Visiting International Scholars

Suhasini Gururaja is a Professor from the Indian Institute of Science, Bangalore, India. She is an expert on machining of composites. She worked from May - July, 2019, with ISM faculty and researchers on "Cryogenic drilling of CFRC materials". A new collaborative project on sustainable machining of composite materials was initiated and this collaborative work still continues.

XiaoLi Wang is an Associate Professor in the Department of Metallurgical Engineering at Jiangsu University of Science and Technology, Zhenjiang, Jiangsu, China. She received her PhD degree in materials science from Shandong University, Jinan, Shandong, China. Her research interests includes welding process and analysis. She was at ISM from August 2018 - August 2019.

Proposed ISM Short-courses in 2020

- Introduction to Sustainable Manufacturing (Professors Julius Schoop, Fazleena Badurdeen and I.S. Jawahir)
- Sustainable Product Development (Professor I.S. Jawahir)
- Sustainable Value Stream Mapping (Professor Fazleena Badurdeen)
- Theory and Practice of Advanced Finish Machining, Grinding and Polishing (Professor Julius Schoop)

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!

Contact ISM

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Phone: (859) 323-3247
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Journals

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

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

ISM Faculty and Staff

F. Badurdeen L. Holloway I.S. Jawahir W. Li J. Schoop D. Sekulic P. Wang Y. Zhang 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

Volume 6, Issue 1 **Institute for Sustainable Manufacturing Newsletter** **Fall 2019**

A Message from the Director

ISM was founded in April 2012, and is marching into its eighth year of operation. ISM continues to focus on products, processes and systems. ISM faculty and researchers have been in the forefront of research and applications in sustainable manufacturing covered by these three major focus areas. During the last seven years, ISM has made excellent progress with our overall mission of conducting academic research (basic and applied), offering educational programs, and providing industry outreach. Our research productivity with new funding, research publications, graduate student productivity, and industry outreach has continued to increase. Here are some highlights of achievements in 2019:

- In Fall 2019, Dr. Peng Wang was hired as an Assistant Professor with joint appointments in the Departments of Electrical and Computer Engineering and in Mechanical Engineering. He is a core ISM Faculty. He brings in a new perspective with his unique expertise in advanced machine learning, process monitoring including diagnostics and smart manufacturing.
- Several ISM faculty delivered invited keynote presentations and lectures. Their research work was also recognized with awards by professional societies – details are shown on p. 2 of this newsletter.
- A new research collaboration was initiated between the University of Kentucky and the Technical University of Berlin (Berlin, Germany) in April 2019. ISM researchers, in partnership with researchers from TU Berlin have recently developed a new research proposal for funding under the US – Germany special research collaboration program sponsored by NSF and DFG (German Research Foundation).
- ISM Faculty 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. Since this program became fully online in 2016 our enrollment has increased significantly.
- ISM faculty, in collaboration with others in the College of Engineering and the Gatton College of Business and Economics are developing a new Online Masters Program in Supply Chain Engineering (SCE). If approved, it will be the first online Supply Chain Engineering Masters program in the nation jointly developed and taught by Engineering and Business Colleges. Prof. Fazleena Badurdeen plays a key role in this initiative and is the Chair of the committee developing the SCE program.
- ISM faculty continued their industry interactions with major companies such as GE Aviation, Toyota and Lexmark International. We look forward to future opportunities for strategic partnerships in large research proposals at the national level.

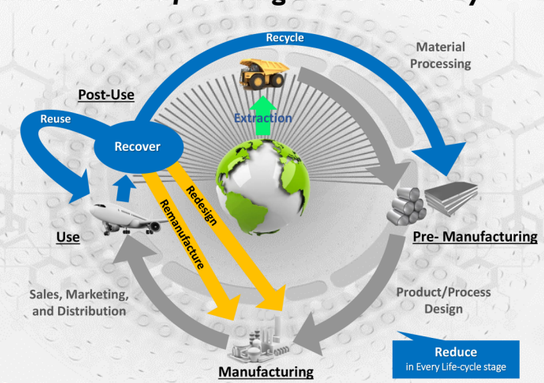
I. S. Jawahir, Director, ISM

7th International Forum on Sustainable Manufacturing

Organized by the Institute for Sustainable Manufacturing at the University of Kentucky
Hilary J. Boone Center, University of Kentucky, Lexington, KY
March 26 - 27,2020

Sustainable Manufacturing in the Industry 4.0 Era

Industry attendees can also earn Professional Development Hours!



Multi Life-cycle Closed Loop Material Flow with 6R

Contact:
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(859) 323–3252
More information on:
www.engr.uky.edu/ism/forum2020

Special features of the event include:

- *Invited presentations by experts in Industry 4.0 and Sustainable Manufacturing*
- *An Emerging Researcher Showcase with presentations from early-career researchers (expenses covered)*
- *A Panel Discussion on 'Sustainable Manufacturing in the Industry 4.0 Era'*
- *A Student Poster Showcase*
- *Sustainable Manufacturing Student Projects (NEW!)*

New Faculty Spotlight - Peng Wang

Dr. Peng Wang joined the Department of Electrical and Computer Engineering and the Department of Mechanical Engineering in August 2019 as an Assistant Professor and is a core faculty member in the ISM. Dr. Wang got his Ph.D. degree in Mechanical and Aerospace Engineering from Case Western Reserve University in 2017.

Dr. Wang's group, "Augmented Intelligence for Smart Manufacturing Lab", aims to develop new insights, theories, and tools to exploit data effectively for the timely delivery of relevant and accurate information and for knowledge discovery towards scientific, technical, and societal advances. For the purpose of effective and efficient learning from the data to improve the operational safety, manufacturing efficiency, energy efficiency, and sustainability in manufacturing, Dr. Wang's group has been exploring machine learning (ML) and artificial intelligence (AI) for improved information extraction and pattern recognition towards smart, data science-enhanced manufacturing.

Dr. Wang's group targets developing advanced ML and AI techniques suitable for manufacturing data analytics that is featured by high-dimensionality, heterogeneity, non-linearity, and uncertainty. Current research thrusts focus on stochastic processes with distributed filtering techniques, interpretable machine learning, auto-ML, data fusion, orthogonal analysis, and dynamic optimization, with applications on:

- Stochastic modeling for machine performance monitoring, anomaly detection, diagnosis, and prognosis, towards predictive maintenance;
- Hierarchical manufacturing process modeling and optimization towards improved manufacturing and energy efficiency;
- Process-structure-property-performance (PSPP) modeling for advanced manufacturing processes, e.g., additive manufacturing;
- Context-aware human action recognition, prediction, long-term and short-term robot motion planning for scalable and robust human-robot collaboration;
- Machine-to-machine communication, big data transmission, semantic indexing, processing, and learning for building digitalized manufacturing factories;
- Digital thread in life cycle analysis for improved product design and supply chain management.

Awards and Honors

Keynote Presentations at International Conferences

Fazleena Badurdeen delivered a keynote presentation titled "Sustainable Manufacturing: A Product, Process and Systems-Integrated Approach" at the Connecticut Sustainability Conference Nov. 21, 2019 organized by Pratt & Whitney in collaboration with Connecticut Business and Industry Association (CBIA).

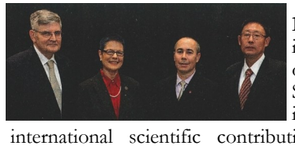
I.S Jawahir delivered a keynote presentation entitled "Innovations in Sustainable Manufacturing for Advancing Circular Economy" at the 2nd World Summit on Advances in Science, Engineering and Technology held in Indianapolis, IN on Oct. 3-5, 2019.

I.S. Jawahir delivered a keynote presentation at the 8th International Conference on Through Life Engineering and Services (TES 2019) held in Cleveland, OH on Oct. 27-29, 2019. This presentation was on "Through-life and Beyond: Leveraging the Internet of Things (IoT) and Industry 4.0 at Product, Process, and System Levels to Advance Circular Economy".

ISM Wins Environmental Sustainability Award!

The ISM was selected as the Kentucky Pollution Prevention Center (KPPC) Douglas C. Griffin Environmental Sustainability Award winner for 2019. The award recognizes Kentucky entities that have demonstrated a commitment to the principles of sustainability and environmental stewardship.

Recognition of ISM Faculty



Dusan Sekulic was inducted into the 2019 Class of Fellows of the American Welding Society, on Nov. 11, 2019. He is recognized for his international scientific contributions supporting the art of brazing, for promoting visualization of the processes of joint formation and his scholarly work.

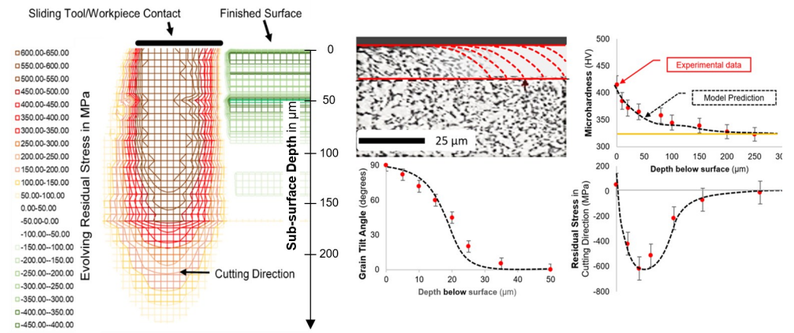
YuMing Zhang was recognized at Fabtech in Chicago, IL on Nov. 13, 2019 for his twenty-five years of AWS membership.

Dusan Sekulic has been awarded the Friendship Award, the highest award from China for "foreign experts who have made outstanding contributions to the country's economic and social progress". Professor Sekulic is a Foreign Expert Chair Professor at the Harbin Institute of Technology.

YuMing Zhang's PhD student **Jinsong Chen** was a recipient of the 2019 Henry Granjon Prize awarded by the International Institute of Welding (IIW). The four recipients in 2019 are from USA (Dr. Chen), Japan and Germany (2).

Research Spotlight: Julius Schoop — Advanced In-Situ Characterization of Cutting Processes for Instantaneous Modeling of Surface Integrity

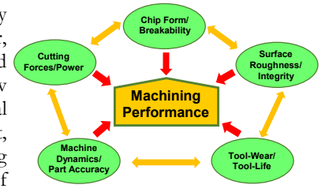
A novel high-speed in-situ testbed and associated analysis techniques were recently developed by ISM core faculty Dr. Julius Schoop to characterize friction and flow stress models for a broad range of work materials at industrially relevant cutting speeds (up to 240 m/min). Based on in-situ experimental data and observations from the testbed, we have developed a set of efficient physics-based analytical models for real-time modeling of surface integrity (i.e., a Digital Twin of finishing processes). This new approach is 3-6 orders of magnitude more efficient than other currently available modeling techniques (results within seconds vs hours/days), while offering similar or better predictive accuracy. As such, our model is ideally suited to act as a real-time process simulator. Initial validation trials were carried out in titanium alloy *Ti-6Al4V*, resulting in better than 10% accuracy in predicting of various surface integrity parameters. These results were presented at a recent conference (17th CIRP CMMO in Sheffield, England) and are summarized in the figures below.



Preliminary results of real-time surface integrity model in Ti-6Al4V (Schoop et al., Procedia CIRP, 2019).

Custom-built In-situ Characterization Testbed (3 patents pending)

ISM Launches IMPACT (Integrated Machining Performance for Assessment of Cutting Tools), a New Major International Collaborative Research Project (2019-23)



In August 2019, ISM faculty group (Professors I.S. Jawahir, F. Badurdeen, J. Schoop and Peng Wang) launched a new major international collaborative research project, IMPACT (Integrated Machining Performance for Assessment of Cutting Tools). This four-year project is sponsored by the CIRP (International Academy for Production Engineering), and will involve 26 researchers from major international research labs from 11 countries (Canada, France, Germany, Italy, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, USA). ISM will lead this effort. Two major cutting tool manufacturers and major manufacturing companies will also participate in this major study.

The goal of this project is to develop an integrated machinability evaluation method to provide the overall performance of a machining system (work material, cutting tool and machine tool). Current machinability evaluation methods are vague, incomplete and only partially address the machining performance of a machining system. New method includes the five major machinability parameters shown in the figure above.

Advanced computational modeling and machine learning methods, in-situ material performance analysis, experimental data and optimization techniques will be used to develop a predictive performance model for IMPACT. A digitally-enabled predictive capability will be developed for determining the optimal machining performance of a machining system for a given machining operation. The figure below shows an example of the chip chart generated using a similar method, but the proposed predictive system will have additional outputs for all machining performance parameters. Phase 1 of this project will target selected applications (e.g., automotive and aerospace machining) for machining of two automotive and two aerospace materials, and using tools from two different cutting tool manufacturers.