Investigate SYSTEMS

IOWA STATE UNIVERSITY
Department of Industrial and Manufacturing Systems Engineering

Summer 2005

# PhD students, faculty embrace new qualifying requirement

With the 2004–2005 academic year, students completing their first year of PhD work in the Department of Industrial and Manufacturing Systems Engineering are taking a qualifying examination that focuses on their ability to do research and results in the submission to a recognized journal of a research paper co-authored with their major professor.

The new process does not require acceptance of the paper, let alone publication, but safeguards are in place to assure that only serious research efforts qualify the student to continue toward the PhD. Not only must the student's major professor verify that the candidate has done at least half of the work on the paper, the professor's co-authorship ensures that the paper is worthy of publication. A high GPA in first-year coursework is also required.

While the paper submission requirement was initiated at the recommendation of Associate Professor **John Jackman**, director of graduate studies for IMSE, the new requirement has been embraced enthusiastically by IMSE faculty at large.

"Most faculty agree that this is more indicative of whether a student can successfully complete the requirements for a PhD," says Associate Professor **Sarah Ryan**. The requirement is fairly unique in engineering programs, she notes, and will serve to distinguish and prepare IMSE PhD students to compete for top jobs in their fields. "As a result, our students are engaged in significant research activities early in their graduate program. The process also helps them to acquire good research skills and work habits."

*Following is a list of PhD students who have met the requirements, along with their article titles and journals. Major professors and submission dates are in parentheses.*

**Somchan Vuthipadadon** (Siggi Olafsson): "An Integer Programming Approach for Scheduling Inbound Calls in Call Centers," *Management Science* (March 2005)

**Ye Li** (Matt Frank): "Machinability Analysis for 3-Axis Flat-end Milling," *ASME Journal of Manufacturing Science and Engineering* (October 2004)

**Shantha Daniel** (Jo Min): "Integration of Machining and Inventory Decisions: On Cutting Speed, Order Quantity, and Reorder Point under Stochastic Demand," *International Journal of Production Research* (August 2004)

**Jie Li** (Jo Min): "Channel Coordination under Constrained Machine Time with an Option to Reduce Production Rate," *IIE Transactions* (August 2004)

**Suphalat Chittamvanich** (Sarah Ryan): "Using Forecasted Information from Early Returns of Used Products to Set Remanufacturing Capacity," *European Journal of Operational Research* (August 2004)

**Zoila Guerra de Castillo** (John Jackman): "Keystroke Biometric Identity Verification Using Hidden Markov Models," *Pattern Recognition* (June 2004)

**Thorsten Baldus** (Pat Patterson): "Study of Input Devices in Elemental Pointing in a Moving Off-road Environment," *Applied Ergonomics* (March 2004)

**Rahul Marathe** (Sarah Ryan): "On the Validity of the Geometric Brownian Motion Assumption," *The Engineering Economist* (December 2003)

**Xiaonan Li** (Siggi Olafsson): "Discovering Dispatching Rules Using Data Mining," *IIE Transactions* (July 2003)

# Research

## Statistics research helps engineers measure up

Iowa State Professor **Stephen Vardeman** doesn't mince words: "Engineers can do nothing if they can't measure," he says emphatically.

That's one reason Vardeman has been studying the interplay between statistics and metrology—the science of weights and measures. "I'm interested in what statistical tools and methods have to say about measurement systems," he explains.

One aspect of Vardeman's research seeks to determine how digital measurement may or may not affect inferences based on readings taken by engineers. He says most standard statistical methods treat numerical data as "real" observations with an infinite number of decimal places. The issue of digital resolution, he counters, can render such methods inappropriate and misleading and is a source of serious difficulty in interpreting engineering and scientific measurements.

To further explain, Vardeman poses an example: Say you take a measurement of 5.1 inches with a digital gauge that reads only to the tenth of an inch. The true measurement, however, could actually be anywhere from 5.05 to 5.15 inches, Vardeman says. And that, he adds, can make a huge difference.

IMSE Chair **Pat Patterson** agrees that engineers must be precise with their measurements. "That's where Professor Vardeman's statistical methods come in," he says. "Yes, we can measure, but how reliable is that measurement and how much do you trust that particular measurement?"

Calling himself a generalist when it comes to research, Vardeman says he works on problems that are considered useful for both engineering and hard-science applications. According to Patterson, that approach brings important practical experience into the classroom.

"Not only does he teach classes that students enjoy," Patterson says, "they obviously benefit in terms of real-world projects, coming up with real solutions and getting a chance to handle real data, which is very important for students nowadays."

Vardeman holds a joint appointment in IMSE and statistics at Iowa State and has been successful in both departments. He received the Faculty Excellence Award from the Board of Regents in 2001 and the same year was voted Teacher of the Year by the Iowa Stat-ers, a group of graduate students in statistics. He has also published three books dealing with the statistical management in engineering, including *Statistics for Engineering Problem Solving*, which won the ASEE Meriam/ Wiley Distinguished Author Award for an outstanding new engineering textbook in 1994.

Vardeman will be promoted to university professor beginning July 1, 2005.

## Sustaining resources for the future

Together with five PhD students, IMSE Associate Professors **Sarah Ryan** and **Jo Min** are leading a four-year initiative to study how we might stretch limited resources using sustainable engineering approaches.

According to Ryan, either we can stay the course we're on and make drastic changes to living standards when our resources are exhausted, or instead make smaller, more tolerable changes now to conserve those resources. "If we don't stop using up resources at the rate we're using them now," says Ryan, "we're going to run out. We need to think about using different materials and ways to reduce waste."

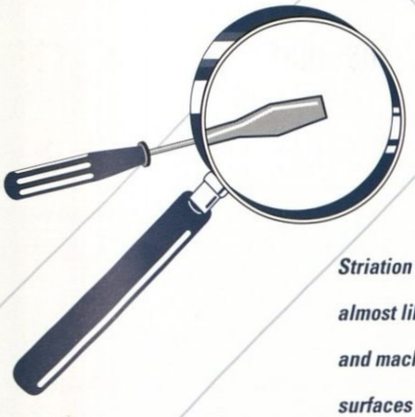
Rather than using a resource to make and sell products to customers with little regard to environmental impact, engineers must ask what happens when customers finish with products. Recycling seems logical. But few companies recycle old computers, for example, and those that do charge fees most in the U.S. are unwilling to pay.

"In Europe," Ryan observes, "there are increasing regulations that say the manufacturer has to take such items back and dispose of them in an environmentally responsible manner."

Instead of waiting for such regulation, Ryan suggests that more U.S. companies adopt voluntary strategies for environmental sustainability. Companies already doing so, she says, are gaining a competitive advantage in the global marketplace.

Engineers, Ryan feels, should emphasize product design and the manufacturing process instead of cleaning up after products go to market. And universities must do a better job of training engineering students to recognize the importance of sustainable engineering. After all, she notes, the essence of engineering lies in solving problems under constraints.

"Our students must be aware of the environmental issues and constraints," Ryan says, "and we have to take those constraints seriously."



*Striation marks are almost like a fingerprint and machined metal surfaces all have unique characteristics if you look at them microscopically, Morris explains.*

## Another CSI spin-off? No, just old-fashioned research.

It might not be as glamorous as television, but Professor **Max Morris** is working on some crime scene investigation of his own. Morris, who has a joint appointment in IMSE and statistics, conducts research that may eventually help solve certain crimes.

Suppose, he suggests, somebody breaks into a house by using a screwdriver to pry open a window. The screwdriver will leave unique scar marks, since every tool has microscopic imperfections and grooves made during its production.

Soon after the break-in, police nab a suspect with a screwdriver in his back pocket and the victim's jewelry in his toolbox. Detectives on the scene take a digital image of the scratch marks on the window and another of the suspect's screwdriver; then, crime scene investigators will compare data from the two images. Morris' research will help investigators say, with some statistical assurance, that the screwdriver in question made the marks left at the crime scene.

Striation marks are almost like a fingerprint, and machined metal surfaces all have unique characteristics if you look at them microscopically, Morris explains. "I'm trying to build an algorithm that says, 'yes, this is the tool used in the crime,' when in fact it was, or 'no, this was not the tool used,' when it wasn't."

The FBI, Morris continues, wants to build firm statistical statements so investigators can be sure that the screwdriver in question is an actual match. "That way they can quantify their answers in court because a good lawyer for the defense is always going to ask a question like, 'how can you be sure that screwdriver isn't exactly like the one my client's neighbor has?'"

Morris has a seasoned veteran helping with the research. **Jim Kreiser**, an expert in the examination of forensic evidence who recently retired from the Illinois State Crime Laboratory, goes through his investigative process in the lab, and Morris mimics that work to build algorithms. Results so far have surprised even Morris, who says the algorithms find matches that he doesn't see and throw out things he sometimes thinks are a match but in fact aren't.

The entire puzzle has many more pieces that must fit together before a crime like this can be solved, but Morris hopes that someday soon his research can help.

"There are a lot of pattern-matching problems that come out of forensic science," Morris says, "and that's what my colleagues and I at the Ames Lab have worked on for the last three or four years."

## IMSE seeks to endow new chair in sustainable engineering

Iowa State University seeks to establish itself as a leader in sustainable engineering, an emerging field critical to the health of our planet. To do that, IMSE is looking to raise $1.5 million to endow the Joseph K. Walkup Chair for Sustainable Engineering, named for the scholar who led industrial engineering at Iowa State from 1942 to 1973.

Attracting candidates with broad experience is a top priority, as the Walkup professor will work closely with industry leaders and provide expertise not currently available at Iowa State. Although the chair will be based in IMSE, interdepartmental collaborations will increase expertise in sustainable engineering throughout the university.

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# Environmental issues inform as part of Walkup Distinguished Lecture Series

**Chris Hendrickson**, co-director of the Green Design Institute and head of the Department of Civil and Environmental Engineering at Carnegie Mellon University, spoke at Iowa State on March 29 as part of the Joseph K. Walkup Distinguished Lecture Series in Industrial Engineering.

Hendrickson's presentation was an overview of research at Carnegie Mellon and included a presentation on power tool product take-back and redesign. He also introduced an economic input-output life-cycle assessment software tool at the seminar.

**Jane Ammons**, associate dean of engineering for faculty affairs at Georgia Tech, spoke about sustainable engineering last November as part of the series.

Ammons' discourse revolved around reverse production systems that support the recovery, processing, and resale of materials and subcomponents when a product's life cycle ends. The design of such systems, she said, is crucial for sustainability.

Ammons, who is also an NSF Advance Professor of Engineering at Georgia Tech, noted that more than 350,000 people work in recycling and remanufacturing worldwide, generating revenues of around $53 billion each year.

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