find the one “right” answer. Mathematics is all about manipulating algebraic symbols, and complexity arises from more difficult expressions or equations. Correctness in mathematics is then situated in some authority such as the teacher or the textbook.

Evaluation of anecdotal evidence that we have gathered from field-tests of one or more MINDSET book chapters suggests that students who are taught using the MINDSET approach are more apt to view mathematics as a tool for solving problems. They tend to think that mathematics is about formulating problems, exploring a range of possible solutions, identifying better and best solutions, and exploring the robustness of a solution. From this perspective, complexity in mathematics derives from the complexity we are surrounded by in the real world. Finally, they tend to see mathematical correctness as based on logic and deduction.

Not surprisingly, the role of a teacher equipped with this new MINDSET is fundamentally different from that of most teachers using a traditional approach. From a traditional point of view, the role of the teacher is to explain and demonstrate, oversee and assess student practice and identify common errors while helping the weakest students. However, from a new MINDSET point of view, the teacher’s role truly is to be more of a “guide on the side” than a “sage on a stage.” The teacher’s role then shifts to things like encouraging students to read (and make sense of) the text, leading discussions centered on problem solving, developing mathematical models of problem situations with the full participation of students, demonstrating mathematical procedures when they arise in the context of solving a problem and overseeing teams of students working together to solve problems, rather than overseeing students’ individual practice.

Fostering such fundamental changes in high school mathematics instruction will not be an easy task. It will demand the continued hard work of the MINDSET Project staff in developing appropriate classroom materials and providing support for implementation. It will require cadres of dedicated teacher-pioneers who are willing to adopt and introduce a new MINDSET that is outside their comfort zone. Lastly, for the MINDSET to spread, we will need the support of professional organizations such as INFORMS whose members know full well the usefulness and importance of mathematics in the solution of interesting problems. It is only through the efforts of all three groups that the MINDSET Project can impact high school classrooms in the United States in ways that will produce high school graduates with a similar appreciation of the role of mathematics in the real world.
ISE’s Healthcare Systems Engineering Research Program: Overview

ISE has an excellent long tradition and track record in healthcare system engineering research and teaching. The faculty members and students participated, involved and helped local and national healthcare institutions in their search for excellence. One of our former faculty members, 2010 Frank and Lillian Gilbreth Industrial Engineering Award winner Dr. Vin Sahney, was a pioneer in healthcare system engineering and the chief architect for Henry Ford Health Systems’ progress in healthcare efficiency and quality for over 20 year. Over the years, the faculty members and students have successfully completed many projects with many healthcare institutions, such as, Henry Ford Health Systems, Detroit Medical Center, and Blue Cross Blue Shield and dealt with such diverse topics as surgery operations, scheduling, and supply chain management.

Our recent breakthrough happened in 2008, when one of our faculty members, Dr. Kai Yang and our student team successfully launched and completed several system redesign projects in John D. Dingell Detroit VA Medical Center. This work was valued highly by Detroit VA leadership, and eventually, one of our students from that team, Ms. Susan Q. Yu, became a leader in Detroit VA’s system redesign group. She along with our other students started Detroit VA System Redesign Department and many more successful projects were completed since then, greatly impacting Detroit VA operations. We outline here some of our major on-going projects that are now impacting large parts of the entire VA Healthcare System.

Veteran Engineering Resource Center (VERC) And ISE

In January 2009, The US Department of Veteran Affairs (VA) sent solicitation letters to all the engineering colleges of US universities asking for submission of concept papers to establish “Veteran Engineering Resource Centers” (VERC). These centers were to be funded by the VA and will be showcases for integrating industrial engineering methods and tools into the fabric of health care delivery. There were 27 initial submissions and ISE faculty member, Dr. Kai Yang, participated in drafting a concept paper with three VA medical centers (Detroit, Ann Arbor, and Indianapolis) and three universities (WSU, UM Ann Arbor, and Purdue). Our concept paper was one of the nine winners. After that, full proposals are submitted by all nine finalists; Dr. Yang and Ms. Susan Yu helped in drafting the initial version of the full proposal. Finally our proposal won and we were selected as one of the four funded Veteran Engineering Resource Centers. Each center is funded at $5 million for two years. Our center is named VISN 11 VA Center of Applied System Engineering (VA-CASE).

The Industrial and System Engineering Department of Wayne State University plays a leading role in VA-CASE as an academic partner. In particular, we played leading roles in the following VA-CASE funded projects:

National Cancer Care Collaborative

National Cancer care collaborative is a focus area for VA CASE, the goal of which is to develop and deploy effective industrial engineering tools for planning, tracking and guiding various cancer care treatment processes. With guides from ISE faculty and Ms. Yu, our student team becomes the technical leader in this program and our team travels to numerous VA medical centers from coast to coast to implement and coach the implementation of our technical tools.

National Telephone Care Collaborative

National telephone care collaborative is another focus area of VA CASE, the goal of which is to find effective ways to reduce waiting time for callers and improve service quality for three types of telephone care centers; pharmacy, triage and scheduling. Dr. Yang, Ms. Yu, and Ms. Anupama Chitrangana are able to conduct comprehensive data analysis to help identify key factors affecting these call centers’ speed of answer and caller abandonment rate. Drs. Chinnam, Murat, Ellis, and Monplaisir along with our student team
also led the ‘Pharmacy Call Center Redesign Project’ that studied five options for call center consolidation for VISN-11 VA network.

Operating Room Simulation Models

Surgery is the most expensive operation in all medical centers. Improving surgery operational efficiencies is always one of the top priorities in medical centers operations. ISE’s simulation team, led by Dr. Murat and Ms. Jihan Wang, developed and validated two versions of the simulation model: operational and tactical. The operational model is used to predict, monitor operating rooms’ utilization levels and identify potential efficiency killing factors and evaluate remedial measures. The tactical model is developed for process re-design and capacity analysis to determine equipment requirements and capacity requirement of the supporting processes. We have developed several simulation models for Detroit, Ann Arbor and Indianapolis VA medical centers.

National Reusable-Medical-Equipment (RME) Management Project

Many types of medical equipment/devices used in key functional areas, such as surgery, examination and checkups, are reusable equipment. After each application, these devices/equipment need to go through sophisticated reprocessing or processes to ensure cleanliness. Zero infection risk, availability and traceability of equipments with reprocessing jobs, cases, and patients’ usage are important considerations. Current practices are prone to noncompliance of reprocess procedures and process traceability is poor. ISE team, lead by Dr. Yang, has initiated the following three programming approaches for RME reprocessing:

a) A human factors based interactive visual process navigator, which is a touch screen based work instruction program that guides operator to perform reprocessing jobs exactly according to optimized procedure and captures vital reprocessing data for quality control and analysis. This work is being led by Drs. Yang and Ellis. VA CASE has provided an initial grant and our pilot program has been very well received from national VA leadership. This effort will receive significant funding for development and nationwide implementation ($300,000 to ISE of Wayne State in 2010-2011).

b) Design evaluation procedure that establishes reprocessibility index for reusable medical equipments: with this index system, we can identify the models of equipment that are difficult to reprocess and having high risk of infections so this equipment will be discontinued; this effort is led by Drs Kim, Monplaisir, and Yang. This effort is awarded $160,000 in 2010-2011 funding for testing in Michigan and Indiana.

c) Simulation and staffing model for optimized capacity, manpower, and operations planning. This effort is lead by Drs. Murat and Chinnam. This project is awarded $160,000 funding for 2010-2011.

National Missed Opportunity Reduction Project

Missed opportunities are major problems in most VA medical centers and they affect resource utilization, efficiency, cost and patient access significantly. When an appointment is scheduled in the VA system and is canceled after appointment time, this appointment is called missed opportunity. Recently, our Ph.D. candidate Adel Alaeddini and Dr. Yang have developed an accurate no show prediction model that can predict each patient’s no show probability for the upcoming appointment with high accuracy. This achievement is well received in VA and a joint proposal with WSU team and University of Pittsburg team is approved for funding. (Wayne State University’s share is $600,000).

VA’S CAPABILITY IMPROVEMENT GRANT

On September 1, 2009, the faculty members from ISE, Drs. Yang, Chinnam, Ellis, and Murat were teamed with Detroit VA Medical Center and submitted a proposal for Capability Improvement Grant worth $1.45 million. While more than 150 VA medical centers submitted proposals, only 20 centers nationwide received funding. Our proposal was ranked number 1 in this round of competition. IME will receive substantial amount from this capability improvement grant. Five faculty members will work on 18 projects in Detroit VA medical center, covering administrative, inpatient, and outpatient areas.
Books and Book Chapters

Archival Scholarly Publications

Books


Book Chapters


Journal Articles


Benjamin, C., Monplaisir, L., Sankat, C. and Thompson, D., “Industrial Engineering Education and Research: Current Issues and Future Directions for the Caribbean.” Journal of the Association of Professional Engineers (ISSN 1000 7924), Volume 37 Number 1, pp. 5-17. 2009.


**Sponsored Research Projects**

**Abrams AED Whole System Design-for-Reliability (DFR); Funded by General Dynamics Land Systems for $82,400; 2010; PI: Dr. Murat, CPI: R. Chinnam**

**Call Center Configuration Analysis and Selection Mode; Funded by VA: VISN11 Healthcare Network; Amount: $50,000; 2010; PI: R. Chinnam**

**Enabling Congestion Avoidance and Reduction in the Michigan-Ohio Transportation Network to Improve Supply Chain Efficiency: Freight ATIS; Funded by U.S. DoT and M-DOT through MI-OH UTC; Amount: $125,448; 2009-2010 PI: R. Chinnam, Co-PI: A. Murat**

**Value of ITS Information for Congestion Avoidance in Intermodal Transportation Systems; Project funded by U.S. DoT through OH-MI UTC; Amount: $133,914; 2009-2010; PI: R. Chinnam**

**IGERT: Incentive-Centered Design for Information and Communication Systems (STIET); Project funded by NSF: IGERT Program, Partnership between Univ. of Michigan and Wayne State University; Senior/Affiliated Personnel; Amount: $3,000,000; ($800k for WSU with six faculty); 2007-2012**


**The Digital Body Development System, NIST ATP grant to the Center for Automotive Research Amount: $389,000; 2003–2008; PI: F. Plonka, Co-PI: M.S. Ahmed**

Autonomous navigation; (Funded by US Army TARDEC SBIR subcontract to Mobile Intelligence, Inc.); Amount: $30,000; June 2010-May 2012; PI: R. Ellis

Complex event detection; (Funded by US Navy SBIR subcontract to SoarTech, Inc.); Amount: $15,000; June 2010-Jan. 2011; PI: R. Ellis


VISN11 Veterans Engineering Research Center; Funded by Sponsor: Veteran’s Administration; Amount: $88,818; July 2009-Sept. 2011; PI: R. Ellis

Predictive Displays and Latency Protections for High Latency Teleoperation; Funded by US Army TARDEC SBIR (subcontract to Signature Research, Inc.); Amount: $5,279; Apr. 2010-Sept. 2010; PI: R. Ellis


Warfighter-Focused UGV System Design: Human Factors Engineering and ATO Experimentation; Funded by US Army Joint Robotics Center; Amount: $100,000; July 2008-June 2009; PI: R. Ellis

Development and Human Factors Evaluation of Augmented Reality-Enhanced Human-Robot Interaction for UGV Operations; Funded by Department of Defense; Amount: $180,432; May 2008-May 2009; PI: R. Ellis

CI-TEAM Demonstration Project: Collaborative Research — A Sustainable Product Development Collaboratory; Amount: $250,000; NSF, 2010-2011; PI: K. Kim, Co-PI: L. Monplaisir, R. Chinnam and A. Murat

Planning Grant: I/UCRC for e-Design; NSF, Amount: $13,000; 2010; PI: K. Kim


Development and Implementation of Degree Programs in Electric Drive Vehicle Technology; Awarded by the Department of Energy; Amount: $5,000,000; Co-PI: K. Kim; Sept. 2009-Aug. 2012; 12 investigators from five departments

A Telerehabilitation System for the Remote Prescription of the Mobility Aids; Awarded by the National Institute on Disability and Rehabilitation Research (NIDRR); Amount: $139,964; Dec. 2005-Dec. 2009; PI: K. Kim

Development of Technology Roadmap and Context-aware-based Design System for Ubiquitous Smart Product u-Smart Space; Awarded by the 21C Frontier R&D, the Ministry of Knowledge Economy (MKE); Korea; Amount: $167,039; Jan. 2009-Dec. 2012; PI: K. Kim

Development of Net-based Data Analysis and Processing Engine for DAWN; Funded by Scientific Research Lab, Ford Motor Company; Amount: $25,000; May, 2009-May, 2010; PI: K. Kim

Development of Weight Efficiency Metrics Application (WEMA) Tool; Funded by Research and Innovation Lab, Ford Motor Company; Amount: $50,000; May 2008-Dec, 2009; PI: K. Kim

Ford Engineering Management Program and Leadership Research Projects; Amount: $650,000 per year; 2008-2010; PI: L. Monplaisir, K. Riopelle and K. Chelst

Discharge Process Improvement and ER Simulation Modeling and Analysis; VAMC Capability SR/I, Amount: $79,344; 2010-2012; PI: A. Murat

OR Simulation Modeling and Analysis; Veterans Affairs Medical Center VISN11 VERC; Amount: $28,875; 2010-2011; PI: A. Murat

A Framework for Operational Improvement in Border Security, DHS; Centre of Excellence – University of Washington; Amount: $23,415; 2009-2010; PI: A. Murat

A Framework for Operational Improvement in Border Security, DHS; Centre of Excellence – University of Washington; Amount: $22,993; 2008-2009; PI: A. Murat

Computerized Standard Operating Procedures for Reusable Medical Equipments; Sponsored by US Department of Veteran Affairs; Amount: $100,000; May 2010-Sept. 2010; PI: K. Yang, Co-PI: A. Murat, R. Chinnam and R. Ellis

VA System Redesign Capability Improvement Grant Sponsored by US Department of Veteran Affairs;
Graduate Student Degrees

Ph.D. (Dissertations)

Gangaraju Vanteddu
Advisors: Julia Gluesing, (Co-advised by Dr. Yang).

Ibrahim Dogan
Modeling and Control of Closed-loop Remanufacturing Supply Chains under Non-stationary Demand, Ph.D. Dissertation, Industrial and Manufacturing Engineering Department, Wayne State University, 2008.
Advisors: Julia Gluesing

Jim McNicol
Advisors: Leslie Monplaisir

Yan Guo
The New Methods on NDE Systems POD Capability Assessment and Robustness Improvement. 2009.
Advisors: Kai Yang

Mubashir Siddiqui
Advisors: Kai Yang

Golenberg, Lavie
Advisors: R. Darin Ellis

Yun-Seon Kim
Advisors: Kyoung Yuin Kim

Xianming Cai
Advisors: Kai Yang

Master’s Thesis/Projects

Rose Khuong
Advisors: Kenneth Riopelle, Leslie Monplaisir
Jerome J. Mullett

Advisor – Kenneth Riopelle, Leslie Monplaisir, Frank Plonka

Christopher Bondanza, Tomas Bozek, Jay Garcia, Marc Greca, Shankar Narayanan, Kenneth Stotzner and Christopher Trombetta

Advisor – Kenneth Riopelle, Leslie Monplaisir

Todd Verville

Advisor – Kenneth Riopelle, Leslie Monplaisir, Frank Plonka

Nayan Patel

*Resource Planning Tool for Optimal Inc.*
On-campus, 2008.
Advisor – Kenneth Riopelle, Leslie Monplaisir, Frank Plonka

Nievelyn L. Tecson

*Effective Communication within Module Strategy.*
On-campus, 2008.
Advisor – Kenneth Riopelle, Leslie Monplaisir, Frank Plonka

Mubasher Cheema

*Product Process and Validation (PPV) Track Tool.*
Advisor – Kenneth Riopelle, Leslie Monplaisir, Frank Plonka

Joseph Benher Dhason

Advisor – Kenneth Riopelle, Leslie Monplaisir, Frank Plonka

Paschal Aguwa, Adam Denlinger, Chris Murray, Chuck Sisson, and Keith Zeitz.

Advisor – Kenneth Riopelle, Leslie Monplaisir, Frank Plonka

John Fransen, Abdullahi Hajjabi, Tuan Nguyen, Anthony Picchioni, Joe Torrence and Jeff Wallat

*GPDS 2.2 Implementation,* Ford Motor Company, 2009.
Advisor – Kenneth Riopelle, Leslie Monplaisir, Frank Plonka

Bavand Hamidi

Advisor – Kenneth Riopelle, Leslie Monplaisir, Frank Plonka

Deborah Malchie-Inman

Advisor – Kenneth Riopelle, Leslie Monplaisir, Frank Plonka, Kenneth Chelst

William Morgan

Advisor – Kenneth Riopelle, Leslie Monplaisir, Frank Plonka
Principal Investigators:
Dr. Ratna Babu Chinnam and Dr. Alper Murat

Funded by:
U.S. DOT and M-DOT through MI-OH UTC

Collaborators:
Ford, UPS, C.H. Robinson, MITS Center and Traffic.com

Summary
Developing dynamic routing algorithms for JIT milk-run deliveries in congested stochastic time-dependent transportation networks is the subject of a series of our projects from 2006-2010. The motivation for this work comes from the needs of our automotive and other non-automotive companies in Southeastern Michigan. We have developed a number of dynamic routing algorithms over the years that exploit real-time traffic information available from Intelligent Transportation System (ITS) sources such as Traffic.com. Using historical ITS data, the models explicitly characterize recurrent congestion state-transition dynamics of each network arc using time-dependent Markov chains. Given the low probability nature of incidents and the resulting non-recurrent congestion, we handle incidents en-route through reactive rerouting procedures. To date, we have tested all our algorithms in a simulated network of Southeast-Michigan highways calibrated using historical traffic data from the Michigan ITS Center and Traffic.com. The travel time and delivery performance savings from dynamic routing algorithms can be very significant, reaching up to 12% depending on the time of day and state of the network. Going forward, we plan to test and implement our algorithms in stages in collaboration with our partners in this research. Two manuscripts are currently under review with journals and are available to interested parties.

Motivation
Just-in-time (JIT) production requires frequent small-batch pickups and deliveries subject to fixed time windows. Since the shipments are usually less than a truck load, the freight carrier planners develop milk-run tours (e.g., a visiting sequence of pickup and delivery sites). In a milk-run tour, for example, the vehicle departs from a distribution center (DC), picks up goods from several supplier sites, and returns to the DC for delivery. In planning milk-run tours, managers also consider heijunka (production smoothing or workload leveling) and muda (waste) philosophies of JIT production. Whereas the former can be achieved by equally spacing the delivery time windows over the suppliers’ operating hours, the latter can be achieved by visiting the supplier sites at an optimal frequency, balancing transportation and inventory costs. The recurrent and non-recurrent congestion on road networks increase the travel time variability thus rendering it difficult to make delivery and pickup visits within the established time windows, which can be as narrow as 15 to 30 minutes (Chen et al. 2003, Groenevelt, 1993). Furthermore, the road-network congestion worsens the costs related to travel time (e.g., labor and overtime costs) such that they might outweigh other operating costs (e.g., vehicle miles traveled) (Figliozzi, 2010).

A survey in California found that 85% of trucking companies miss their time window schedules due to road network congestion. Furthermore, 78% of the managers surveyed stated that the time-window schedules for pickup and deliveries force their drivers to operate under congested road network conditions (Golob and Regan, 2003). Some industries allow early or tardy delivery and/or pickups with a penalty (soft time windows). However, there are many practical settings (e.g., JIT production) with hard time windows where vehicles may pickup or deliver only during fixed times without exception (Cordeau et al., 2000).
Approach

In our research, we address the problems of planning milk-run tours for JIT production subject to hard time windows in congested road networks, e.g., an automotive OEM's DC is replenished by milk-run pickup and deliveries from multiple suppliers. We model milk-run tours as a Traveling Salesman Problem (TSP) with hard or soft time windows. We typically represented the road network congestion through random network arc travel times and time-dependent congestion states.

The classical TSP is concerned with finding the least cost tour that visits each site exactly once given the set of sites. The travel between any pair of sites is a path which can be static (e.g., a fixed sequence of arcs) or can be determined through a dynamic policy. The cost of travel between pairs of sites can be measured in time, distance or a function of both, be deterministic or probabilistic, and be time-dependent or independent. In our problem setting, we consider a TSP with hard time windows under stochastic time-dependent (STD) arc travel times. All of the preceding TSP literature assumes that the path travel cost between pairs of sites is either deterministic or stochastic with a known probability distribution. In our network setting, the path travel times are both stochastic and time-dependent. We determine the distributions of these path travel times through optimal dynamic routing on network arcs using the real-time traffic information (e.g., speed data) available from the Intelligent Transportation System (ITS) sensor network. In optimal dynamic routing between pairs of sites, we consider only the recurrent congestion (e.g., rush hour) and exclude the non-recurrent (e.g., traffic incidents and inclement weather). This is necessary since the milk-run TSP tours are established for longer periods where the recurrent congestion is more dominant. We generally model the recurrent congestion by defining congestion states of arcs based on historical ITS traffic data using Gaussian Mixture Model (GMM) based clustering (Verbeek et al., 2003). The changes in arc congestion states represent the traffic dynamics and are modeled as Markov processes. Accordingly, the optimal dynamic routing problem is then cast as a Markov decision process (MDP) where the states space consists of the position of the vehicle, the time of the day, and the current and projected congestion states of arcs with limited look ahead (examining the state of the full network is computationally prohibitive and even unnecessary, see Kim et al., 2005). We identify the paths' optimal dynamic routing policies (DRP) by solving a stochastic dynamic programming formulation for each pair of sites.

By simulating the optimal DRPs, we estimate the travel time distributions between every pair of sites. We then use these distributions to determine the optimal TSP tour by solving a stochastic dynamic programming formulation for TSP. Since the travel times are STD, we employ the convolution approach in Chang et
al. (2010) to estimate the distribution of site arrival times for pickup and delivery. Whereas the routes between pairs of sites are dynamic, the TSP tour is static. This is because, in JIT production systems, the tours for pickups and deliveries support such objectives as production smoothing and workload leveling and remain fixed for extended periods (e.g., months). The optimal TSP tour can be obtained by minimizing the mean criteria combination (e.g., travel time, mileage, and truck utilization) or a mean-variance objective which also accounts for the variability of criteria. Although our methodology could have accommodated a wide range of these objectives, we selected a mean-variance objective based on the trip time which accounts for the transportation cost and service level (i.e., on-time performance) trade-offs in JIT production systems. We defined the most robust TSP tour as the tour with minimum trip time mean-variance objective.

Key Contribution

The contribution of these studies is three-fold. First, we developed an integrated methodology for identifying the TSP tours of sites in STD networks where the stochastic path travel times between pairs of pickup and delivery sites are estimated through optimal dynamic routing. Second, we propose approaches for dynamic routing between pairs of sites in STD networks using the real-time congestion information available from ITS sensor networks. Third, using a real network and data, we simulated the results of the proposed integrated approach in a case study application for an automotive JIT production system and demonstrate the transportation cost and delivery service level improvement based on optimal dynamic routing between sites.
The Global Executive Track (GET) Ph.D. in Industrial Engineering originated when a number of leaders from Michigan-based industries approached Wayne State University looking for a program that would allow busy executives to earn a fully accredited Ph.D. degree, while accommodating a demanding work schedule. In the spring of 2007, GET Ph.D. co-directors — Dr. Ratna Babu Chinnam and Dr. Julia Gluesing — worked together with an advisory group made up of senior executives from industry to create the GET Ph.D., which was launched in January of 2008. This is the first such engineering Ph.D. track in the United States designed for technical managers and executives! Since its inception, the GET Ph.D. has successfully recruited cohorts of six to ten students for each academic year.

The GET Ph.D. is an extremely rigorous program. During the first two years, the normal course load each winter and fall semester includes three separate courses:

- A core course delivering integrative models and knowledge from contemporary theory and research for taking an idea for a product or service from a concept to a sustainable business.

- A core course on the globalization of engineering and manufacturing, encompassing global perspectives on legal, political, economic and cultural environment of business or focusing on the application of these perspectives to a particular region or country such as South America or China.

- A technical course such as Decision and Risk Analysis, Management of Technology Change, or Operations Research.

Unlike many other executive doctoral programs, the GET Ph.D. in Industrial Engineering requires the successful completion of a technical dissertation. Learning partners will take the knowledge and best practices gained from their coursework and apply it to an area of original research. They have the opportunity to pursue management science or technical research and work with faculty members to determine the best plan of study in accordance with personal interests and organizational objectives. In 2011, Darrell Williams (Cohort 2008) and Rick Mueller (Cohort 2008) are scheduled to become the first GET Ph.D. learning partners to enter the dissertation writing process.

In addition, the GET Ph.D. supports the notion that doctoral students are expected to generate new knowledge that advances both the academic discipline and the world of professional practice. To enhance writing skills and provide the learning partners with the opportunity to contribute to the body of teaching knowledge in industrial and systems engineering, learning partners will draw on their years of relevant experience to develop and present two original teaching case studies. During Winter 2010, GET Ph.D. learning partners presented case studies on topics, including:

- Automotive Hybrid Technology Decision
- Total Productive Maintenance
- Intellectual Property Challenges in China

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- Rachel Itabashi-Campbell (Cohort 2008) – King-Chavez-Parks Future Faculty Program
- Kumar Singarajan (Cohort 2010) – Graduate-Professional Scholarship
- Susan Qian Yu (Cohort 2011) – Graduate-Professional Scholarship