

Visiting International Scholars



Alper Uysal
Obtained M.Sc. and Ph.D. degrees from Yildiz Technical University in Istanbul, Turkey. Currently an Associate Professor at Yildiz Technical University, Department of Mechanical Engineering. He joined the ISM/UK in Sep 2017 as Visiting Professor for a year to conduct research on slip-line modeling of sustainable machining operations.



Mine Uslu Uysal
Completed Ph.D. degree in 2015 at Yildiz Technical University, in Istanbul, Turkey. She joined ISM/UK in Sep 2017 as Postdoctoral Scholar for a year to conduct research on manufacturing processes with functionally-graded materials, finite element modeling and analysis, and behavior of composite materials.



Ana E. Bonilla Hernández
Ph.D. student at the Subtractive and Additive Manufacturing research group in the Production Technology Department of the University West, Trollhättan, Sweden. Visited ISM/UK for three months in July 2017 to conduct collaborative research on metrics for sustainable machining processes.



Shujin Chen
Professor of Materials Science and Engineering at Jiangsu University of Science and Technology specializing in friction stir welding. Assignment dates at ISM: Oct 2017-Mar 2018. Project at ISM: Modeling of Friction Stirring Welding Process.



Ming Zhu
Associate Professor of Materials Science and Engineering at Lanzhou University of Technology specializing in welding process sensing and control. Assignment dates at ISM: May 2017-Apr 2018. Project at ISM: Monitoring and Control of Welding Process.



Hongyan Wang
Associate Professor of Materials Science and Engineering at Dalian University of Technology specializing in laser and laser-arc hybrid welding processes. Assignment dates at ISM: Oct 2017-Sep 2018. Project at ISM: Advanced modeling and control of laser-hybrid welding process.

About the Institute for Sustainable Manufacturing

Details about our new projects, lab facilities, books, recent publications, patents, and more can be found on our [website!](#)

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Journals

International Journal of Sustainable Manufacturing
www.inderscience.com/ijism

Journal of Machining Science and Technology
www.tandfonline.com/toc/lmst20/current

ISM Faculty and Staff



F. Badurdeen Y.T. Cheng L.Holloway I.S. Jawahir W. Li D. Sekulic Y. Zhang J. Seay A. Price D. Harrod

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- Visit www.engr.uky.edu/mfs
- Contact Professor Fazleena Badurdeen, Director of Graduate Studies for Manufacturing Systems Engineering Program at badurdeen@uky.edu
- Contact Graduate Program Coordinator at (859) 218-0611 or manufacturing@uky.edu

Sustainable Manufacturing

Products, Processes, and Systems

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Fall 2017

A Message from the Director



ISM is in its sixth year of operation, and is continuing to make excellent progress with our overall mission of conducting academic research (basic and applied), offering educational programs, and providing outreach to industry. With our focus on *products, processes and systems*, ISM faculty and researchers have been in the forefront of research and applications being actively engaged in several research projects sponsored by industry groups and agencies. Once again, we have exceeded our expectations in research productivity with increased funding, research publications, etc., and industry outreach. Here are some highlights of achievements in 2017:

- ISM formed a strategic partnership with United Technology Research Center (UTRC), in collaboration with Edison Welding Institute (EWI), industry partners (GKN, BOCAR, AAM) and the University of Michigan – Ann Arbor, and proposed a major advanced manufacturing project to LIFT (Lightweight Innovations for Tomorrow, a NNMI institute funded by the DoD - Office of Naval Research, ONR). In May 2017, this research consortium secured a total funding of \$2.35M, including cost-sharing, for a two-year project on *Sustainable High Efficiency Machining*. ISM's share of this funding is \$500,000.

- ISM faculty, Professor Fazleena Badurdeen and Professor Dusan Sekulic continued their research with major funding from DoD agencies (DMDII, another NNMI institute, and NASA) totaling over \$2.2M for two projects involving industry partnerships and international collaboration. They both also continued to serve as Co-PIs for a major DoE-funded five-year project on *Developing Next Generation Energy Assessment Workforce*, with total funding of over \$1.8M.
- ISM continued with strong industry interactions with major companies such as GE Aviation, Toyota and Lexmark International. We also continued our interactions with several US universities and national labs. We look forward to future opportunities for strategic partnership for large proposals at national level.
- We continued to offer courses for the *Online Masters Degree Program in Manufacturing Systems Engineering*, focusing on sustainable manufacturing, with more online courses added to the list. From 2016 this program is fully online, and our enrollment has increased significantly during the last few years.
- ISM faculty continued to expand our international collaborations with researchers from Australia, Brazil, China, Finland, France, Germany, Italy, Lebanon, Malaysia, Norway, Portugal, Slovenia, Sweden, Turkey and United Kingdom. New researchers from Germany, Sweden, China and Turkey joined ISM this year to conduct collaborative research.

I. S. Jawahir, Director, ISM

ISM is a Partner on a DoD (Office of Naval Research)-funded LIFT Institute Project on Sustainable High Efficiency Machining

The scope of this project is to develop and demonstrate advanced sustainable high efficiency machining technologies to achieve at least 3X material removal rate improvement for machining lightweight metals. A systems engineering approach will be used to mature and integrate key machining technology components to achieve the much higher removal rates. These components

include *cryogenic machining, ultrasonic machining, advanced NC programming, process dynamics modeling, physics-based machining process optimization, and model-based process monitoring*.

ISM researchers will develop *predictive model for cryogenic machining of lightweight aerospace and automotive alloys (Ti and Al alloys) and cast iron*.

Project Objectives (UK's Project Segment)

- Develop analytical and finite element-based models for cryogenic cooling on machining processes
- Prediction of process-induced surface integrity characteristics
- Optimize cutting tool edge design to achieve effective cryogenic cooling delivery
- Experimental validation of the modeled/optimized cryogenic process



University of Kentucky Project Team

I.S. Jawahir (PI)
James Caudill (Graduate student)
Buddhika Hapuwatte (Graduate student)

Partners

United Technology Research Center
Edison Welding Institute
GKN
BOCAR
American Axle & Manufacturing
University of Michigan – Ann Arbor



New Faculty Spotlight - Joshua Werner



Joshua Werner joined the Mining Engineering Department as an Assistant Professor at the University of Kentucky in Fall 2017, and is an Affiliate Faculty of the Institute of Sustainable Manufacturing (ISM). He has an active research program working on collaborative rare earth element projects (Co-PI) totaling over \$7 M in total project value. His research interests include design, performance and process control of extractive metallurgical systems, with an emphasis in hydrometallurgy. He holds a PhD in Metallurgy from the University of Utah and a Bachelors in Mechanical Engineering from the University of Idaho. He has varied industrial and entrepreneurial experience, is a P.E. and a certified Six Sigma black belt.

Joshua Werner conducts basic and applied research to improve design, performance and process control of extractive metallurgical systems, with an emphasis in hydrometallurgy. Josh's diverse educational and industrial background have lead him to pursue projects in the juncture between academia and industry. Pursuing collaborative research in the intersections of academia and industry allows for significant and achievable advances in both primary (mining) and secondary (recycling)

metals production. His current research on extractive metallurgical processes and technology contributes to society's sustainability needs with environmental benefits. Extractive metallurgy is critical in today's world to balance environmental stewardship and responsibility with ever increasing metals consumption. Josh's research focus is to develop solutions to meet our needs for metals produced efficiently, effectively and in a sound and sustainable way.

His current research projects include:

- Design and modeling of an advanced pressure oxidation reactor
- Copper upgrading from auto shredder residue
- Rare Earth element extraction from coal and coal byproducts (Co-PI on a \$7M project from the US Department of Energy)

To accomplish his research objectives, he is building and outfitting a lab to allow quick-turn testing utilizing a variety of hydrometallurgical techniques. (See Figure)



Awards and Honors

Keynote Presentations at International Conferences

I.S. Jawahir delivered two invited plenary keynote papers:

- "Sustainable Living Factories for Next Generation Manufacturing", 15th Global Conference on Sustainable Manufacturing (GCSM), Haifa, Israel, September 25-27, 2017 (Jointly presented with Prof. Y. Koren of University of Michigan, Ann Arbor, MI). This paper was co-authored with Y. Koren, F. Badurdeen and X. Gu.
- "Metrics-based Integrated Predictive Performance Models for Optimized Sustainable Product Design", 4th International Conference on Sustainable Design and Manufacturing (SDM-2017), Bologna, Italy, April 26-28, 2017. This paper was co-authored with B.M. Hapuwatte and F. Badurdeen.



YuMing Zhang delivered two invited plenary keynote presentations:

- "Recent Developments in Real-Time Monitoring and Control of Weld Joint Penetration", 70th IIW Annual Assembly and International Conference, Shanghai, China, June 25-30, 2017.
- "Human-Robot Collaborative Cyber Physical System Based Learning of Human Welder Intelligences", 7th Annual IEEE Int. Conf. on CYBER Technology in Automation, Control, and Intelligent Systems, Waikiki Beach, Hawaii, USA, July 31-August 4, 2017.

Y.T. Cheng delivered an invited presentation:

- "A solvent-free dry powder coating process for low-cost manufacturing of lithium ion battery electrodes - Working Towards Making Better and Cheaper Lithium-ion Batteries", 4th Int. Symposium on Sustainable Secondary Battery Manufacturing and Recycling during the Sustainable Industrial Processing Summit and Exhibition—2017 in Cancun, Mexico, October 22, 2017.

YuMing Zhang was elected as the **Chair** of the Technical Papers Committee (TPC) of the American Welding Society during the TPC meeting on Tuesday, Nov. 7, 2017 in Chicago, IL. The term starts January 1, 2018.

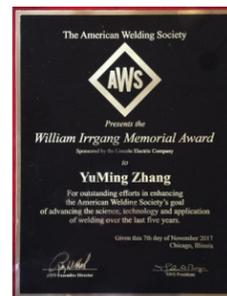
Dusan Sekulic was appointed as a **Foreign Expert Chair Professor** at the Harbin Institute of Technology, China, starting August 2017.

I.S. Jawahir served as the **Honorary Chairman**, 16th CIRP Conference on Modeling of Machining Operations (CMMO), Cluny, France on June 15-16, 2017.

I.S. Jawahir was awarded the **2017 University Research Professorship** by the University of Kentucky, Lexington, KY, USA in April 2017.

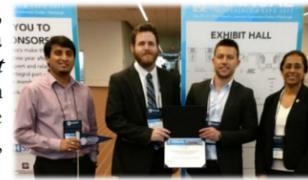
I.S. Jawahir was selected as a **Member** of the US Team for US-Italy Research Collaboration in Advanced Manufacturing, (Selected by NSF) in October 2017. He also previously served as a **Member** of the US Team for US-Germany Research Collaboration in Manufacturing, and visited a number of German universities and research institutes in February 2016.

YuMing Zhang received the 2017 **William Irrgang Memorial Award** from the American Welding Society. "It is awarded each year to the individual who has done the most to enhance the American Welding Society's goal of advancing the science and technology of welding over the last five years." The award comes with a plaque and \$2,500 prize.



YuMing Zhang is a **co-recipient** of the 2017's **A. F. Davis Silver Medal Award** for the field of Machine Design from the American Welding Society for his paper "Current-independent metal transfer by using pulsed laser irradiation. Part 2: affecting factors" published in *Welding Journal*, 95(6): 194s-201s, 2016 that was co-authored by J. Xiao, S.J. Chen, G. J. Zhang, Y. M. Zhang. The award comes with a plaque and a silver medal.

Ridvan Aidin, Adam Brown, Ammar Ali and Fazleena Badurdeen received the **Best Paper Award Third Place**, within the Manufacturing Track, at the IISE Annual Conference, May 2017.



Fazleena Badurdeen was nominated to the **LIFT Expert Educator Team** (more information is available here: <https://uknow.uky.edu/professional-news/uk-professor-selected-team-aligning-higher-ed-manufacturing-workforce-needs>)

Jeff Seay received a **Fulbright Specialist Award** to teach a course in Sustainable Power and Energy at Makerere University in Kampala, Uganda during the summer of 2017.

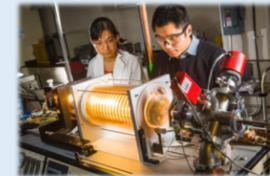
Graduate student **Chandni Joshi** was awarded the **AICHe SEF Student Paper Award** at the AICHe Annual Meeting in Minneapolis, MN on November, 2017. (Joshi, C. and J. Seay (2016): "An Appropriate Technology Based Solution to Convert Waste Plastic into Fuel Oil in Underdeveloped Regions").



ISM Research Programs

Dusan Sekulic

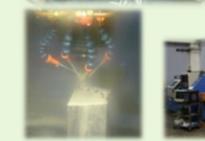
- High temperature liquid metal surface tension driven flow modeling (brazing and 3-D printing)
- Kinetics of brazed joint formation in terrestrial and space conditions
- Impact of nano-particles doping on microstructure evolution for refractory metals systems
- Homogenization of ceramics-metal-ceramics interface domains



Controlled Atmospheric and Vacuum Brazing Lab

I.S. Jawahir

- Predictive model development for sustainable product design
- Modeling and optimization of sustainable manufacturing processes (including dry, MQL and cryogenic machining)
- Metrics-based sustainability analysis of manufactured products and manufacturing processes
- 6R-based technological models for circular economy



Closed-loop Material Flow for Multi Life-cycle with 6Rs

Sustainable Machining Lab

Jeffrey Seay

- Converting Waste Plastic to Fuel Oil in Developing Countries
- Converting Biomass to Green Chemical Products in Developing Countries
- Modeling Biomass Conversion Reaction Kinetics

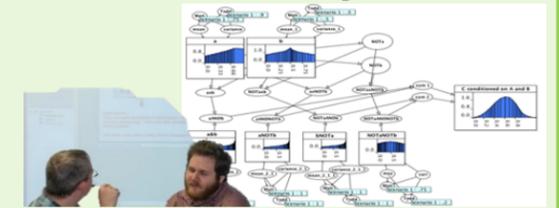
Wood fired pyrolysis reactor built in Kampala, Uganda in collaboration with Makerere University



Parr Reactor for biomass conversion studies

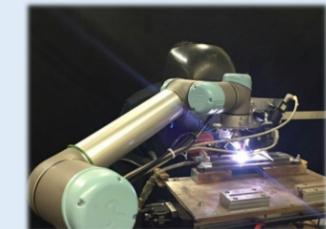
Fazleena Badurdeen

- Multi-lifecycle Sustainable Product Design
- Sustainable and Reconfigurable Manufacturing Systems
- Supply Chain Risk and Resilience Modeling



YuMing Zhang

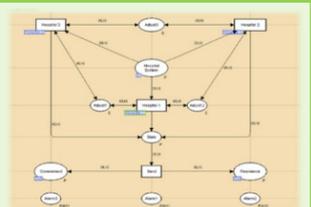
- Real-time monitoring and control of innovative welding processes
- Human-robot collaborative systems
- Human welder centered control
- Human welder modeling



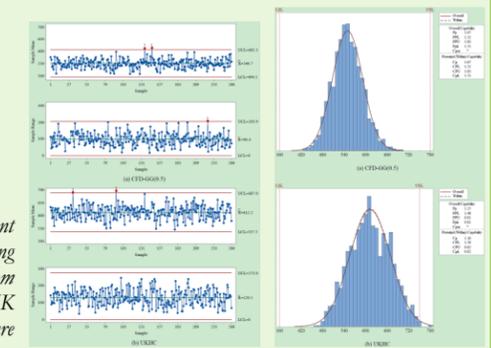
Intelligent Welding Robot

Mike Li

- Adaptive production scheduling and control
- Trade-off balancing with time series
- Operating room scheduling in healthcare systems
- Coordination of material flows in supply chain



Simulation model development for UK HealthCare



Results of current research, improving operating room scheduling for UK HealthCare