

GET TO KNOW THE DEPARTMENT!

NEW quarterly newsletter featuring recent events and current department faculty research.

UPCOMING EVENTS:

- Senior Design Night (Thursday, May 7th)
- Spring 2015 MIE Advisory Board Meeting (Friday, May 8th)
- Spring 2015 Commencement (Graduate May 15, Undergraduate May 16)
- Fall 2015 MIE Advisory Board Meeting (Friday, October 9th) and Homecoming (Saturday, October 10th)



MECHANICAL & INDUSTRIAL ENGINEERING

College of Engineering
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<http://www.engineering.uiowa.edu/mie>

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GET STARTED RIGHT AWAY

The University of Iowa Mechanical and Industrial Engineering Department would like to share with students, faculty and staff events and activities within the department that include faculty research, student organizations and upcoming events.

"To the optimist, the glass is half full. To the pessimist, the glass is half empty. To the engineer, the glass is twice as big as it needs to be." –Unknown

BIG WIN FOR BAJA

The University of Iowa Society of Automotive Engineering BAJA student organization participated in the Winter BAJA competition hosted by Michigan Tech University on February 21, 2015. After competing against 18 other colleges and 31 racing cars, they placed first at the competition! Competing against top ranked universities, this was the first big win in several years. Now the group is preparing for the upcoming BAJA SAE Series Nationals competition on May 27-30.

THE GANG

UISAE BAJA is open to all students, including non-engineering majors. They focus on taking elements and aspects from the classroom and turning them into hands-on projects, concentrating on analyzing and creating optimal cars for competition. The leadership of the organization includes seniors Corey Harthoorn (President) and Frank Ross (Secretary), and juniors Austin Evens (vice-president) and Alan Callender (treasurer).

Contact Us! Alan Callender, Treasurer/Sponsorship:
uisae@engineering.uiowa.edu.

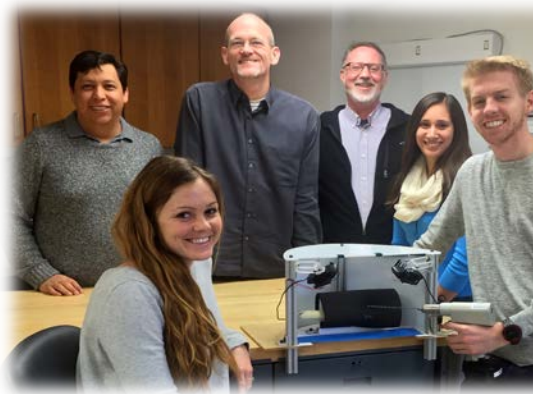


UISAE BAJA competing at the Winter BAJA International Competition in Houghton, Michigan. Pictured from L-R are Alan Callender, Adam Westbrook, Trevor Lough, Frank Ross, Codie Weeding, Corey Harthoorn, Jacob Knock, Austin Williams, Austin Evens, and Shane Peot

SIMULATION PREPARATION

A team of engineers led by Associate Professors Geb Thomas and Don Anderson is developing Surgical Training Simulators in collaboration with Drs. Matt Karam and Larry Marsh in the UI Department of Orthopaedics and Rehabilitation. The current simulator is being tested here and at 15 other teaching hospitals throughout the Midwest, including the University of Minnesota, Mayo Clinics, Northwestern University, and the University of Wisconsin, through the Midwest Orthopaedic Surgical Skills (MOSS) consortium founded by the Iowa team two years ago. The research will help surgical residents develop and assess their surgical skills during their residency training.

The simulators provide residents with an opportunity to practice before operating on a live patient and without being exposed to x-ray radiation. Trainees use standard surgical tools to drill into plastic, artificial bone. A position tracker follows the tool movement within the bone. The graphics system uses the tool position and known bone positions to generate simulated fluoroscopic images similar to those used in surgery. The simulation will allow residents to easily and frequently practice the correct movements needed to perform specific surgical tasks and receive immediate quantitative feedback on their performance.



Pictured (left to right): Salvador Rojas Murillo, Leah Taylor, Dr. Donald Anderson, Dr. Geb Thomas, Colleen Rink & Steven Long

Professor Thomas began collaborating on the project in 2011 after Don Anderson, Director of the UI Biomechanics Lab, contacted him to bring his previous experience in simulation and virtual reality.

Over the years, the team has enjoyed success in developing a string of projects and funded proposals. Thomas spent this past summer in an operating room at The University of Iowa Hospitals and Clinics, observing the surgeons and their techniques in order to further improve simulation training. The project has

enjoyed the support, hard work and insight from many MIE and Biomedical Engineering students, including Brian Johns (Ph.D. 2014, industrial), Gary Ohrt (M.S. 2013, biomedical), Steven Long (Ph.D. candidate, biomedical), Salvador Rojas-Murillo (Ph.D. candidate, industrial), Leah Taylor (M.S. candidate, biomedical), Colleen Rink (M.S. candidate, biomedical), Jon Myers (B.S. candidate, mechanical), and Lauren Taylor (B.S. candidate, industrial). The work of these students has been supported by generous grants from the Agency for Healthcare Research and Quality, The National Board of Medical Examiners, the American Board of Orthopaedic Surgery, the OMeGA Medical Grants Association, the Iowa Orthopaedic Research Foundation and the Orthopaedic Trauma Association. Over the next few years, the team plans to make trips to each of the 15 schools participating in the project as well as to a regional conference for surgeons already in practice. The team looks forward to eventually establishing a central surgical training center for orthopaedic surgical skills training here at the University of Iowa.

METAL SOLIDIFICATION

Professor Christoph Beckermann, University of Iowa Foundation Distinguished Professor of Mechanical and Industrial Engineering, is focusing his time on multiple research projects, including one sponsorship from NASA. This project includes experiments to improve the understanding of the columnar-to-equiaxed transition (CET) in the grain structure during solidification of metal alloys and to clarify the role of gravity-drive melt convection and sedimentation or floatation of unattached dendrite fragments and equiaxed crystals on the CET.

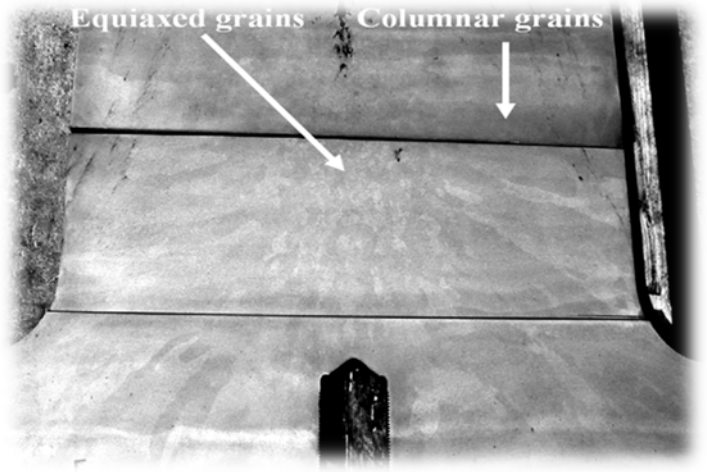


Fig. 2 Example of a CET in a steel casting.

The hypothesis of the proposed research is that fragmentation of columnar dendrites can lead to a CET in non-grain-refined alloys. As opposed to current theories, a growth velocity increase and nucleation of equiaxed grains ahead of the columnar front are not necessary conditions for a CET to occur. A growth velocity decrease causes fragmentation of columnar dendrites. The secondary dendrite arms that detach from the primary columnar trunks are a potent source of new (equiaxed) grains. However, for a CET to occur, the growth of the primary columnar trunks must be blocked by equiaxed grains. This can only be accomplished if the dendrite fragments are transported to the columnar front rather than remain between the primary columnar trunks. Due to natural convection of the melt and sedimentation or floatation of the fragments, such transport can be expected to readily occur in the gravitational field of earth. In the absence of gravity, it is not clear if fragmentation alone, without fragment transport, is sufficient to cause a CET. Hence, identical CET solidification experiments will be conducted both in the microgravity environment of the International Space Station (ISS) and on earth. The experiments will be supported by theoretical and computational modeling studies.

Professor Beckermann has been working with NASA since the early 1990's but began this specific project in 2011. This project will continue for the next 3-4 years, as the first round of experiments on the ISS will begin next year. His team includes several researchers from Europe through collaborations with the European Space Agency (ESA). One of his favorite aspects of the research is being part of a large international team and interacting with different professors from across the globe.

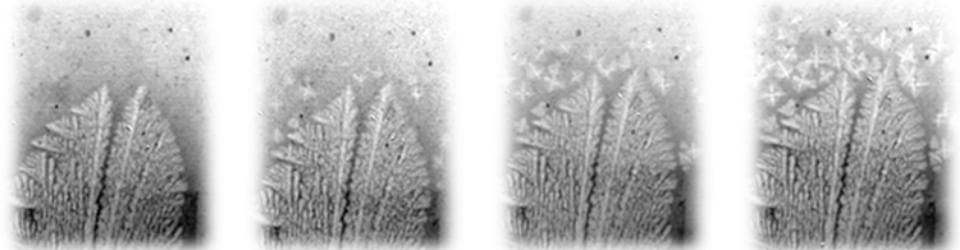


Fig. 4 Observation of the CET in a grain refined Al-3.5wt%Ni alloy using synchrotron X-ray imaging. The Al dendrites appear in a light gray shade, while the Ni-rich liquid is darker. (Courtesy of B. Billia, 2010)

INNOVATIVE TECHNOLOGY



Pictured (left to right): Hamed Salehi, Brennan Ayres, Dr. Priyadarshini Pennathur, Dr. Afrooz Moatari Kazerouni & Amirmasoud Momenipour

Professor Priyadarshini Pennathur has recently researched how doctors and nurses generate and use information for their work. Her interests are in understanding what tools and technologies best support cognitive work of providers, and how we can best design systems to support provider work needs. The project is funded by the National Library of Medicine, and is in its second year.

Professor Pennathur and her team participate in several patient safety and quality improvement research projects. A project from a graduate course on healthcare

human factors taught by Dr. Pennathur is seeking to understand how opening doors in operating rooms affects surgical site infections. Her team conducted surveys, observations, and interviews in C-section operating rooms to understand door openings. Dr. Pennathur's graduate student Brennan Ayres presented research findings at the IIE Healthcare Systems Improvement Conference in February 2015.

Dr. Pennathur is also collaborating with colleagues in Nursing on a NIH funded study to understand and support caregivers of people with dementia. The project seeks to enable caregivers to use technology to receive support on dementia care. Ensuring that the technology is usable by caregivers is an important part of the study. Dr. Pennathur's dynamic research team of undergraduate and graduate students conduct research in her Information and Cognitive Systems Engineering (ICSE) research lab. Her team includes Brennan Ayres, Amirmasoud Momenipour, Afrooz Moatari, Hamed Salehi, and a recent member Tram Messerly.

Brennan is pursuing his MSIE with interest in Human Factors. He is currently working on the NLM funded information use study, and is leading the project on door openings in the OR. Brennan's long-term goal is to study and practice Medicine. Amir, who is pursuing a PhD in IE, joined ICSE in Fall 2014. He primarily works on the information use project and examines how people organize information. He is also beginning to work on projects related to dementia and work.

Hamed Salehi, who is also pursuing a PhD in IE, joined ICSE in Spring 2014. He works on projects related to mobile communication among healthcare providers, supplies process management in ORs, and is beginning work on dementia. Tram Messerly, a senior in Psychology, recently joined the group to explore and experience human factors research firsthand in the lab. She will be working on the information use project in addition to conducting lab experiments on information organization.

Dr. Afrooz Moatari Kazerouni, who was with the group in Spring and Fall of 2014, was a visiting PhD scholar from Montreal. She worked on two projects during her short visit in the ICSE lab. One was to relate occupational safety risks with the layout and physical design of an operating room, and the other project was on stairwell use at work for healthy living. Afrooz has since graduated with a doctoral degree and works at a hospital in Montreal.

If you would like to be a part of the exciting research in the Information and Cognitive Systems Engineering Research Group, please contact Dr. Pennathur at priyadarshini-pennathur@uiowa.edu.

RELIABILITY-BASED OPTIMIZATION SPECIALIZATION

Professor Kyung K Choi, (Roy J. Carver Professor in Mechanical Engineering) at the University of Iowa has been working on one of his current projects for more than a decade and is finally beginning to see the light at the end of the tunnel and impact to the design community. This project consists of developing a simulation-based design software system to optimize multidisciplinary design problems (such as ground vehicles, wind energy turbines, construction equipment, aircraft, etc.) to minimize the cost function while satisfying target reliability of product performances, such as ride quality, safety, durability, etc. to reduce maintenance and operational costs.

Multidisciplinary Applications of RAMDO
RAMDO provides Sensitivity-Based & Sampling-Based RBDO of Simulation-Based Designs in

- Fatigue Analysis & Durability
- Explosion Analysis & Survivability
- Vehicle and Machine Dynamics
- Noise, Vibration & Harshness (NVH)
- Crashworthiness
- Casting Process Design (Manufacturing)
- Robotic Systems
- Wind Power Systems
- Electromagnetics
- Advanced & Hybrid Powertrain
- Fluid-Structure Interaction
- Human Centered Design
- MEMS & Nano/Micromechanics Based Materials Design

And a lot more

The University of Iowa

As this project began 14 years ago, Professor Choi worked with Ford Motor Company to create a simulation-based optimum design software for a light automotive body framework, while improving the ride quality of the vehicle. As he was working with Ford, this new reliability-based design optimization method began to attract the attention of the United States Army Tank Automotive Research, Development & Engineering Center (TARDEC) who also needed better innovation when dealing with their ground vehicles. For Army, reliability and survivability was much more important for these ground vehicles, as well as reducing the weight to improve fuel efficiency. As Professor Choi and his students have worked over

the last 14 years creating a software system to complete the trade-offs between the cost function and reliability, not only for the United States Army but for commercial manufacturers as well, the final stage of completion and commercialization is in view. These next two years are crucial for completing commercialization of the Reliability Analysis and Multidisciplinary Design Optimization (RAMDO) software so that manufacturing industries, such as automotive, construction, heavy equipment, aircraft, DoD contractors, etc., to begin the process of using the RAMDO software in the future development of their products to perform at the highest performance rate possible.

Professor Choi has worked with a number of Ph.D. students throughout the years of this project, but one former Ph.D. student, Dr. Nicholas Gaul, has been one with whom Choi has worked closely throughout the commercialization process of the RAMDO software. As both of them are finalizing the process to commercialize their RAMDO software to optimize and while satisfying reliability for DoD and commercial manufactured products.

If you would like to send highlights of your current research or events, please contact Megan Grubb at megan-grubb@uiowa.edu for more information. Contributions made by: UISAE, Geb Thomas, Christoph Beckermann, Priyadarshini Pennathur & Kyung K. Choi.