IMSENews

Applying industrial engineering ingenuity to football during the era of COVID-19

10

Letter From the Chair

Dear Friends and Alumni,

Last Spring when we had to move to online learning due to COVID, we were half way in the semester. Switching the instruction delivery mode was difficult, but faculty and students knew each other, and that familiarity and the care for the material and one another kept us moving.



Dr. Kremer poses with Cy

Preparing for the fall was another matter... We had two guiding principles: 1) we would do everything in our power to keep everyone safe, and 2) we would not produce "pandemic engineers" with skills less than where they need to be. I will not give out the secret recipe for our success here; but do visit us in Ames, I am happy to introduce you to the top brains and warmest hearts IMSE has. Student testimonials from this semester (see page 3) tells this in a nutshell: i) engineering requires in-person learning, ii) keeping everybody safe and productive required industrial engineering at its best, and iii) number one ingredient for learning is a caring professor.

One sad part of it all was not being able to celebrate our graduates with the regular fanfare. But they know, they are all welcome back to celebrate when it is safer for them and their families and loved ones. In the meantime, we had CY show some love to us all!

With warmest regards from Cyclone land!

Shi F. W

Gül E Kremer Professor and C.G. "Turk" and Joyce A. Therkildsen Department Chair



Right: Michael Dorneich (left), associate professor, poses with Rick Stone, associate professor.

Cover Photo Caption

Faculty and staff in Iowa State University's Department of Industrial and Manufacturing Systems Engineering collaborated with equipment managers for Iowa State University to create an inexpensive way to modify the team's helmets to be functional for the players, while also reducing the potential spread of COVID-19. The "Cyclone Shield" has made lowa State's football program safer, and plans have been made available at no cost to the general public. It has since been used by over 35 high school and club teams across the state of lowa.

Photo courtesy of ISU Athletics

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Please enjoy the excerpts from student course evaluations from Fall 2020 showing IMSE resiliency

"I really enjoyed all of the examples. Seeing each worked out thoroughly throughout the class was useful for homework and understanding the topics. I also appreciated the opportunity to come to class in-person, even if only one day a week, and take in-person exams."

"The days where we had class in person I always learned the most because I was engaged and I love how the professor asked questions and wanted student participation. This is by far my favorite class and I liked being able to ask questions during lecture."

"I was very skeptical coming into this semester and taking this class online. I just want to say I was very impressed with how this course was delivered. Professor X is very knowledgeable about the course and I learned a lot about approaching complex mathematical problems that would take me much longer to solve before taking this course. Usually an online class is less engaging compared to in-person, but professor X did a good job trying to make this class interesting and engaging through this online experience."

"Social distancing measures set in place for lectures and exams were enforced and followed. Thank you for creating a safe environment for us students given the circumstances."

"This class has been one of my top 3 favorites and easily my favorite this semester. I recommended it to friends at the beginning of the semester because it seemed interesting and will continue to recommend it to people because it is interesting, useful, and an overall incredible class. This class could, and probably should be used as a model for others. I looked forward to these lectures and labs. Thank you."

"Very flexible with students who missed classes. Nothing can compare to in person instruction though. I am grateful to be able to attend every class session!"

"Dr. Z is one of the best professors I have had at Iowa State so far. He was really good at teaching the material effectively without adding busywork or making it seem complicated. It is also obvious that he genuinely cares about his students and is always willing to help. I love his "unsolicited advice" because it is always relevant to our lives and makes him seem more approachable. He is more than willing to answer any questions we have about course material, or even internships, career options, etc."

"All covid-related regulations were followed in the classroom. People were spaced out and always wore masks. I do like how he continued to provide us the opportunity to ask questions in person after class by keeping in mind spacing and masks. Not all of my professors have allowed us to ask questions after class in person, so I really appreciate the fact that he was willing to and able to do so in a safe way."

"I hope to take more of his classes. I feel ready for the real world, and that's something I don't usually get in my classes. I'm excited and happy to try out what I learned. He helped not only in class, but also our career fair, our real world money, and talked about future jobs. He also kept out confidence up by telling us we will get that job, we can do it. Most professors don't do that, and even if it's a small point, it's huge in our eyes."

"I love how the labs were still able to happen and the class truly felt like a real lowa state class. It didn't feel very effected by covid which was nice."

"Constantly asking how students are makes a big difference. The instructor made necessary changes and made this my favorite class of the semester. I really appreciated this class."

"The class was very organized. I appreciated the weekly videos all being available at the beginning of the week. I like that it was asynchronous for the most part, but the professors were very available to help. Having 1 hour a week in lab was nice and helped establish groups for projects."

"I enjoyed the asynchronous format with some in-person time in lab. Having access to the computer lab was SO HELPFUL to be able to work on our projects in small groups. They used the online format well, splitting lectures by content into 15-25 min videos and not just going with the traditional 50 min lectures 3 times per week."

"The COVID add-on meant that interactions with the client were not in person. I think this enhanced the experience since some members were globally dispersed and allowed for internal team members to have more flexibility."

"I'll mention this again later, but simply your enthusiasm and excitement every day helped me stay focused and be ready to learn. I've had many professors that just ramble on about material and I think that leads to a less productive learning environment. All of the assignments and material in this course were great, but it was your enthusiasm and excitement every day that made me motivated to learn the material and complete each assignment to the best of my ability."

"Thank you for such a fun semester!!! I am currently a senior that has switched majors more times that I wish to admit. Because of this, this is also my 3rd "101" class that I've taken. Without a doubt, this was by far the most helpful to me and you did you a great job keeping me engaged during class. Now, this could also be due to the fact that I am more interested in industrial engineering than my previous majors, but still. You have a great spirit and bring a great attitude to class every day. It really helps my learning if the professor is enthusiastic and excited every day, which you definitely were. Once again, thanks for such a great semester and I hope to talk to you again in the future!"

"The flipped classroom works wonderfully with COVID and we're able to use the in-person time to collaborate with the others in your group. I appreciated watching the videos on my own time as well and I was able to set up my schedule better. I really liked being able to go back to review other sections if I felt I missed something and with having COVID myself, I never really felt like I got behind."

"This course has honestly been one of my favorite courses that I've taken here at Iowa State. I've loved learning about machining theory and different manufacturing processes, and I know that these are all topics that I can use and apply it to the real world. I feel more confident in using the different machines and using both Solidworks and AutoCad, and I know that this wouldn't be the case if it wasn't for this class. Overall Dr. T did a fantastic job teaching the class, and I've enjoyed every minute of it."

"In person lecture was a main reason I was motivated to do well in this class. I thought the professor taught the class in a very positive way and truly did want his students to learn and understand the material. I felt he was consistent with his grading and always had an explanation for why a student had missed a point. He did care about his students and made time to be available when the students needed it. The single notes sheet for the exam helped me do better on the exam, I didn't reference my sheet much during the exam but making the sheet gave me a better understanding of the material prior to the exam and I actually felt I did better because of it."

"The real world examples and application Dr. A provided really helped to drive understanding of the principals in a way that was immediately valuable. His sharing of experience and lessons made recognizing and acting on opportunities to apply the principals much easier."

"I could tell that the instructor considered the material from the student's perspective and provided additional aids and concepts to clarify difficult topics. It is clear the instructor is not only very knowledgeable about the course topics, but also about how to teach them."

Liao brings a diverse skillset to the department

With background in materials science and engineering, biomedical engineering and industrial engineering, Yiliang (Leon) Liao brings a unique and diverse skillset to Iowa State University's Department of Industrial and Manufacturing Systems Engineering (IMSE).

Liao joined IMSE as an associate professor for fall 2020. Prior to coming to Ames, he served as an assistant professor of mechanical engineering at the University of Nevada, Reno. He holds his B.S. in materials science and engineering from the University of Science and Technology of China, a M.S. in biomedical engineering

from South Dakota School of Mines and Technology, and a Ph.D. in industrial engineering from Purdue University.

"Advanced manufacturing research and teaching is multidisciplinary, involving knowledge from material science, mechanical engineering, industrial engineering and more," said Liao. "My diverse educational background helps me when collaborating with researchers from other research fields."

At Iowa State, Liao is teaching I E 248: Engineering System Design, Manufacturing Processes and Specifications. He has also developed a new course, I E 645X: Laser-based Advanced Manufacturing, which will be offered in the spring.

His research falls within the department's focus area of advanced manufacturing (AM). Specifically, Liao studies advanced manufacturing process innovation and advanced materials processing towards applications in biomedical, energy storage, structural engineering and soft robotics. He utilizes research concepts and methods such as process design and optimization, finite element method, firstprinciples modeling, and manufacturing simulation.



Liao

Liao is currently working on three research projects supported by the National Science Foundation (NSF). The first project aims to develop a new manufacturing process, named photon-enabled atomic drilling, to fabricate holey-graphene frameworks for supercapacitor applications. In the second project, he will develop a novel nanomanufacturing strategy, named confined laser shock detonation, to realize room-temperature, scalable fabrication of nano-diamonds towards the multimodel drug delivery application. For the third project, he will design a new manufacturing methodology to fabricate

high-performance smart materials for soft robotics applications.

Going forward, Liao hopes to collaborate with some of the department's other AM researchers such as Matt Frank, Gül Kremer, Frank Peters and Hantang Qin. He also plans to work with researchers from IMSE's operations research and analytics focus area as well as faculty in other departments such as chemical engineering, materials science and engineering, and mechanical engineering. It was these chances for collaboration that attracted him to the position at Iowa State.

"Iowa State University has an excellent reputation in science and engineering. I am very excited to have the opportunity to join IMSE, and look forward to collaborating with ISU's top researchers and scientists," Liao said.

Outside of the classroom and lab, Liao enjoys sports, particularly soccer, tennis and table tennis. He also enjoys classical music and has played the violin for more than two decades, having previously worked as a part-time violin instructor. He also stays busy with his family and his two kids: Derek and Elliana.

CYstarter summer: IE student launches startup in entrepreneurship accelerator program

Three Cyclone Engineering students, including one from industrial engineering, are building new, innovative businesses last summer as members of the 2020 CYstarters cohort. CYstarters is an 11-week program giving Iowa State students with a passion for entrepreneurship the funding, skill development and mentorship to start their business while still in school.

Ahmed Ismail, a senior in industrial engineering, is working on TK Holograms. TK Holograms uses holographic fans to attract visual attention to storefronts.

IMSE | 2020

A Hawkeye back home in Cyclone country

Despite being an alumnus from a public university on the east side of the state, one of industrial engineering's newest faculty members has picked the right school for where to continue his career.

Brendan Devine joined Iowa State University's industrial and manufacturing systems engineering department as an assistant teaching professor beginning in fall 2020. Though he's new to the faculty at Iowa State, he is quite familiar with the institution.

Devine was born in Ames and both of his parents graduated from Iowa State. His father, Barnett Devine, studied psychology while his mother, Susan Devine, majored in biology/zoology, both of whom are active Cyclone alumni. Devine's initial time in Ames was short lived though as he grew up in Iowa's capital city when his parents took jobs in Des Moines.

Even though he has family ties to Iowa State University, Devine bucked the family trend when it came time for college and he chose to attend the University of Iowa. He majored in mechanical engineering (ME) at a time when the university was placing a greater emphasis on thermodynamics and thermal-fluid systems design.

"I guess I had a knack for boiling things, then measuring their latent heat," said Devine. "Eventually I met other students that were studying the ignition of fuels, and I gained a taste for burning, blasting and blowing things up."

This experience, coupled with his B.S. and M.S. in ME, caught the eye of the U.S. Air Force because upon completion of his graduate studies, he was hired as an officer specializing in developmental engineering. In this capacity, he described himself as a "project engineer wearing a uniform" and much of his work involved collaborating with major contractors such as Lockheed Martin, Boeing and Northup Grumman, in developing cutting-edge technology specifically with weaponry.

"I have more than 250 hours as a backseater in the F-16, B-52 and C-17 aircrafts as a flight test engineer," he said. "Every weapon the military deploys gets run through the ringer – on the drawing board, in the lab, and eventually, over a test range – before it ever gets sent into combat."

Devine met his wife of now 15 years, Twila, in the service where she served as a logistics officer, responsible for all fuel, spare parts, ground equipment, weapons and personnel for the 33rd Fighter Wing when it deployed. She led more than 300 airmen as a young lieutenant.

"When it comes to getting organized, home repair projects, or planning a vacation, I kind of stand out of the way and let her do her magic," Devine said of his wife. "Let's just say my lectures in value stream mapping and design for agility probably start with an example of Twila's leadership and knack for organization."

Brendan Devine has been involved with projects for air-toground missiles, computer networks, missile defense systems and aircraft battle damage repair. Not only did Devine gain research experience during his time in the service, but he even got introduced to teaching through his role as an ROTC instructor. **Right:** Devine (right) poses with Air Force ROTC cadets at Vance Air Force Base in Oklahoma.



"It is an expectation that all airmen, marines, soldiers, and seamen train the next generation of soldiers to make sure there's no loss of skills in our national defense. That's where I truly found a joy for teaching," he said.

In his new capacity at Iowa State, Devine is teaching I E 305: Engineering Economics and I E 561: Total Quality Management. Eventually he said he would like to teach courses in project management as well as in systems requirements and design. He also plans to develop a course on "how to objectively do systems testing."

"Engineers are frequently hired to test systems before they go to the field," said Devine. "It's one of the most enjoyable jobs as an engineer. You get to be an expert on a systems before anyone hears about it in the press or buys it online."

Outside of teaching, Devine will also be involved with other projects and administrative responsibilities. He is expected to assist the systems engineering program, and has ideas from his military experience which he hopes to bring to the table. He explained how the a standard aircraft contains several miles of wiring throughout, and it is important that the those designing and manufacturing the aircraft use material that is able to function effectively at high elevations (as high as 42,000 feet above sea level) as well as temperatures that can fluctuate from 120 degrees Fahrenheit in Jordan to minus 20 degrees Fahrenheit in Nova Scotia.

"The industrial and manufacturing engineers need to make sure they can make that multi-mile wiring in a cost effective way. The systems engineers need to design sensors to make sure the industrial and manufacturing engineers were right," he said.

In his free time Devine enjoys golfing, and though he admits he's not great he said he'll trash talk his 17 handicap against anyone. His two children, Ella and Isaac, keep him busy as well. He also enjoys working on and riding his 2003 Triumph Bonneville motorcycle, even though his wife jokes that he takes it apart and puts it back together more than he rides it.

But for now, Devine is focused on the projects and other work he'll do at Iowa State, which he said was part of what attracted him to come back to his home state to accept this position.

"In all truths, Iowa State University does more projects, and nimbly pursues new ones, than anything I have seen before. They may not all come to fruition, but they are an incredible chance to learn and explore. This is where ideas are born," he said.

Cora Hicks: Outstanding senior in industrial engineering

Major: Industrial engineering

Hometown: Carroll, Iowa

Clubs and Activities: WiSE, Tennis Club, teaching assistant, freelance tutor, undergraduate research assistant

Awards and Honors: Third Place Industrial Engineering 361 Project, Co-ed Intramural volleyball champions, Dean's List, Carroll Cattlemen Award, Gold Calculator Award

Cora Hicks comes from a long line of Cyclones. Both her parents, grandma and two older brothers are lowa State alumni.

As soon as she continued the family tradition and arrived at lowa State, Hicks hit the ground running, getting as involved as she could, joining Women In Science and Engineering (WISE), Tennis Club, becoming an engineering teaching assistant, undergraduate research assistant and a freelance tutor. Hicks also made time to remain active, by joining co-ed intramural volleyball and placing third.

When it comes to her role as an engineering teaching assistant, the opportunity was given to her by who she considers one of her most influential mentors throughout her time at Iowa State.

"For me, it has been Stephen Gilbert, associate professor of industrial and manufacturing systems engineering," Hicks said. "He really noticed my potential in programming and brought me on as a teaching assistant and also got me into undergrad research. He was definitely my mentor."

Parks Library will always hold a special place in Hick's heart due to the memories of time spent with her brothers.

"My two brothers, we were all in engineering, so we would spend nights in the library and I will always treasure those moments," Hicks said.

Hicks encourages students to take advantage of the resources Iowa State has to offer in terms of academic help and never to let academic obstacles get the best of you.

"Don't be afraid to ask for help, because the first year is hard," Hicks said. "Tutoring is a great thing to take advantage of at Iowa State because it's really cost-effective."

Outside of engineering, Hicks can be found spending time with her dog, going out to eat with her grandma, who also lives in Ames, going to concerts and volunteering.

Post-graduation, Hicks will work full-time for Colony Brands, a company she interned with over the summer. She will be doing a job created specifically for her, as a continuous improvement analyst.

Contributed by Laurel Tiedeman/Engineering College Relations



Briley receives Staff Excellence award



Krista Briley, administrative specialist for industrial and manufacturing systems engineering, received the Iowa State University College of Engineering Staff Excellence Award during the fall 2020 virtual convocation reception.

As a nearly 30-year employee in the College of Engineering (20 years in MSE, roughly 10 years in IMSE) and this university, her dedication to her work and the Cyclones are shown in her spirit, office décor, and even her car. Krista is a journalism and mass communications graduate of Iowa State, so staying true to her alma mater is important to her. She is also a diehard fan of ISU Cyclones athletics. Iowa State Cyclone pride is always there - Loyal Forever True!

Industrial engineering team bests field at national competition for VR design

A team of Iowa State University industrial engineering students took first place in a national contest which showcased their ingenuity in the time of COVID-19.

The Iowa State team bested the field in the Data Analytics and Information Systems division of the Institute of Industrial and Systems Engineers' (IISE) Mobile/Web App Competition. The contest recognizes "creativity and excellence among its members and motivate[s] them to commercialize their research/learning outcomes to accelerate the economic and societal benefits."

In response to the adaptions made to learning during the COVID-19 pandemic, the team of Cyclone Engineers wanted to develop an online educational software to recreate the teaching laboratory experience through virtual reality (VR).

"This project is to apply VR technology to the teaching of manufacturing to improve students' lab experience and reduce the difficulty of learning machining," said Hantang

Qin, assistant professor of industrial and manufacturing systems engineering (IMSE) and faculty adviser for the team. "We have successfully developed several machines, such as drills and lathes, in this virtual software that can achieve the same function as the lab to train students."

Qin added that in the future the team hopes to further improve the software to guide students on learning machining knowledge, and make it possible for students who cannot join the physical lab to obtain the knowledge of machining. The group wants their software to be used by engineering students at other universities, not just at Iowa State. Work on this software started in 2018 as a collaboration between Qin and his group at Iowa State alongside Yi Cai, assistant professor of applied engineering technology at North Carolina Agriculture and Technology State University, and his team.

> **Below:** A virtual reality (VR) rendering of a machine shop, similar to the learning lab classrooms that are part of the industrial engineering curriculum at lowa State University.





Above: Brett Galles (left), an Undergraduate Research Assistant (URA) in industrial engineering, works with Zach Ford, URA in industrial engineering, as he explores a virtual machine shop.

Xiao Zhang, Ph.D. candidate in industrial engineering (IE) and Liangkui Jiang, Ph.D. student in IE, have both been instrumental in this effort. Xiao has mostly focused on designing and improving the 3D models, while Liangkui developed the functions of the machines. To build the system, the researchers used problem solving skills from I E 544X: Micro/Nano Scale Additive Printing as well as aspects of human-computer interaction from I E 681: Cognitive Engineering. The researchers introduced a beta version of the software to students in I E 248: Engineering System Design, Manufacturing Processes and Specifications during both the fall 2019 and fall 2020 semesters. They then took feedback from those students to improve the system.

Undergraduate research assistants also contributed directly to this effort, including: Morice Burnett, Zachary Ford, Brett Galles, Vandi Hartanto and Thomas Hotard. These contributions were made possible because of financial support from the IMSE department's undergraduate research assistant (URA) program.

Additionally, Qin and his team have been selected as a top-100 for the 2020 Create the Future Design Contest. The Create the Future Design Contest was launched in 2002 by the Society of Manufacturing Engineers – Tech Briefs magazine to help stimulate and reward engineering innovation. The annual event has attracted more than 14,000 product design ideas from engineers, entrepreneurs, and students worldwide.

Davarnia honored with Harvey J. Greenberg Research Award

Danial Davarnia, an assistant professor of industrial and manufacturing systems engineering at Iowa State University, was recently honored with a prestigious award from a top professional society in the area of operations research.

Davarnia, along with Willem-Jan van Hoeve, a professor and associate dean at Carnegie Mellon University, were recipients of the Harvey J. Greenberg Research Award, bestowed by the INFORMS Computing Society.

"I was very pleased," said Davarnia. "It is a great honor to be selected as the first recipient of this prestigious award."

Davarnia and van Hoeve were selected for this award because of their paper titled "Outer Approximation for Integer Nonlinear Programs via Decision Diagrams" which is forthcoming in the journal *Mathematical Programming*.

The authors developed a novel methodology based on the concept of decision diagrams to solve optimization problems that

involve integer variables. Through computational experiments conducted on certain synthetic and benchmark instances, they found that the



Davarnia

proposed framework can significantly outperform modern solvers in terms of solution time and quality. The findings from this research can have a wide range of applications from healthcare to supply chain management to finance.

"I am currently working on an extension of this framework that can be used to solve challenging optimization problems that appear in the energy market. The goal is to obtain high quality solutions for power generation problems more efficiently, which can in turn lead to reducing energy cost for the end consumers," said Davarnia.

Davarnia is now applying some of the findings from this research to a current project, supported by the Iowa Energy Center, which involves expanding the applicability domain of the framework to include a broader array of different problem classes.

APEX-E still gives incoming students opportunity to connect (virtually)



Pumroy

Paiton Pumroy, incoming freshman, checks a Facebook group chat. A prompt is waiting for her in the APEX-E group, connecting her with dozens of other students, professors and mentors within the program.

A prompt such as sharing your favorite food along with the recipe, or what look you decided to go with today, whether it be cozy loungewear or Zoom professional, encourages those who would have been meeting face to face to connect virtually.

APEX-E, or Academic Program for Excellence in Engineering is an eight-week program designed to help incoming multicultural freshmen kickstart their engineering education with workshops to help acclimate them not only with Iowa State, but engineering at Iowa State as well.

Students who take advantage of this opportunity stay in the dorms during the eight weeks they're enrolled in APEX-E and are given the chance to explore campus during their free time.

However, due to COVID-19, APEX-E, like most programs, was held virtually. And instead of a duration of eight weeks, it was reduced to four.

The switch to a shorter online program was enticing to Pumroy, who was hesitant about applying to a program that would take away portions of her summer.

"I was kind of on the fence about actually doing the program, because I didn't want to take away most of my summer and start college early," Pumroy said. "But when I heard it was actually online and it would be three to four times a week, that it wouldn't be my entire day, I was like, 'actually, now I want to do it.""

One of Pumroy's main goals throughout APEX-E was to step out of her comfort zone.

"That's something I definitely want to apply to college in general because sometimes I can come off as shy, or like I just won't put myself out there," said Pumroy, who is majoring in industrial engineering.

The multiple group chats she's in has helped her reach out to others and create a network that will make the transition to college and her major easier. If anything, APEX-E is helping students recognize their passion for engineering.

"I was so excited and it made me realize how fit my major is for me, I was so happy," Pumroy said.

8

IE graduate student takes 2nd place at national poster competition

Industrial engineering (IE) graduate student Saba Moeinizade did not know what to expect when the student poster competition for the INFORMS annual meeting was made virtual. She certainly was not expecting a podium finish, so she was pleasantly surprised when the judges awarded second place to her entry.

Her presentation – "A Simulationbased Optimization Approach for Improving Response in Multi-trait Genomic Selection" – was based off of a project she's been working on with a team of interdisciplinary researchers at Iowa State University. The team proposed a simulation-



based optimization approach for improving response in genomic selection while considering multiple characteristics, such as grain quality, yield, plant height and drought resistance.

"The motivation behind this work is to enhance efficiency of plant breeding programs by taking advantage of operations research methods," said Moeinizade, a Ph.D. candidate in IE. "We want to find out how to optimize selection and mating decisions in a breeding program considering multiple traits of interest."

The team's proposed algorithm focuses on optimizing genetic gain with respect to a focal trait, such as yield, while controlling the variation in multiple secondary traits, like plant height. This research, which was published in the journal *Genetics* in August 2020, brought together researchers from not only Iowa State's Department of Industrial and Manufacturing Systems Engineering (IMSE) but also the agronomy department.

Patrick S. Schnable, C.F. Curtiss Distinguished Professor in agronomy and Iowa Corn Endowed Chair in Genetics, and his graduate student Aaron Kusmec, contributed their expertise in genetics and plant breeding. IMSE associate professors Guiping Hu and Lizhi Wang provided expertise from an operations research and analytics perspective. Hu and Wang are also Moeinizade's major professors.

"This collaboration has been an invaluable experience for me," Moeinizade said. Stochastic simulation and computational optimization were the main IE techniques Moeinizade applied to her parts of the project. She said courses like I E 534: Linear Programming and I E 634: Computational Optimization provided her with the foundation to apply these techniques to other projects.

"Actually, during my first year at Iowa State, I took these two courses and one of the course projects was a competition in genomic selection which later on led to the research interests that I am pursuing today," she said.

Moeinizade completed her B.S. in IE from Amirkabir University of Technology in Iran's capital city, prior to coming to Iowa State University. She said it was the faculty and research taking place in Ames that attracted her to the institution nearly halfway across the globe.

"What attracted me to this specific program were the interesting research areas that faculty work on and also knowing that the department provides opportunities for students to work close to industry leaders to solve challenging analytics and operations research problems," she said, adding that she appreciates the opportunity to attend professional conferences in the field

Moeinizade plans to complete her studies in spring 2021. After graduation she hopes to work as a data scientist for a "fast-growing and data-oriented company."

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IMSE faculty and staff log 1735 miles during 2020 Next Step Challenge

A team of 14 faculty and staff members from Iowa State University's Department of Industrial and Manufacturing Systems Engineering (IMSE) collectively logged enough miles to walk from Voyageurs National Park in Minnesota to Black Canyon of the Gunnison National Park in Colorado – and passing through five other national parks on the trip – during their participation in the 2020 Next Step Challenge.

The team was led by Gary Mirka, university professor in IMSE. Gary's wife Jami suggested a tour of national parks as a way of tracking the team's progress from week to week. Gary Mirka, who also serves as the John Ryder Professor of Engineering, has recruited his departmental colleagues to participate in this friendly competition since 2017.

"The Next Step Challenge is a fun way for us to work as a team towards a common goal, and also develop habits for a healthy, active lifestyle," said Mirka. "Social distancing requirements of COVID-19 made this an ideal time for this type of physical activity."

The Next Step Challenge is sponsored by Live Healthy Iowa, a program of the Ames-based Iowa Sports Foundation. The program was developed "as a strategic health initiative to address the state's growing obesity problem." This year's Next Step Challenge started on Monday, September 14 and concluded on Friday, October 23. During those six weeks, participants tracked their steps using a smart watch, a FitBit or another pedometer device then logged their steps on the Live Healthy Iowa website. By the end of the competition, the IMSE team had collectively logged 1735 miles.



This map tracks the progress made by members of the industrial and manufacturing systems engineering department after they completed the 2020 Next Step Challenge. Image created using Google Maps

Participants in this year's event included: Michael Dorneich, associate professor; Jim Fay, affiliate instructor; Nick Fetty, communications specialist; Matt Frank, John B. Slater Professor in Sustainable Design & Manufacturing; Kate Garretson, administrative specialist; Guiping Hu, associate professor; Aaron Jordan, laboratory supervisor; Deb McDonough, student services specialist; Gary Mirka, John Ryder Professor of Engineering and university professor; Frank Peters, C. G. "Turk" and Joyce A. Therkildsen Professor and associate professor; Devna Popejoy-Sheriff, student services specialist; Leslie Potter, teaching professor; Sarah Ryan, Joseph Walkup Professor; and Steve Vardeman, university professor.

Three from IMSE part of Research Collaboration Catalysts for 2020-2021

Three IMSE faculty members will participate in the Research Collaboration Catalysts 2020-2021 cohort, designed to train the next generation of research team leaders.

The Research Collaboration Catalysts program is based on Team Science principles. Using evidence-based training, tools, and resources, participating Iowa State faculty will develop strong leadership skills and learn how to manage challenges that are specific to interdisciplinary collaborations to foster high-performing research teams. To participate, tenured, tenureeligible, and research term faculty had to be nominated by their supervisors as individuals who have demonstrated potential to lead future high-impact interdisciplinary research teams.

Through the course of the 2020-2021 academic year, cohort participants will interact with each other and with a variety of internal and external content experts in eight sessions to learn about and practice evidence-based means to build and lead highfunctioning, high-performing research teams.

IMSE reserachers participating include: Michael Dorneich, associate professor; Stephen Gilbert, associate professor; and Gül Kremer, professor and C.G. "Turk" and Joyce A. Therkildsen Department Chair.

Examining and mitigating musculoskeletal strains experienced by medical professionals

Surgeons and other medical professionals can develop musculoskeletal problems because of the excessive amount of time they spend on their feet and the awkward postures that they assume during their work tasks. Researchers in Iowa State University's Department of Industrial and Manufacturing Systems Engineering (IMSE) aim to better understand these issues so they can be mitigated in the future.

In a major collaborative research effort, Gary Mirka, John Ryder Professor of Engineering and a university professor in IMSE, and Susan Hallbeck, Robert D. and Patricia E. Kern Scientific Director and Professor of Healthcare Systems Engineering at Mayo Clinic, have been examining the strains on the musculoskeletal system that medical professionals such as surgeons experience when performing their work tasks.

"Exoskeletons are an intervention that has shown promise in industry for fatiguing work," said Hallbeck, who also serves as an affiliate professor in IMSE. "We are testing these same commercially available exoskeletons for ultrasound technicians and surgeons."

Emmanuel Tetteh, Ph.D. candidate in industrial engineering (IE) who is co-advised by both Mirka and Hallbeck, has been instrumental to this project and brings with him a background in biomedical engineering.

"The biomechanical load associated with awkward postures on the body segments, like the low back, neck and shoulders, can lead to fatigue and discomfort in the short-term, and careercurtailing musculoskeletal pain and disorders in the long-term," said Tetteh. "Exoskeletons are potential interventions that may reduce the biomechanical loading on body segments but their potential benefit in the operating room is unexplored."

Tetteh, who holds a B.S. in biomedical engineering from the University of Ghana and a M.S. in biomedical engineering North Carolina Agricultural and Technical State University, said the project's goal is to understand how exoskeletons can help with reducing musculoskeletal pain and disorders, using a combination of theoretical, as well as laboratory-based experimental approaches. He is utilizing design concepts he learned in the IE curriculum to create laboratory experiments that closely emulate what happens in the operating room. He is also utilizing risk assessment tools such as rapid upper limb assessment (RULA) as the core part of the theoretical modeling aspect of his research to inform the use of exoskeletons in the operating room.

This project falls within the department's research focus area of human factors and ergonomics. With his background in biomedical engineering, Tetteh said he often applies the biomechanics concepts that he's learned in coursework to his research. He said he sees commonalities in the physical ergonomics part of industrial engineering and biomechanics as a subset of biomedical engineering.

Hallbeck, who graduated with her B.S. in IE from Iowa



Above: IE Ph.D. student Pramiti Sarker (right) uses a goniometer to verify the trunk flexion angle of IE Ph.D. student Emmanuel Tetteh's torso as he simulates a surgical catheterization procedure while wearing a lead vest.

State in 1984, said that IE concepts have been applied to the healthcare field for more than a century, citing a 1916 study by an industrial engineer who pioneered time and motion study, which outlines the benefits of adding the "scrub technician" to the operating room. This technician handles the instruments for the surgeon to ensure a faster and more sanitary procedure, compared to the surgeon going it alone. Hallbeck added that collaborative projects such as the one she's involved with can do much to advance the biomedical field, much like the 1916 study.

"The partnership between Iowa State University's industrial and manufacturing systems engineering department and our program at Mayo Clinic has been beneficial for both partners. Mayo Clinic is happy to train the next generation of IEs changing health care for the better, which is the goal of the Robert D. and Patricia E. Kern Center for the Science of Health Care Delivery," Hallbeck said.

Though this project does not focus on the COVID-19 pandemic that has overtaken the country and the world, the virus has had an impact on the researchers' ability to carry out their work. When Iowa State University's campus closed down midway through the spring 2020 semester, the researchers were unable to bring human subjects into the lab which impeded their progress. However, the university has since created guidelines for conducting safe research with human subjects and lab members have been certain to follow those rules in order for them to continue their research. Any work that can be conducted remotely is done that way, and when researchers and subjects are in the lab they wear proper PPE, use hand sanitizer frequently and maintain adequate physical distancing.

Tetteh, the graduate student, plans to complete his studies at the end of spring 2021 and hopes to enter the field of academia upon graduation.

Engineers modify football helmet to reduce the spread of COVID-19



With the start of the college football season fast approaching, equipment managers for Iowa State University were searching for a way to modify the team's helmets so they would be functional for the players, while also reducing the potential spread of COVID-19. After putting out a call for help, their colleagues on the other side of campus were quick to answer.

Faculty and staff in Iowa State's Department of Industrial and Manufacturing Systems Engineering (IMSE) were the ones to answer that call. The idea first came about when IMSE teaching professor Leslie Potter was contacted by two of the football team's equipment managers, Chase Clark and Michael Dryer. They asked if Potter could assist them with creating a shield for existing players' helmets. After consulting with Gül Kremer, professor and C.G. "Turk" & Joyce A. Therkildsen Department Chair of IMSE, Potter assembled a team that included professor Matt Frank and teaching lab supervisor Aaron Jordan to design and fabricate an exact-sized plastic insert for the lower part of the helmets' facemasks in less than three weeks.

"When Chase and Michael called me, I understood immediately that the need was both urgent and real. They were talking about student and staff safety, and the deadline was short. The ISU Athletics Department has been a great academic partner for me with my I E 101 classes the past several years, and I was determined that we could reciprocate. I was so happy that we could put a team together and begin design discussions within a matter of hours," said Potter.

During the design and testing process, the researchers knew they needed something that was functional for the players and durable enough to withstand the physicality of the game while also redirecting the increased exhalations from player's noses and mouths during games and practices.

For a more in-depth look at the Cyclone Shield, check out the College of Engineering podcast - **Factor Analysis**: *www.imse.iastate.edu/cyclone-shield-pod*



12 IMSE | 2020

After participating in discussions regarding the team's needs, Potter's role included testing plans, documentation and dissemination, while Jordan and Frank took on the extensive design and prototyping required. Jordan was responsible for working on a method to make the first prototypes, and then an efficient process that would manufacture shields easily and quickly.

Frank, who also serves as the John B. Slater Professor in Sustainable Design & Manufacturing, applied his expertise in rapid manufacturing and prototyping to look at what geometry and material combination would result in a shield that could attach to a variety of facemasks with simple assembly. He was tasked with something similar toward the end of

his sabbatical with John Deere earlier this year when he helped to develop plastic face shields for Deere employees and designed a new N95 respirator along with Oak Ridge National Laboratory.

The material used for the insert in the football helmets is LEXAN[™]Polycarbonate film that is only ten-thousandth of an inch thick (0.010"). The researchers chose this particular material because of its stability, durability, and flexibility even at extreme temperatures. It is already used extensively in other similar applications like visors and helmets.

"We needed a material that was just rigid enough to hold a curved shape, yet pliable to conform to a variety of facemasks and be easy to cut and produce at a rapid manufacturing pace," said Frank.

The researchers also relied on feedback from the players while testing the prototypes. One of those players was Blake Clark, a quarterback on the team who happens to be an industrial engineering student.



From left: Michael Dryer, Leslie Potter, Matt Frank, Chase Clark and Aaron Jordan

"Engineers design for users, and getting user feedback from the beginning of a project is critical to success. We wanted player feedback as early as possible, and with our own industrial engineering student on the team, who better to provide that user perspective? Having already had Blake as a student when I taught IMSE's second year I E 222 process improvements course, I knew that he would appreciate the need for honest feedback," said Potter.

The researchers have made the "Cyclone Shield" design free and available to anyone via a public online folder, particularly for high school teams where funding and other resources might be limited. Once the materials are purchased, the shields can be made on a Cricut® cutting machine at a rate of one shield every 40 seconds. An 11-inch by 11-inch sheet of Lexan film provides enough material for three mask inserts at a cost of less than 50 cents per shield. Frank said he is ready to make additional modifications as needed.

> "We've done as much testing as we can, and early feedback from players is very positive, but the true test is when we put them through full contact practice and finally on game day. We'll be ready to make modifications based on feedback we get from players, coaches and staff and will help support them in any way we can," Frank said.

Left: Aaron Jordon, teaching lab supervisor in IMSE, develops a blueprint for the Cyclone Shield.



An engineering entrepreneur with an athlete's mindset

Gymnasts are often meticulous in their routines. They perfect their bodily mechanics to make their routine as efficient as possible. As a former student-athlete, Courtney Middelkoop is now applying this mindset to her company.

After completing her M.S. in industrial engineering (IE) in fall 2019, Middelkoop returned to her hometown in suburban Dallas, Texas and launched KOOP. KOOP is a remote consulting service that provides "convenient and innovative" solutions to help companies improve their organization.

"We observe their processes to find ways to reduce waste and unnecessary time, improve methods, and minimize hand and body movement," said Middelkoop. "Our goal is to provide our customers with a smarter way to work, ultimately saving them time and money."

Middelkoop holds both her M.S. and B.S. in IE from Iowa State University and often applies the concepts and methods she learned in the curriculum to her business. I E 222: Design & Analysis Methods for System Improvements and I E 271: Applied Ergonomics and Work Design are two of the courses she's found to be most useful in her professional life. She often applies concepts such as time studies, root cause analysis, product flow analysis, and ergonomic assessments during her day-to-day operations. Courses such as I E 430: Entrepreneurial Product Engineering and I E 434X: Entrepreneurial Product Engineering Design Project exposed her to the entrepreneurial side of engineering.

While her father, a fellow industrial engineer, is what inspired her to pursue IE, she was also inspired by some IE faculty members during her time at Iowa State. Leslie Potter, Rick Stone and Mike Helwig are three that especially standout to her.

"Leslie is a great example of a woman in engineering and she is a good inspiration for young women to follow after. Dr. Stone is a very engaging professor to listen to in class and the labs for class are hands-on which allows you to directly apply what you learn in class. And Helwig teaches great classes relating to engineering management which provide you with effective material you can use for your whole engineering career," she said.

In addition to her coursework, Middelkoop was part of the Cyclones women's gymnastics team as an undergraduate. Gymnastics, a sport in which she had competed since she was four years old, is actually what brought her to Ames. "One of my favorite memories from college was being able to be a part of

the lowa State



Middelkoop strikes an ending pose after finishing a routine during a competition inside Hilton Coliseum. Photo courtesy of Luke Lu/Kl6photo

gymnastics team. I have so many great memories to choose from and I am just thankful to have been with the program," she said.

Middelkoop maintained that competitive, athletic spirit in graduate school through her involvement in intramural sports. She and other IE students formed a broomball team and won back-to-back titles in 2018 and 2019. Her interest in athletics attracted her to the human factors and ergonomics side of IE and for her master's thesis she partnered with American Athletic Inc., a gymnastics equipment manufacturer based in Jefferson, Iowa, to analyze how gymnasts interact with different vault boards and landing mat equipment. She used qualitative and quantitative analysis methods that related to human impact, performance, and product design and testing.

Even though she now lives more than 700 miles away, Middelkoop has remained connected to the department. With the support of a grant, KOOP is helping the senior capstone class (I E 441: Industrial Engineering Design) by providing the resources to allow students to remotely monitor their partner manufacturing company's processes, as COVID-19 has prevented many teams from visiting their companies in person. In previous years, field trips to the companies were part of the project but now Middelkoop aims to provide that same experience but from the comfort of the students' home workspace.

When she's not busy working, Middelkoop is probably spending her time outdoors. She enjoys sailing, riding her bike and going on walks with Kya, her three-year-old Great Dane. She encourages other creative engineers to consider the entrepreneurial routes they might pursue with their degree after graduating.

"Act on your ideas and get connected with the entrepreneurial programs," she said. "Not only will this provide you a foundation to build upon, but you will learn a lot about yourself during the process."

Learn more about all that KOOP has to offer, visit **KOOP**

Cognitive engineering: The brain behind innovative work systems

Cognitive engineering is a unique discipline that has allowed researchers to improve many industries, including industrial systems, self-driving cars, autonomous drones, healthcare planning and virtual assistants.

Guliz Tokadli, Ph.D. candidate in Human-Computer Interaction (HCI) and Human Factors Programs, is part of this ever-evolving engineering discipline.

"Cognitive engineering studies how humans form cognitive models of a work system," Tokadli said. "It models the mental work humans do and identifies the challenges and issues in a work system. This discipline combines the skills of cognitive psychology and systems engineering. It keeps humans in the center while developing technology."

Unique blend of mind and matter

Michael Dorneich, associate professor of industrial and manufacturing systems engineering, has his research area in cognitive engineering. This research has given him a deep understanding of the subject as a whole.

"I have always considered cognitive engineering to be a blend of engineering and psychology," said Dorneich, who is also Tokadli's Ph.D. advisor. "As engineers, we want to build things. But if we are building machines, automation, or any technology that works with humans, then we should design it with the human in mind. That is where the psychology comes in."

"We know a lot about how people process information, pay attention, or not pay attention, to things and make decisions. We want to take that knowledge and apply it to the design of technology, so it works in the way people expect and need," Dorneich said. "Rather than train people to work with technology in a way that makes sense for the technology, we want to design the technology to work in the way that makes sense for humans supporting the way they think, make decisions and speak."

Complementary cognitive coursework

There are two categories of cognitive engineering courses offered at Iowa State. Some courses provide hands-on experience in designing and conducting cognitive engineering studies while other classes focus on the various, unique methods used to analyze the data from the studies.

"Having both theoretical and practical courses supports the quick, critical thinking that is necessary when doing cognitive engineering research," Tokadli said. "I think that students should be prepared to work in teams during both types of courses and be prepared to learn how to engage with human participants."



Dorneich (left) and Tokadli.

Due to the involvement of human participants in the research cognitive engineering students also study human-subject experiment ethics. Before recruiting for and conducting these experiments, the students must receive training and approval from Iowa State's Institutional Review Board (IRB). This allows the IRB to ensure the students are upholding the highest ethics, aren't violating participant rights or putting risk to their experiment plans.

"Your role as a researcher is to understand how your subject would perform their task without any bias or intervention from you," Tokadli said. "I think that one of the important skills to learn is how not to influence your participants during a study."

Driving the future at Uber

While she is a Ph.D. candidate, Tokadli is already putting her lowa State education to use on exciting cognitive engineering challenges. She is currently taking on these challenges as a UX researcher at Uber ATG.

"I do user experience research to support system development and improvement for 'Mission Specialists' – aka safety drivers – interaction with self-driving cars. For my research, I use different research methods that range from cognitive engineering to human factors to deliver results for my team," Tokadli said. "I am grateful for all of the experiences I've gained from cognitive engineering and human factors courses at Iowa State. These programs helped me prepare for my job and determine this is what I want to do in the future."

Contributed by Laurel Tiedeman/ Engineering College Relations

Online IE degree opened new doors for alum

While the COVID-19 pandemic has forced many courses to be delivered virtually, one industrial engineering alum had an entirely online learning experience prior to the pandemic and said that it served him well.



Michael Glazer completed his M.Eng. in industrial engineering (IE) in 2015. Considering he lives in the northeast, online delivery was

Glazer

the most feasible way for him to attend Iowa State University. He said it was the flexibility of the program coupled with Iowa State's strong engineering reputation that attracted him to the institution more than 3,000 miles away.

"I was interested in getting back to my industrial engineering roots and working in operations research and analytics," said Glazer. "Iowa State provided a quality online experience with the courses I wanted to take in operations research and analytics, as well as a well-regarded reputation in engineering."

Glazer grew up in Peabody, Mass., roughly 20 miles north of Boston and studied industrial engineering and operations research as an undergraduate at the University of Massachusetts Amherst. Prior to pursuing his graduate studies at Iowa State, he was working in the field of information systems. His work involved using Microsoft programming technology including .NET, SQL Server, and MS Access for various companies and some consulting projects.

Eventually he decided that pursuing his master's degree would be the next step he would need to take to advance himself professionally. He said that his graduate studies challenged him in a way that allowed him to learn without being too overwhelming. he provides data analysis for the Coast Guard's Advanced Logistics Center in Elizabeth City, N.C. He said he applies many of the operations research concepts he learned in Iowa State's IE curriculum, such as queuing analysis, statistical analysis and optimization.

He also cited I E 514: Production Scheduling with Guiping Hu and I E 534: Linear Programming with Lizhi Wang as being some of the most important courses and impactful faculty members during his time at Iowa State. Though the courses he took for his program were entirely online, he did have an opportunity to visit Ames for the first time after graduating. He said he enjoyed meeting some of the department's professors and students, and was taken aback by the beauty of the campus.

In his free time, Glazer enjoys spending time outdoors. He especially likes hiking and riding his bike on the various trails in the Virginia Beach area. He is also part of a local photography club and spends many hours shooting with his Canon DSLR camera and its various lenses.

Despite taking his classes remotely, he developed a strong connection to Iowa State during his graduate studies. He said he is proud to call Iowa State University his alma mater.

"Earning my master's degree was key in allowing me to apply and obtain the analytical roles I was looking to work in. These included operations research analyst and data science roles. My engineering degree from Iowa State University gave me the necessary knowledge to work in these fields," Glazer said.

Here is a shot Glazer took of the Thunderbirds at the annual PEASE ANGB Airshow in New Hampshire. Photo by Michael Glazer

"Going back to school after many years was a challenging and enlightening experience. I enjoyed interacting with the students on campus, and praised their help, especially with the difficult calculus problems in Stochastic Processes," he said with a laugh.

Glazer now works for BayFirst Solutions LLC as a journeyman operations research analystdata analyst. For this work



Iowa State University, John Deere collaboration advances research in hybrid manufacturing

Advancements are being made within the field of hybrid manufacturing because of a research collaboration between Iowa State University and John Deere.

Matt Frank, professor in industrial and manufacturing systems engineering, has spent the past year working alongside researchers in John Deere's Advanced Technology and Engineering group as part



Frank

of a professional development assignment, also known as sabbatical. He has reported to the Ames Technology Innovation Center, located in Iowa State's Research Park, and the Moline Technology Innovation Center on these projects which combine both design and manufacturing within the realm of additive manufacturing (AM).

"The goals of these projects are to reduce cost and lead time in delivering prototype and production solutions for the business," Frank said.

Frank, who is also the John B. Slater Professor in Sustainable Design & Manufacturing and has a Ph.D. in industrial engineering from Penn State University, is focused on a field known as hybrid manufacturing, which combines two or more processing methods to manufacture a component. For Frank, this means combining computer numerical controlled (CNC) machining with additive manufacturing.

"The challenges lie at the integration of the two methods, even more so than the individual engineering of the separate processes," said Frank. "We need to re-imagine how a part is made when a portion of the process is additive, while the other is subtractive."

As a professor focused on hybrid manufacturing, Frank said he is encouraged by the possibilities that these hybrid options provide.

"I really think combining the strengths and diminishing the weaknesses of two systems is a huge force multiplier. However, it does not mean you try to make Process A more like Process B, nor vice versa. A CNC machine will never be a 3D printer and a 3D printer will never be a CNC machine," he said.

Frank has collaborated with Deere staff on various projects for more than a decade. This initial collaboration involved developing a rapid machining center for the Service Parts Operations at John Deere Waterloo Works. The goal of the project was to create software that would enable push-button process planning for CNC machining, which was made possible because of advancements in 3D printing at that time.

Since then, Frank and Deere staff have partnered on an America Makes-funded project involving the CNC machining of 3D printed parts as well as a project for MxD, formerly called the Digital Manufacturing and Design Innovation Institute/DMDII, focused on developing software for Design for Manufacturability called "ANA." More recently, they worked together on another MxD project aimed at creating a commercially viable version of the rapid machining software that they initially developed years ago.

Frank said that while the equipment available at the Deere facilities and at lowa State is relatively similar, it is the people and the systems within each that really makes the difference.

"At Deere, you are within a world-class system at a scale and complexity that is truly extraordinary. The network of people around the globe that come together to solve complex engineering problems like they are in the same room is certainly a game-changer," he said. "We, too, have an extraordinary system and environment at Iowa State in our academic research and teaching labs. These complementary strengths create the synergies that make a public-private partnership valuable to both of us."

Eric Johnson, a senior staff engineer in John Deere's Advanced Manufacturing group who holds a Ph.D. in materials science and engineering from Iowa State, echoed Frank's sentiment.

"Collaborations such as this are an excellent example of the ways in which companies can benefit from working together with our great public universities," said Johnson. "The ability to have a world class researcher embedded within our team has provided a much deeper understanding of the technologies."

Frank returned to campus for the fall 2020 semester and brought his experience and what he learned with Deere into both his classroom and his lab.

"I encourage all faculty to consider the immersion I just experienced," Frank said. "There is so much to be gained by Iowa State from Deere, and from Iowa State by Deere. We just need to continue collaborating in more creative ways. This experience exceeded my expectation for a professional development assignment and I am very grateful for the opportunity."

IE student notches her 11th intramural championship

It's been a busy year and a half for one industrial engineering student and she may not be done yet.

Sharon Lau, a Ph.D. student in industrial engineering, recently won her 11th intramural championship as a student at Iowa State University. Lau, who first came to Iowa State in August 2017, now has four titles in mini golf (summer 2019, fall 2019, summer 2020 and fall 2020), four titles in badminton (singles – fall 2019, women's doubles – fall 2019, coed doubles – fall 2019, and singles – fall 2020), one title in broomball (fall 2019) and two titles in ping pong (women's doubles – spring 2020 and coed doubles – spring 2020).

"I just enjoy participating in these events to take a break from research and classes," she said.

Lau has been active in sports throughout much of her life. She played badminton competitively while growing up in her hometown of Kuantan in Malaysia, before an ankle injury forced her to put down the badminton racket and pick up a golf club. She played competitive golf throughout high school and was even on the Malaysian national team from 2007 to 2009.

"Being a part of the national team was one of the best times of my life," said Lau. "It taught me so many things and I am grateful that I had such supportive parents that got me involved in sports. Some of the things that I still apply to my life today are good sportsmanship, perseverance and teamwork. This means that when we are done with a tournament, we do not let our performance dictate our actions outside the golf course. We play hard no matter how bad we are doing, and we win as a team and lose as a team."

As an undergraduate at Tarleton State University in Texas, Lau was awarded a full-ride golf scholarship. She graduated in 2014

with her B.S. in manufacturing engineering and during her time there she racked up a slew of honors. She was named Division II Freshman of the Year by the National Golf Coaches Association, was a two-time Women's Academic Player of the Year in the Lone Star Conference and was awarded First Team All-Lone Star Conference honors.

IMSE | 2020

Right: Lau poses with one of her 11 t-shirts recognizing she is an intramural champion.

After graduation, she worked as an R&D product test engineer for Nike's golf division for two and a half years. However, this division was shut down in 2016 which was the catalyst for Lau's decision to go to graduate school and how she ended up at Iowa State. She completed her M.S. in IE in 2019 and decided to stick around Ames to complete her doctorate.

"I really enjoy working with Dr. Peters, fellow graduate students, and faculty and staff in the department. I also felt like there was more for me to learn and grow by staying here so it was a nobrainer for me," she said.

Lau now has her sights set on the spring and fall 2021 broomball championships. She was part of the fall 2019 championship team which included all IE students and in fall 2018, an all-IE team (not including Lau) also claimed the title. Lau said part of the team's success and consistency can be attributed to Mike Helwig, associate teaching professor for industrial and manufacturing system engineering (IMSE), who sponsors and supports the IE team each year. Helwig and Lau are currently recruiting players for this season's team.

> **Below:** Lau putts as Head Coach Jerry Doyle watches. Image courtesy of Tarleton Athletic Communications.





Lau has also proven herself to be an accomplished student and researcher. She is advised by Frank Peters, C. G. "Turk" and Joyce A. Therkildsen Professor and associate professor in IMSE, and her research focuses on advanced manufacturing. Specifically her dissertation looks at reducing measurement error associated with nondestructive testing (NDT) in the field of metal casting.

"My research focuses on one of these NDT methods, magnetic particle inspection, or MPI, which is able to detect defects at or near the metal casting's surface," said Lau. "The goal is to identify and quantify the influence of factors on the reliability of MPI and subsequently create innovative solutions to raise the capabilities of MPI to be able to improve the performance of metal castings."

As a graduate student at Iowa State, Lau has completed an internship with BUNN in Creston, Iowa and has served as a data scientist for the Ames-based Curiosity Labs. She also helped to establish the Rapid Manufacturing Club on campus and currently serves as the co-founder and president.

Lau plans to complete her studies in spring 2022 and after graduation she hopes to pursue a career in academia.

Above, right: Lau (right) presents her research to W. Samuel Easterling, dean of Iowa State University's College of Engineering, during a visit to the Slater Laboratories for Advanced Manufacturing in 2019.

Right: Lau (bottom row, left) poses with othermembers of the fall 2019 championship broomball team. **Below:** While working for Nike, Lau (circled in red) had the







Engineering a career in marketing

Longtime industrial engineering chair Joseph Walkup (1942-1973) always said, "Engineers can do anything." For industrial engineering alum Kim Ditter, that "anything" happened to be a career in marketing.

Ditter grew up in Mason City, Iowa, and because of her strengths in math, her mother encouraged her to pursue a technical field. Ditter was exposed to industrial engineering (IE) specifically through an older neighbor, who at the time was studying IE at Iowa State University. The neighbor was eager to talk about Iowa State's strong program and the career opportunities available for IEs while visiting home during breaks. This catalyst led Ditter to Ames.

"I looked at other schools, but lowa State seemed the obvious, best choice because I had such a well-respected engineering college right in my backyard with in-state tuition," said Ditter. "I was one of those rare students that started my freshman year as an IE major, and graduated with that major."

Despite being committed to IE from the start, Ditter's time was not without struggle. Physics, in particular, gave her such difficulty that she seriously considered switching majors. However, she persevered and it served as a learning opportunity for her.

"My engineering career almost ended before it even started," she said. "But nearly failing that physics class taught me what I really wanted and to persevere, even through the most challenging times."

Another memorable experience for Ditter was her senior design course with John Jackman, who is now an associate professor of industrial and manufacturing systems engineering at Iowa State but is currently on administrative leave with an appointment at NSF. Ditter described Jackman's teaching style as "strict" and said many of the concepts seemed difficult to grasp. In the end though, she said that much of what she learned was directly applicable to her work early in her career.

Her involvement in various student groups and other activities at ISU also contributed to her professional development. She held various leadership roles in her sorority, Alpha Phi. She also served on committees for Engineers-Week, Homecoming and VEISHEA. She said these experiences taught her about leadership, collaboration and conflict management, which allowed her to set herself apart from other candidates during job interviews.

Ditter completed her B.S. in IE in 1992 and was hired as a manufacturing engineer for 3M. She worked at two different manufacturing plants in Missouri but discovered she wanted to use her engineering skills to work more closely with people.

"I learned that while I loved engineering, process thinking, and designing and implementing system improvements, I was better at working with people than with machines," she said.



Left: Kim Ditter (left) poses outside of the Alumni Center with her son Nick Lees, a senior in supply chain management at Iowa State University, during the 2019 Iowa State-Northern Iowa football game.

Therefore, she transitioned from the manufacturing side of 3M to the business side, specifically marketing. In this capacity, she spent three years living in Brussels, Belgium where she led a European marketing team for a key 3M business unit. She described the

opportunity as "an amazing experience both personally and professionally."

After her stint in Europe, she landed in Saint Paul, Minnesota where she currently resides. In 2009, Ditter left 3M, "after seventeen terrific years," to work for Ecolab. Then in 2017, she became Vice President of Marketing for Coloplast, a medical device company headquartered in Denmark with its U.S. office in Minneapolis. As a marketer, Ditter said the emphasis is on the customers and understanding their needs, as well as making good business decisions for the company.

"My IE degree has been extremely helpful in giving me the skills to think analytically, translate customer needs to solutions, and make sound financial decisions," said Ditter. "In addition, having an engineering degree has given me credibility with customers in my marketing roles, whether I am talking to a plant manager about 3M products or a physician about a Coloplast solution."

Outside of work, Ditter stays busy with her triplet boys, who are all three currently seniors in college. Nick Lees is studying supply chain management at Iowa State, while Justin studies marketing at the University of North Dakota and Cooper studies communications at the University of Minnesota, Duluth. She also enjoys skiing and gardening as well as reading and is on the board for Friends of the Saint Paul Public Library.

Even though she now lives more than 200 miles away from Ames, her memories from her alma mater remain close in her heart.

"We had so many great times in the A-Phi house, and some of my best friends to this day are A-Phis. Building the VEISHEA floats each year, and the parade was always great fun, too. We also spent a lot of time at the local establishments on Welch Avenue," she said with a laugh.

Ditter said that when she was in college, she never would have seen herself on the career trajectory she is on today. She encourages today's IE students to be opened-minded about their own career possibilities, particularly if they choose not to pursue a traditional engineering career with their IE degree.

"My Iowa State engineering degree was a terrific foundation for my career. While I no longer am a practicing engineer, I use these skills every day. I owe much of my career success to Iowa State University. Loyal. Forever. True," Ditter said.

Research in nondestructive evaluation, thermal imaging leads to national award

A team of Cyclone Engineers are the recipients of a national award in part because of advancements they have made in the field of nondestructive evaluation, specifically in thermal imaging.

Hantang Qin, assistant professor of industrial and manufacturing systems engineering (IMSE) at Iowa State University, is the lead on the project titled "Data fusion approaches to improve real-time capabilities of in-situ NDE via a thermal imaging case study on a hybrid machine." Qin, who is also affiliated with Iowa State's Center for Nondestructive Evaluation (CNDE), is supported by Zhan Zhang, associate scientist with CNDE, and Xiao Zhang (no relation to Zhan), Ph.D. candidate in IMSE.

"Our research goal with this project is to utilize in-situ thermal imaging and data analytics to reduce defects during the direct energy deposition, or DED, processes," said Qin. "In this project, we will utilize thermal imaging to record the thermal history of the melting pool during manufacturing. Through correlation studies, we are trying to establish a relationship between in-situ thermal data and off-line CT data."

Qin, who also oversees the Flexible Electronics and Additive Printing Lab, said they would eventually like to predict porosity generation based on in-situ thermal information and make realtime corrective actions to ensure manufacturing quality. Zhan Zhang, who has a M.S. in nuclear engineering from Georgia Tech University, brings his expertise in CT data analytics to this project, while Xiao Zhang is exploring the possibilities of developing in-situ NDE capabilities for the DED process. Xiao Zhang said he would utilize concepts and methods from courses like I E 544: Micro/Nano Scale Additive Manufacturing and I E 547: Biomedical Design and Manufacturing for this research project.

"These two courses provided me knowledge about innovative design, cutting edge problems, and various nondestructive evaluation methods for additive manufacturing," he said.

Defects such as porosity and cracks can generate internally during the printing processes of metal additive manufacturing. The traditional method to detect such defects is CT scanning, similar to how an x-ray scans bones in humans and other animals. However, according to Qin, CT scanning equipment usually cannot scan large parts because the x-ray may not effectively penetrate the object to acquire usable scanning results. CT scanning equipment is also large in size, making it difficult to scan big metal objects.

"We are trying to utilize in-line data analytics to predict the quality of printed parts, making it possible to replace traditional CT scanning partially. What's more important, the in-situ data can be utilized to create feedback controls for the additive manufacturing systems," Qin said.

In September 2020, the trio received a 2020 Fellowship Award from the American Society of Nondestructive Testing, a professional organization focused on creating "a safer world by advancing scientific, engineering, and technical knowledge in the field of nondestructive testing." The engineers will receive \$20,000 to support their research.

"I was super excited and grateful when I heard about winning this national award," said Xiao Zhang. "It is a fantastic recognition of our lab's hard work and a great honor for my academic career."

Work on this project began in September 2020 and it will be supported through

May 2021, when Xiao Zhang plans to complete his Ph.D. After graduation he hopes to pursue a postdoctoral opportunity or a faculty position in academia.



Qin



Z. Zhang



X. Zhang

Learn more about 100 years of Industrial Engineering history at Iowa State University www.imse.iastate.edu/history-book



Engineering takes alum's career to Europe

Despite growing up in beautiful southern California, Brian Fleming chose to leave behind the sun and the beach when he came to college at Iowa State University.

Fleming did not just pick Iowa State randomly, though. He is an Iowa State University legacy as both his parents, Joe and Therese Fleming, graduated from ISU in the early 1980s. While his mother studied accounting, Brian followed in the footsteps of his father, an industrial engineer who holds his B.S. and M.S. from Iowa State.

While the industrial engineering (IE) field was somewhat familiar to him, the state of Iowa was less so. He saw this as a good thing.

"I decided early on that I didn't want to stay in California because I thought I would be too comfortable and never break out of my shell. I was a shy guy," Fleming said.

Though Fleming eventually found IE, he came in undecided as a freshman. By the end of his first semester, however, he had found a home and family in IE.

"After meeting some people within the IE field and seeing how broad the opportunities were, I declared IE as my major," said Fleming. "I think that was one of the best decisions I made during my time at ISU."

Several courses and faculty members stand out to Fleming as he reflects on his time in college. Fleming said he learned a lot about manufacturing through I E 348: Solidification Processes with Frank Peters, C. G. "Turk" and Joyce A. Therkildsen Professor in industrial and manufacturing systems engineering (IMSE). Specifically, Fleming said his understanding of materials and CNC code came to be a real asset right out of school as it helped him to build his technical vocabulary and better communicate with his colleagues. Fleming said effective communication is one key to being a great engineer.

Fleming cited I E 430: Entrepreneurial Product Engineering and I E 434X: Entrepreneurial Product Engineering Design Project, both taught by IMSE affiliate instructor Jim Fay, as also being influential in his professional development. These courses taught him more about engineering's business side, and how to listen to people and design effective products based on their needs. Fleming added that Fay has become a mentor for him and that the two remain in contact today.

Through his I E 434X course, Fleming and his team developed a product called Serona Craft Butter, which was inspired by today's robust craft beer scene. They went on to take first place and \$500 in prize money during the Engineering Pitch Competition in February 2019. After that, the team continued on to win the university-wide competition.

Fleming said that I E 305: Engineering Economic Analysis with associate professor Lizhi Wang, was perhaps the most practical class he took in college.



Brian Fleming poses while hiking along the Alps in Switzerland.

"Learning about the present versus future value of money as well as the calculations behind it has been extremely useful in both my career and my personal life, as I am fascinated by personal finance," he said.

As if his course work did not keep him busy enough, Fleming was also involved with various student organizations and other commitments. He served as an undergraduate teaching assistant (UTA) for I E 148: Information Engineering and was a student ambassador for the IMSE department as well as a peer mentor for the College of Engineering. He said helping to establish the Entrepreneurial Product Development Engineering Club is one of his proudest accomplishments, particularly since the chapter has remained active since he left campus.

Fleming completed his B.S. in IE in spring 2019 and joined Emerson Electric's Engineers in Leadership Program. This twoyear rotational program places engineers from any discipline into two one-year rotations. Fleming's first rotation actually took him halfway across the world, to Cluj, Romania. He spent the year working on continuous improvement projects for Emerson's European supply chain.

"This role allowed me to travel all over Europe for work and fun. I learned a ton about international business and what it is like to live and work in another country," Fleming said.

He returned stateside in June and began his one-year rotation as a project manager for the strategic operations team for RIDGID Tool, based in Cleveland, Ohio. He said that he hopes to stay with Emerson once his rotational program ends, and wants to eventually move over to the marketing, product management or business development side.

Much like Fleming left his comfort zone when he relocated from San Diego to Ames, he encourages others to move out of their own comfort zones when they come to college.

"Your time in college is a unique period of your life," said Fleming. "There are few other places that afford you the opportunity to learn from world-class experts, travel abroad for school, be surrounded by eager young minds and have access to many social and professional groups. Take this opportunity to push yourself out of your comfort zone. Learn difficult things, join student orgs, make connections with peers and professors and, most of all, have fun."

22

Cyclone Engineer designs safer COVID-19 office furnishings

Within a year, Evan Hundley went from sitting in an Iowa State classroom to working the frontlines of the COVID-19 pandemic on HNI's rapid response team. She accepted a position at HNI immediately following graduation in their early career development program.

HNI is a parent furniture company and a leading provider of workplace furnishings and residential building products. In recent years, the push has been to make workplaces an open collaborative environment with



Panel stacker. Photo courtesy of HNI Marketing.

everyone connected. But when COVID-19 hit, HNI saw the need to outfit offices to make work safer.

"The fact that our company has been able to pivot so quickly is really impressive. How we are able to go after helping companies keep their employees safe is really exciting and I'm really glad I got to be a part of it," said Hundley, a 2019 industrial engineering graduate.

Adjusting to the demand

Offices were scrambling to try to put separation back into their workplace to promote physical distancing. Workplaces needed creative, inexpensive quick solutions, which is why HNI formed their rapid response team.

Hundley said, "That's why this team was formed was to answer those needs and make sure we aren't only helping others come back more safely, but we are also helping our company go through this with minimal damage."

The normal production timeline is over three years from the initial design to production. HNI's rapid response team has been able to condense the timeline down to four or five weeks.

Hundley joined the team in May, about two months after it began at the beginning of COVID-19.

"We are trying to work really fast, getting these solutions out three months from now isn't fast enough. People need these solutions now," Hundley said.

Success in products

In March, HNI released its first big product: hand sanitizer stations. After seeing hand sanitizer stands were sold out

everywhere, they knew they had all the capabilities of making them. They designed it in about a week and started creating it. Once they saw the success of that product, they put the team in place to go after the other market opportunities.

Since development, the team has produced foot pulls so employees can open doors with feet instead of touching them with their hands, both freestanding and wall-mounted PPE stations, which hold different sized gloves and tissues, and multiple

different versions of screen options to add separation between workstations, panel stackers and a work from home desk.

lowa State preparation

Hundley grew up the daughter of an engineer and has always enjoyed problem-solving, math and science, which is what engineering is all about. These skills lead her to pursue engineering at Iowa State.

"Graduating with an engineering degree from Iowa State is not easy and something people should be proud of. You always face obstacles whether it be a certain class or time management, you learn how to handle yourself and deal with obstacles calmly and move on and get to a solution," Hundley said.

During her time at Iowa State, Hundley was an accomplished member of the swim team earning many accolades including Big 12 Women's Swimming and Diving Scholar-Athlete of the Year in 2019. Hundley credits both her experience in the classroom and the pool for preparing her to take on the professional challenges COVID-19 brought on.

"In swimming, sometimes you hit a wall and don't improve for years. You just have to put your head down and continue to grind through. There are a lot of times in product design where you design something, and somebody tells you it isn't going to work after putting in all this time and effort. Having that mental toughness to be able to work through challenges like that has really paid off in this position," Hundley said.

Contributed by Martha Haas/Engineering College Relations

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