DISCOVERY through Simulation

Computational Modeling Revolutionizes Research
CONTENTS
Lab Notes 2
Iowa Watershed Approach 8
Cardinal Power Plant Modeling 12
Flood Forecasting 14
Naval Ship Hydrodynamics 16
Force Multiplication 18
Simulating the Sea 20
Oxbow Restorations 22
Remembering Lou Landweber 24
Profiles 26
Fiscal Year in Review 36
Parting Shot 37

Follow IIHR, the Iowa Flood Center, and the Iowa Geological Survey on social media!

Director of Development and Communications: Carmen Langel
Editor/Writer: Jacqueline Hartling Stolze
Contributing Writers: David Gooblar, Shianne Fisher
Design: Benson & Hepker Design
Photography: Aneta Goska and David Herwaldt

On the Cover: Art and engineering often converge in simulation imagery. Image created by IIHR’s Pablo Carrica and his research team
**All Things Water**

I’m proud to tell you that IIHR’s role in Iowa has only grown over the last year. Proof came from Mark Schouten, director of Iowa Homeland Security and Emergency Management. He was touring the state with Governor Terry Branstad in the wake of Iowa’s September floods (see story page 14). Mark told me that as they visited flooded communities in Eastern Iowa, they heard again and again what a difference the Iowa Flood Center has made to Iowa’s flood preparedness. To be that reliable to state leadership—that’s a good place to be!

While IIHR’s presence is growing in Iowa, we also maintain a leadership position in hydroscience and engineering across the country and around the world. In many ways, Iowa is becoming a testbed for our research, and that of other academics drawn to Iowa programs and data resources. Collectively, we are advancing the science of water to benefit all humanity.

More evidence of IIHR’s continuing success came in January 2016 when we heard the news that the state of Iowa had been awarded $96.9M to support the Iowa Watershed Approach (IWA), a statewide watershed improvement program. The Iowa Flood Center took a leadership role in writing this grant proposal to the U.S. Department of Housing and Urban Development, and we continue to lead several key IWA activities. The IWA will work to reduce flood risk, improve water quality, increase resilience, and engage stakeholders to improve the quality of life statewide (see story page 8). Stay tuned for more developments!

I am proud (and I hope you are, too) that IIHR is taking its rightful place in Iowa—our reputation as a reliable source for all things water is really blossoming. IIHR’s success in projects such as the establishment of the Iowa Flood Center, the Iowa Statewide Floodplain Mapping Project (see story page 2), the Iowa Watersheds Project, and now the Iowa Watershed Approach is causing people to take notice. They recognize that this is a place of action, vision, delivery, and reliability.

Although 2020 is still several years away, I’d like to ask you to “save the date” for IIHR’s centennial celebration, especially if you have aspirations to visit Iowa City again sometime. We have some exciting events in the planning stages, and we hope that our alumni and friends around the world will celebrate with us. In the meantime, I hope you enjoy this latest issue of *IIHR Currents* highlighting some of the many examples of simulation-based research and discovery at IIHR. From ship hydrodynamics to biofluids, flooding, and beyond, simulation is truly revolutionizing our work.

*Larry J. Weber*
Director, IIHR—Hydroscience & Engineering
Professor of Civil and Environmental Engineering
Edwin B. Green Chair in Hydraulics

*I am proud (and I hope you are, too) that IIHR is taking its rightful place in Iowa—our reputation as a reliable source for all things water is really blossoming around the state.*
Iowa Floodplain Mapping Complete
Easy-to-access, science-based information is one of the best tools we have to protect ourselves from flooding.

Working with the Iowa Department of Natural Resources (IDNR), the Iowa Flood Center team recently completed a six-year project to develop updated floodplain maps for the 85 Iowa counties that were declared Presidential Disaster Areas after the 2008 Iowa floods. The U.S. Army Corps of Engineers mapped the remaining 14 Iowa counties.

“The maps will provide Iowans with good information concerning flood risk in their communities, so they can make informed land-use and land management decisions,” says Nate Young, Associate Director of the Iowa Flood Center and the leader of the project.

The new floodplain maps provide Iowans with sound information on flood risk in their communities. The maps define the boundaries of flooded areas for 100-year (1 percent annual chance of flood) and 500-year (0.2 percent annual chance) floods. Funding from the Iowa Natural Heritage Foundation also allowed the team to create maps for 2-, 5-, 10-, 25-, 50-, and 200-year floods.

The easy-to-use Google Maps–based web interface allows Iowans to directly access information about their flood risks. The IFC developed the entire library of flood maps to meet the standards of the Federal Emergency Management Agency (FEMA). FEMA will adopt some of the maps as regulatory documents. The remaining maps are available on the website to provide accurate information to Iowans, but are not considered FEMA regulatory maps.

For more information, visit: www.iihr.uiowa.edu/iowafloodmaps

(Above) In 2016, the Iowa Flood Center completed updated floodplain maps for most of the state of Iowa, like this one of Audubon. (Left) IFC Associate Director Nate Young speaks with the media at an event held to celebrate the completion of the floodplain mapping project.
IFC and NASA Study Soil Moisture

Farmers are understandably fascinated by soil moisture—after all, nothing grows without water. Last summer, students and researchers at the Iowa Flood Center (IFC) helped carry out a NASA soil moisture research project designed to help us better understand and monitor soil moisture in an agricultural landscape.

The IFC was part of a team comparing data collected by NASA’s Soil Moisture Active Passive (SMAP) satellite to information gathered on the ground near Ames in a tributary of the Iowa River. The goal was to learn the effects of vegetation and agricultural practices on satellite-based soil moisture measurements.

The SMAP satellite images Earth’s surface at a specific microwave radiation wavelength that allows the satellite to “see” through vegetation and into the soil. As the water in the soil increases, the Earth’s surface looks darker to SMAP.

“As with many remote-sensing products, there is a continued need for evaluation,” says IFC Director Witold Krajewski. The Iowa River tributary was one of several SMAP validation sites around the world. Researchers here set out to answer a specific question: How do the state’s abundant crops, which also contain water, affect the accuracy of the satellite’s soil moisture data?

Instrumentation is important, but so is the human element, says Tom Jackson, hydrologist and SMAP science team validation lead with the U. S. Department of Agriculture, Agricultural Research Service’s Hydrology and Remote Sensing Lab. “You need people who are not afraid to get dirty and have some appreciation of the scientific process,” he says.

In May and early June, four IFC students “got dirty” as part of Phase I, which brought together researchers from around the state to deploy and maintain the soil-moisture instruments when crops were just emerging. The next phase got underway in early August, gathering similar data when the crops were fully developed.

IIHR graduate student Andre Della Libera Zanchetta says he appreciated the opportunity to work in the field. When working for hours in front of a computer, he says, it’s easy to forget you’re dealing with real-world data, from elements that can be touched and sensed. “Measuring them in the field was the perfect way to remind us of that,” he says.

Besides operating rainfall measuring instruments provided by NASA, the IFC team also deployed two mobile X-band polarimetric radars to study rainfall.

“Understanding the rainfall variability gives you an idea how much water gets into the soil and how it dries out,” Krajewski says.
A Flume for Cy
If flumes were cars, this one would be a Mercedes-Benz.

The cardinal and gold flume lives in the heart of Cyclone country, in the Agriculture and Biosystems Engineering Department’s Hydrology Laboratory at Iowa State University (ISU). Commissioned by ISU and designed and built by engineers and staff at IIHR—Hydroscience & Engineering, the flume offers a very high level of control and instrumentation.

Researchers at ISU turned to IIHR because they were aware of the institute’s high level of expertise in the area of flume design and fabrication. “It’s a really nice state-of-the-art system,” says IIHR Director of Engineering Services Troy Lyons. “It’s one that we’re all very proud of. The guys worked incredibly hard on it and did a really nice job of putting it together.”

Hydraulic Engineer Andy Craig designed the flume, working closely with draftsman Jason Knox. Shop Manager Brandon Barquist led the team that built and fabricated the flume. Craig says he was proud of how the team overcame the project’s technical challenges. “I’m very happy with the resulting product and look forward to seeing what the ISU researchers produce with the new flume.”

IIHR staff first constructed the flume in the shop in Iowa City. The flume was designed in pieces so it could be disassembled, moved to Ames, transported to the basement level of the new facility, and reassembled on-site.

The new tilting flume is fully instrumented with an integrated computer interface that reads all the data signals from the flow meter, inclinometer, and other instruments (implemented by IIHR’s Mark Wilson and Jim Niemeier). “If you’re collecting data,” Lyons says, “you have all the variables recorded in real-time.”

ISU Associate Professor of Agricultural and Biosystems Engineering Michelle Soupir says she and her colleagues are very pleased with their new flume. She explains that they’re especially interested in simulating low-flow systems, and this flume allows them to do that. “It’s really amazing what they came up with,” she says.

If “flume envy” is a thing, researchers at IIHR might have it. “They got a really nice flume,” Lyons says. “I’d love to have one just like it.”
Not Your Typical Engineering Degree

A new graduate program in the Department of Civil and Environmental Engineering at the University of Iowa will offer a revolutionary new approach to engineering education: the Sustainable Water Development (SWD) Graduate Program. With $3M in funding from the National Science Foundation Research Traineeship program, the SWD program will prepare students to meet the resource challenges of communities most in need of professional engineers, researchers, or educators.

“This is not a ‘one-size-fits-all’ MS/PhD program,” says Michelle Scherer, a professor in the Department of Civil and Environmental Engineering.

“Students can tailor the curriculum to fit their unique interests and career goals — everything from politics to public health, chemistry to microbiology, and informatics to entrepreneurship and beyond — all while earning a generous student stipend.” Scherer is co-PI on the grant with David Cwiertny; both are faculty members in civil and environmental engineering and faculty affiliates of IIHR.

SWD students will conduct innovative research at the food, energy, and water nexus, focusing on the impacts of climate change, resource recovery from waste, technologies for sustainable and healthy communities, and more. Community service and professional development, including immersive internships, will complement the research.

This is the only NRT-funded training program of its kind in Iowa. Learn more at the SWD website: waterhawks.uiowa.edu.
Family Tree
Three owlets in a nest near Lone Tree, Iowa.
PHOTO BY CHING-LONG LIN
Before the first plow turned over Iowa’s lush grassland, the deep-rooted tall grass prairie stabilized the thick black topsoil. These roots held water like a sponge, slowing runoff.

Today, water flows much more rapidly through the landscape, almost like water spinning down a drain. These accelerated flows erode topsoil, transport nitrogen fertilizer away from crops and into rivers and streams, and flood nearby roads, cities, and farms.

Iowa’s watersheds have lost much of their natural resiliency. More frequent extreme rainfall events affect peak water flows, flooding, and water quality. Tiled fields and straightened waterways move water more quickly, which heightens flooding risks. Nutrients (nitrogen and phosphorus) also move through the waterways, especially during flood events, affecting water quality and impacting drinking water supplies, recreation, tourism, and biodiversity.

A Return to Resiliency
The Iowa Watershed Approach (IWA) is a new statewide watershed improvement program designed to slow down the movement of water through the landscape by strategically building farm ponds, wetlands, and other conservation practices in the watershed. IWA researchers hope to restore some of Iowa’s natural resiliency to heavy rainfall, while also improving water quality, adding natural beauty to the landscape, creating wildlife habitat, and restoring ecosystem services.

The U.S. Department of Housing and Urban Development awarded the state of Iowa almost $100M for the IWA, which is a collaboration of many organizations and agencies statewide, including the Iowa Flood Center (IFC) (see sidebar, page 11).

The IFC played an important role in developing the project proposal. IIHR—Hydroscience & Engineering Director Larry Weber compares the process to a game of high-stakes poker. “We were all in,” he says. “We put in every effort—we put every chip on the table.”

The gamble paid off. The state now has five years of funding with which to improve eight rural watersheds and support flood-related infrastructure improvements in three Iowa cities. A new resilience component will focus on the human aspects of flooding. The emphasis on resilience acknowledges that flooding doesn’t just destroy buildings and infrastructure, Weber says. “It destroys lives.”

The IWA’s systems-based approach includes a hydrologic assessment of the watershed, planning, monitoring, modeling, implementing conservation projects, and more. One of the unique aspects of the IWA is its collaborative approach, bringing together groups and constituents from across the state. “This Iowa Watershed Approach is about everybody coming in and lifting a little bit for the benefit of the greater all, if you will,” Weber says.
The IWA in a Nutshell

The IWA represents a vision for Iowa’s future that voluntarily engages stakeholders throughout the watershed to achieve common goals, while moving toward a more resilient state. It is a replicable model for other communities where the landscape has lost its natural resilience to floods. This program is not only about Iowans helping Iowans, but also about demonstrating Iowans’ commitment to agricultural stewardship, to the environment, to their neighbors, and to the future. The goals of the IWA include the following:

• Reduction of flood risk;
• Improvement in water quality;
• Increased resilience;
• Engagement of stakeholders through collaboration, outreach, and education;
• Improved quality of life and health for Iowans; and
• Development of a replicable program.
Simulating the Watershed

Computer simulations of the watershed are a key aspect of the project. Researchers will model relatively large-scale watersheds using a detailed, distributed, physically-based model. Weber and his team have chosen the Penn State Integrated Hydrologic Model (PIHM), an open-source code with an extensive community of users. The model describes the watershed in detail and calculates surface runoff, infiltration, soil moisture, and more. “It not only relates to the physical landscape,” Weber says, “It also describes that physical landscape with first principles—fundamental equations that govern water movement in the natural environment.”

Using this detailed model requires lots of computing power and time. But it’s worth it, Weber says. “You get a lot more out of it,” he explains. “It’s more science-based—it leaves less to the modeler and his or her interpretation.”

In basic terms, the computer model is a simplification of reality, says Assistant Research Engineer Antonio Arenas. “Depending on how much you simplify, you lose certain things, but you might gain others,” he explains. It’s a balancing act: the modeler has to weigh the desire for more detail versus the additional computing time required. You can’t capture everything. “But we hope to capture the important features—the most relevant ones for the problem we are trying to analyze,” Arenas says.

One of the most vital aspects is the model’s ability to quantify the effects of agricultural best management practices (BMPs) on water quantity and quality. PIHM permits customizations that will allow the IWA team to do just that.

“WE HAD A VISION. PEOPLE GOT IT, AND THEY BOUGHT INTO THAT VISION.”

IIHR Director Larry Weber
The Human Touch
The Iowa Watershed Approach is an interesting mix of advanced technological tools and old-fashioned human interactions. Weber and his colleagues travel the state for meetings with partners and stakeholders in all the watersheds. In the beginning, Weber says, he had to “sell” the IWA to local landowners, some of whom were just a bit skeptical. It didn’t take long, though, before people began to share his excitement.

“We had a vision,” Weber says. “People got it, and they bought into the vision.”

Arenas says he is happy to attend the meetings, even though it involves time away from his young family. “It’s something I personally appreciate,” he says. “Having the opportunity to talk to people on the ground—it gives you a sense of accomplishment that other projects cannot give you.”

He says Iowans are eager to be part of the new project. “People are extremely engaged,” he says. “They are grateful and appreciative for what we can do.” And since participation is voluntary, landowners can make their own decisions about the benefits of the IWA. “They have to raise their hands and say, yes, I’m all for it,” Arenas explains. “We are not there to tell anyone you have to do this or that. That is not the Iowa Watershed Approach.

“But at the end of the day, the message is OK, we have a plan, and we are happy you are engaged with us,” he continues. “We want to work with you. And there is more to come.”

The Iowa Watersheds Project: A Roadmap for IWA
IIHR—Hydroscience & Engineering recently successfully completed a similar five-year watershed improvement project, the Iowa Watersheds Project (IWP), which served as a roadmap for the new project. In collaboration with local stakeholders, IWP researchers developed a hydrologic assessment for each watershed, and landowners voluntarily stepped up to construct farm ponds, wetlands, terraces, and other conservation practices on their property. Landowners received 75 percent cost share assistance. In five years, the project established more than 100 conservation practices in three sub-watersheds. The documented success of the IWP gave a boost to Iowa’s successful IWA proposal.

IWA Partners
The IWA program is a collaboration of numerous agencies, universities, nonprofits, and municipalities, including:
- Iowa Economic Development Authority
- Iowa Homeland Security & Emergency Management
- University of Iowa/Iowa Flood Center
- Iowa State University/ISU Extension/Iowa Water Center/Iowa Nutrient Research Center
- University of Northern Iowa/Tallgrass Prairie Center
- Iowa Department of Agriculture & Land Stewardship
- Iowa Department of Natural Resources
- Natural Resources Conservation Service
- Local Soil & Water Conservation Districts
- The Nature Conservancy
- Iowa Natural Heritage Foundation
- Iowa Soybean Association
- Iowa Corn Growers Association
- Iowa Farm Bureau
- Iowa Agriculture Water Alliance
- Local Resource Conservation & Development offices
- Iowa Department of Transportation
- Iowa Association of Counties
- Silver Jackets Flood Risk Management Team
- City of Dubuque, Iowa
- City of Coralville, Iowa
- City of Storm Lake, Iowa

IWA Watersheds
Bee Branch Creek, Dubuque
Upper Iowa River
Upper Wapsipinicon River
Middle Cedar River
Clear Creek
English River
North Raccoon River
West Nishnabotna River
East Nishnabotna River
Marcela Politano needed to sleep, but even as she lay in bed, her mind couldn’t let go of her latest project — a computer simulation of the Cardinal power plant on the Ohio River. In her dreams, she had a bird’s-eye view of the river below near the Cardinal plant, which she had been modeling.

Suddenly, she jerked awake and hurried to her computer. The IIHR research engineer didn’t want to risk going back to sleep and losing the ideas her dreaming mind had created.

“I was working full-time on the Cardinal project, day and night,” Politano says. “It was a very demanding project for us.”

Simulating Sediment
IIHR—Hydroscience & Engineering is completing a multi-faceted research effort for American Electric Power (AEP) that includes a physical model of the Cardinal plant as well as computer simulations. The power plant draws cooling water from the Ohio River, but AEP has a sediment problem in the forebay area near the intakes. Every five years or so, the company must dredge the forebay to allow the water to flow in unimpeded — a costly proposition. AEP hired IIHR to model the site and test mitigation strategies to reduce the sediment problem.

In addition, a new U.S. Environmental Protection Agency rule requires companies that draw water from the river to protect fish, fish larvae, and other aquatic organisms. If the velocity of the intake water is too fast, fish larvae and other small creatures can be swept in, and bigger creatures can get stuck on the screens that cover the intakes. To comply with the rule, AEP asked IIHR to test new screen configurations in the forebay that meet the new velocity criteria.
A Model is Born

IIHR Director of Engineering Services Troy Lyons says that his team traveled to the site to collect bathymetry (riverbed topography) data needed to build the 1:24 scale model of the riverbed near the plant. While there, they also gathered velocity, sediment, temperature, and water-quality data.

Back in Iowa, the team used the information to build the Cardinal model in IIHR’s James Street facility. “We replicated everything exactly how it was in the field,” Lyons says.

They then used the model to test several options to try to slow the sediment deposition: vanes, walls, submerged walls, and more. Each test runs continuously for 12 hours. The team meticulously set the river flow rate, intake flows, and the amount of sediment to simulate what would occur in the plant’s forebay. At the end of each test, they used a laser scanner to produce a contour map of the surface. Lyons says they compared the new scans to those taken before the test. “By looking at the difference, we know exactly how much and where sediment was deposited, scoured, or changed,” he says.

IIHR is uniquely prepared for this sort of project, Lyons says. “We have a lot of experience with structures in rivers and mitigating sediment, especially Jacob Odgaard, who has spent his entire career studying rivers.” The IIHR shop staff, led by Brandon Barquist, also has specialized expertise in precision model construction.

Politano’s fully three-dimensional computer simulations (based on FLUENT, with several add-on functions Politano wrote herself) ran parallel to the physical testing at James Street. Each form of modeling offers strengths and limitations. For instance, it is impossible to scale the sediment particle size exactly in the physical model. “You can’t just scale a grain of sand 1:24,” Lyons says. “You’d end up with clay.” The team used ground-up acrylic material to simulate sediment, which Lyons says minimizes the scale effect. The physical model also allows researchers to study erosion and deposition of sediment, which can influence flow patterns during the course of a test.

On the other hand, researchers can run computer simulations full-scale, using actual particle sizes and densities. But the current numerical model computer simulation doesn’t demonstrate erosion or deposition in the same way that physical model does.

“They’re both powerful tools,” Lyons says. “They can be used together, and there are ways to compare the data side by side. But you have to be very careful to understand the differences.”

Heating Up

One strength of the computer simulation is its ability to model temperature differences. “It turns out that was a very important factor that we didn’t see at the beginning of the project,” Lyons says. The team noticed a significant recirculation effect in the field data from the Ohio River. Water was leaving the plant and recirculating into the forebay, bringing with it water that was warmer than normal river water. Obviously, this was a problem.

“Neither of our models predicted it,” Lyons says. “When we added a thermal component to the CFD model, all of a sudden, it matched! It was incredible.”

By simulating various options and integrating both models — computer and physical — the IIHR team was able to recommend two potential options to AEP. “It’s been a really fun project,” Lyons says. “Thinking through the process, doing the engineering, understanding the science behind it — it was fun.”

Politano agrees. She says that every time she takes on a new challenge, she finds herself deeply involved in the work. “It was the first time I worked with sediment in this way,” she says. “It is my new passion!”
In September of 2016, people in Cedar Rapids were preparing for the worst. Rainstorms of 10 inches or more had drenched northeast Iowa, and the wall of water was headed downstream. Cedar Rapids was in the crosshairs of another massive flood.

The National Weather Service was predicting a 23-foot crest on Tuesday, Sept. 27 (later revised to 22 feet). The city shifted into overdrive in the days before the crest. Residents and officials deployed more than 10 miles of sand and earthen barriers to successfully protect the city, including a quarter of a million sandbags.

Meanwhile, at the Iowa Flood Center (IFC), Ricardo Mantilla was running the IFC flood prediction model. Mantilla, who is a research engineer at IIHR and an assistant professor of civil and environmental engineering, says that four days in advance, the IFC model was predicting a crest of 22 feet in Cedar Rapids. If two more inches of rain fell over the weekend, the model predicted a crest of 26 feet.

“It didn’t rain on Saturday (Sept. 24),” Mantilla says. “Our prediction, made on Friday, was right on the spot. It was amazing.” He admits that the IFC model predicted the arrival of the crest in Cedar Rapids a day early, which tells him that the model needs a bit more refinement.

Still, Mantilla is encouraged. “We have more and more evidence that we are on a good path,” he says.

Welcome to Iowa
Mantilla, a native of Colombia, arrived at the University of Iowa as a postdoc just in time to experience the flood of 2008. It was, he says, a defining moment in his life. He interpreted the flood as a signal to shift his research to applied science—the science of flood prediction.
“I came to Iowa with a lot of understanding about how water moved in rivers, how river networks shape flows. I thought it was a good opportunity to put that knowledge to work,” Mantilla says.

In 2009, IFC Director Witold Krajewski was formulating a vision for the Iowa Flood Center to study flooding and create new tools to predict and communicate flood risk. Mantilla’s PhD work at the University of Colorado-Boulder had focused on surface hydrology and water transport geographical information systems. He says it was a natural transition to direct his efforts specifically to Iowa’s river networks.

Expanding the model to include the entire state of Iowa was a major challenge, but with the help of mathematicians such as Scott Small, the team was able to develop tools to see flows on the statewide scale. They call their model HLM-Async; HLM stands for Hillslope Link Model, and Async is the numerical equation solver that runs on high-performance computers.

“The scientific challenges were difficult, and they still are today,” Mantilla says. Nevertheless, he calls the flood of 2016 a small success story, because the systems worked, producing reasonably accurate predictions as the flood was happening.

A Forecast for Cedar Bluff
HLM-Async is a distributed model, designed to make predictions accurately and consistently, all the time, throughout the state. “That’s not an easy task,” Mantilla says. “I think the Iowa Flood Center is definitely at the forefront of that in the world.”

Proof came when the National Weather Service (NWS), which makes point flood forecasts for specific cities, asked the IFC for help in the most recent flood. The NWS asked what HLM-Async was saying for Cedar Bluff, a tiny town southeast of Cedar Rapids.

“They wanted the number, and we were able to produce a number,” Mantilla says. “We were an extra source of information, and I think that’s where we want to be.”

Mantilla says he continues to be fascinated by water and river networks. The math and physics he uses to understand water movement are the same math and physics needed to understand complex systems such as the economy or society in general, he says. “Everything that matters—love, food, water—I can always connect what I know to these aspects of life.”
Fred Stern, a well-turned-out figure who favors sweater vests and neckties, might not look much like a revolutionary. However, he is a key figure in the virtual revolution that is modernizing naval ship design.

Stern believes computer simulation is transforming engineering. It’s a revolution taking place in the computational world, where sophisticated software codes simulate movement—in this case, the movement of water around ships.

Researchers use applied mathematics, physics, and computational software to simulate and visualize how water flows around an object, such as a ship or submarine. Computational fluid dynamics, or CFD, is based on the Navier-Stokes equations, which describe the relationships between velocity, pressure, temperature, and density of a moving fluid.

A Virtual Revolution

When Stern arrived at IIHR in 1983, he found himself on the frontlines of this simulation revolution.

According to *Flowing through Time*, by Cornelia F. Mutel, former IIHR Director V.C. Patel had opened up a world of possibilities through his own revolutionary research, which used computational techniques to apply the full-blown Navier-Stokes equations, coupled with turbulence modeling, to flows around ships.
Stern, who is now the Ashton Professor of Hydroscience and Engineering and an IIHR research engineer, developed his first code with PhD students using viscous-inviscid interaction techniques. They then moved on to RANSTERN, a computer code that included the free surface, or the waves generated at the boundary between water and air.

**CFDShip-Iowa**

Over time and step by step, Stern and his team advanced their code, adding more features with each new version. The focus, he says, has always been on accuracy—the science and technology—rather than on industrial applications.

By 1994, Stern and his colleagues had completed a code—CFDShip-Iowa—that would change the world of ship hydrodynamics. “Our codes had developed very rapidly, to the point that we were able to predict the exact trajectory of the model, including rudders and rotating propellers,” he says. Created with funding from the Office of Naval Research, CFDShip-Iowa is a general-purpose computational fluid dynamics simulation software that is widely used today by the U.S. Navy, university laboratories, and industry.

Stern says CFDShip-Iowa continues to evolve and grow. “We’re still developing it as we speak.”

**A Three-Pronged Approach**

Simulation alone is not enough, however. “A key feature for us was integrating CFD with the experiments—the towing tank and now the wave basin,” Stern explains. “It’s the CFD, the experiments, and uncertainty analysis that, taken together, make our approach so strong,” he says.

By thoroughly exploring these three critical areas, the IIHR team has developed a successful formula for simulation-based ship hydrodynamics.

**Aristotle’s Logic + Galileo’s Observations = ?**

Stern says that simulation-based design (SBD) is the future of engineering. “We can simulate things we can’t measure,” he explains. He believes that SBD will eventually bring about a major shift in the scientific method.

The Greek philosopher and scientist Aristotle based everything on logic, Stern explains. “He thought men and women had a different number of teeth in their mouths,” he says. “That’s one of my favorite stories. Of course, they don’t.” Aristotle could easily have seen his own error if he had just looked in his wife’s mouth—but no. His approach depended on logic, with no validation.

Fast forward a couple of centuries to Galileo, who relied on validation, experimentation, and physical observations. “But there are limits there, too,” Stern says. He believes that simulation-based design hearkens back to the logic of Aristotle, but coupled with the experiments of Galileo. It’s the best of both worlds.

Stern calls this “the engine of simulation-based design.” For IIHR’s internationally renowned ship hydrodynamics program, it’s an engine that promises to power many more exciting future developments.
Force Multiplication

IIHR’s Sarah Vigmostad and H.S. Udaykumar make a great team—at home and at work.

By David Gooblar
If you saw him trying to fix anything in the house, you’ll know he’s not an engineer.” So says Sarah Vigmostad of her husband H.S. Udaykumar (known as Uday) as he laughs and agrees. In truth, both are engineers—she in the biomedical engineering department, he in mechanical and industrial engineering—and both are important members of IIHR—Hydroscience & Engineering. But if you hear them tell it, Vigmostad’s the engineer, looking to find solutions to tricky problems with real-world applications, Uday’s the theory guy. “I don’t like nuts and bolts,” he says. “They irritate me.”

The Side Project that Took Center Stage

Much of Uday’s research is indeed theoretical. He has published extensively on computational physics, using mathematical and numerical models to better understand physical processes that range from the solidification of matter to the impact of a meteorite collision.

But he has spent a lot of time in recent years on what he calls his “side project”: an interdisciplinary effort to help improve the efficiency and reduce the environmental impact of the three-stone hearth, the wood-burning stove used by billions of people worldwide. After attempting to introduce solar-powered high-efficiency cookstoves—an effort that failed mostly due to the devices’ high cost—Uday and his collaborators came up with an ingenious solution: a $1 metal insert that separates ash from wood, doubling the hearths’ efficiency and cutting pollutants by almost a factor of 10. The insert has so far been distributed to thousands of people in India, Kenya, and Ghana, and Uday and a team of researchers from across the university will return to India this winter to do additional work on the project.

Although he thinks of this undertaking as separate from his main research, Uday is adamant that it’s more meaningful than almost anything he does. He speaks excitedly of the effects this “side project” can have on the quality of life of so many people. “In terms of its importance to me,” he maintains, “it’s a central project.”

Fluid Mechanics in the Bloodstream

Vigmostad, too, is devoted to using her research to help people. Through a collaboration with UI cancer biologist Michael Henry, she began studying the way cancer cells survive the stresses of traversing the bloodstream as they metastasize and spread to different parts of the body. Through this collaboration and the insights they gained by studying these cells and how they respond to fluid stresses, Vigmostad and Henry are now working to develop medical devices that can discriminate between benign and malignant cancer cells to better diagnose and treat cancer.

She is also studying solutions to issues around treatment of cardiovascular disease. She is working to create a surgical simulation that uses computational models to help surgeons try out various approaches before surgery. The tool, she says, will allow a surgeon to “look at a particular patient’s physiology, look at their diseased valve, and determine through trial and error—on a simulation rather than on a patient on the operating table—what the best way to repair that valve is.”

Making an Impact

Given how committed both Uday and Vigmostad are to research applications that help people, it’s not surprising to hear them say that the most meaningful and valuable part of their jobs is that they get to help the students they work with every day. “I think the thing that really gives us both a great deal of satisfaction,” Uday told me, “is the impact we have on other people.” Uday may profess a dislike of “nuts and bolts,” but it’s clear that the day-to-day life of the mind, the hands-on interactions with undergraduates and graduate students, is what keeps both of these engineers going.

“The most impact we have is on the students,” Uday continued. “Think about the force multiplication: you’re just one person, but you impact hundreds of people who are going out and doing great things, and who in turn will help others.”
ART AND ENGINEERING SOMETIMES CONVERGE IN COMPUTATIONAL FLUID DYNAMICS IMAGERY.

- (Clockwise from top; all computations performed with the IIHR CFD code REX) Notional submarine Joubert BB2 in controlled turn maneuver. An autopilot actuates the propeller, sail, and stern planes to control speed, depth, and pitch angle. Vortical structures are shown as isosurfaces of the second invariant of the rate of strain tensor.

- Airflow on the superstructure of the ONR Tumblehome advancing in waves.

- Flow around the U.S. Navy Athena Research Vessel advancing in a stratified background in self-propulsion at 10.5 knots.

- IIHR faculty researcher Pablo Carrica leads a research group focusing on interactions between ships and water.
It all happens in seconds. The plane is flying at 140 knots (161 mph), the runway is only 300 feet long, and beyond that for miles and miles is nothing but sea. There’s no margin for error. Oh, and the runway is not a fixed object—it’s in constant, unpredictable motion.

Landing a plane on an aircraft carrier—often described as a Navy pilot’s toughest task—is a harrowing job requiring negotiation of a dizzying array of variables: how fast the plane is moving, what angle it’s coming in at, how fast the carrier is moving, and how the carrier is pitching (front-to-back movement), rolling (side-to-side movement), and yawing (up-and-down movement) in the waves, to mention just a few.

Now imagine that it’s not an expertly trained pilot landing the plane, but an on-board computer on an unmanned aircraft. How do you program a computer to perform such a task?

Strength through Adaptability

Working with IHRR’s James Buchholz, Pablo Carrica’s research group is investigating this question and others with funding from the U.S. Navy. The center of Carrica’s work is REX, a computational fluid dynamics code that models the interactions between ships and water. Developed over many years, REX focuses on motion simulation, modeling the movement of ships and submarines in dynamic and often turbulent marine environments. Its strength, Carrica says, is its adaptability. “There are many, many applications, and many of these capabilities are unique in the world.

We work with the Navy, trying to add capabilities that are useful for Navy applications.” Those applications tackle some of the trickiest problems of managing hugely expensive ships and aircraft and the seemingly unpredictable sea.

Among the things REX can do is help to understand the nature of submarine and ship “bubbly wakes”—the huge trails of tiny bubbles that extend behind a moving ship. This bubbly wake can become a miles-long target detectable with acoustic sensors.

The Navy is interested in better understanding how those bubbles are formed, how they cluster and break up, and how ship and submarine maneuvers might affect the features of that wake. With the work Carrica and his research group are doing, the Navy hopes to be able to design maneuvers that will allow naval vessels to evade threats.

Powerful Calculations

There’s also the matter of that unmanned aircraft trying to land on a surface ship or aircraft carrier. With the increased military use of such drones, the capability to land them in extreme circumstances is more and more important. Carrica and his research group are working on the problem by simulating the dynamic interface between the moving ship, the water, the wind, and the aircraft. REX’s powerful calculations of these factors help the Navy develop simulators to train pilots to land at sea, as well as the autopilot technology that could help drones land successfully.

Carrica estimates that 90 percent of his research group’s work is on projects for the Navy. It’s no surprise the Navy would have so much work for Carrica and his team to do, given the difficulty and uncertainty of operating in maritime environments, and given the impressive capabilities of REX. “REX is one of the most capable codes in the world for naval hydrodynamics applications,” Carrica explains. “We’ve been working for many years adding these capabilities, and the result is a code that can do a lot of things.”
Before Europeans arrived in Iowa, the state’s streams were shallow and often spilled out of their banks after a heavy rain. Most of the time, though, they meandered lazily across the rolling landscape, taking their time to reach the eventual destination.

When Iowans straightened rivers and creeks in the 20th century, they likely didn’t understand the chain reaction they had set in motion. They simply wanted to make their land easier to farm. But according to IIHR Research Engineer Chris Jones, the straightened dredge ditches of today are disconnected from the floodplain and have lost much of their ability to process nutrients. The water moves faster, eroding downward and increasing the flood risk downstream.

A Haven for Wildlife

Jones says that although it is impossible to re-meander all of Iowa’s streams, it is feasible to restore some of the oxbows that have been lost over the last century or so. An oxbow is usually in the shape of a horseshoe or a C because it’s a historic river bend, cut off from the main channel most of the time. Restored oxbows can re-establish part of the ecological function of the system while also providing habitat for the fish, birds, reptiles, and amphibians that like these quiet backwaters. Oxbows can also process nutrients, and they’re surprisingly affordable.

“Habitat projects tend to be really expensive because they involve land retirement,” Jones says. But oxbow restorations are usually on land in the floodplain that is unusable anyway. “It’s very cheap habitat—$10,000 to $15,000 to restore one of these,” he explains. Crews with earth-moving equipment remove the accumulation of sediment down to the native sands and gravels that were once the river bottom. The oxbow then fills in with water, and that’s pretty much it, Jones says.

He’s part of a project to restore an oxbow in Morgan Creek Park in Linn County—the first restored oxbow in eastern Iowa. A nearby trail makes the Morgan Creek site accessible to hikers, and Linn County Conservation staff have reseeded the surroundings with beneficial plants. “It’ll provide opportunities for people to look at birds,” Jones says. Sometimes sport fish even colonize an oxbow, making it a haven for fishermen.

Jones say he and his colleague Keith Schilling, along with graduate student Bryce Haines, want to quantify the water-quality benefits of restored oxbows. They’ve installed monitoring wells near the Morgan Creek
oxbow to study the water quality; restored oxbows can also provide flood storage.

**Nitrate Processing**

IIHR researchers also conducted an oxbow restoration project last year in the Boone River Watershed, with collaboration from The Nature Conservancy and the Iowa Soybean Association, and funding from the Iowa Nutrient Research Center. Schilling led a team including Harvest Ellis and Nate Young that set out to map potential oxbow restoration sites in the Boone River basin using GIS and LiDAR (laser radar) data. According to Schilling, they found hundreds of sites that could be restored.

In addition, Schilling’s team set up intensive water-quality monitoring on a restored oxbow on White Fox Creek, also in the Boone watershed. Discharge from two tiles partially feeds the oxbow. Schilling says they found that the White Fox oxbow removed 45 percent of nitrate from the water—a level comparable to nitrate processing by wetlands or bioreactors. Because restored oxbows are often on marginal agricultural land, they can be an attractive option for producers looking for a best management practice for tile drainage. “You get treatment and ecosystem value,” Schilling says. In the future, he hopes to develop a conservation practice standard for oxbows.

Jones agrees that oxbow restoration can check off a lot of boxes. “Oxbows can provide a triple benefit of habitat, flood storage, and stream water-quality enhancement,” he says. “And all for not much money.”
Lou Landweber could really spot talent.

In 1970, V.C. Patel was looking for a job. His position at Lockheed Martin in Georgia had ended. Patel and his wife liked life in the United States, but where to go next? Patel wrote three letters seeking a position — one of them to Lou Landweber at IIHR—Hydroscience & Engineering (then the Iowa Institute of Hydraulic Research).

Landweber responded almost immediately with a handwritten invitation to present a seminar at IIHR. “Lou and Mae picked me up at the airport,” Patel remembers. “They made me feel so welcome.” He gave a seminar about computational fluid dynamics (CFD) in aerospace. “Nothing to do with hydraulics or ships!” Patel laughs.

But even so, Landweber saw the potential in Patel’s work. Patel was working on the boundary layers of airplanes, and Landweber immediately saw how this could be applied to ships. "Within a couple of weeks, I got a telegram offering me a job—from Jack Kennedy!" Patel says. "Can you believe that? Whoever can respond that fast deserves my attention." Patel went on to serve IIHR for decades, culminating as director from 1994–2004.

A Fascination with Ships

Lou Landweber was born in 1912 in New York City. He graduated from City College of New York in the dark days of the Great Depression with a BS in mathematics (later, he earned an MS and a PhD, both in physics). He found work at the U.S. Experimental Model Basin in the Washington Navy Yard (later renamed the David Taylor Model Basin).

Landweber was appointed head of the hydrodynamics division at the David Taylor Model Basin in 1940. In 1947, the U.S. Navy presented him with the Meritorious Civilian Service Award for his World War II research efforts, primarily on minesweeping problems.
In 1954, then-IIHR Director Hunter Rouse invited Landweber to IIHR to assume the role of researcher and professor of mechanics and hydraulics. To sweeten the deal, the Office of Naval Research (ONR) funded the conversion of one of IIHR’s basement river channels into a large ship towing tank, one of only a few such facilities in the nation at that time.

The Father of Ship Hydrodynamics at IIHR

Landweber happily set to work as a researcher, educator, and innovator in the field of ship hydrodynamics at the Iowa Institute of Hydraulic Research. His influence transformed IIHR. Landweber, who never considered himself an engineer, developed a strong theoretical and experimental research program in ship hydrodynamics that has continued to the present day and likely into the future. Under his guidance, IIHR became a national leader in research related to naval architecture and ship hydrodynamics, with continued financial support from the ONR.

With his colleagues, Landweber carried out a variety of research projects related to ship hydrodynamics, including analysis of wakes, drag of truncated bodies, ship vibration, ship rolling, resistance from waves, and studies of turbulence and cavitation. Landweber focused particularly on wave and viscous resistance, with groundbreaking work on the ideal-flow theory and its application to ship hydrodynamics.

He was also a pioneer in computational fluid dynamics, providing a foundation for later work at IIHR. Landweber would lay out the problem—usually a classical equation-solving problem—and IIHR Research Scientist Matilde Macagno would program it. Together, they solved the problem, using her computer expertise and his analytical knowledge.

A Real Sweetheart

Landweber’s career at the institute was among the longest in its history. Even after his retirement and well into his 80s, he continued to secure grant funding, conduct research, publish papers, and mentor graduate students. Landweber was a generous mentor, freely offering his time and support to colleagues and students. His deep integrity and his technical stature impressed and influenced those around him. Always soft-spoken and helpful, he would invite visitors requesting his help into his office, where together they would talk through a problem step by step. He ushered more than 50 MS and PhD students through their studies. They remember his integrity, warmth, support, and humor—characteristics that rival even his vast technical achievements in their recollection.

“He was a very dear man,” Patel says. Landweber’s successor in ship hydrodynamics at IIHR, Fred Stern, agrees. “He was a real sweetheart. He was always a very helpful and kind fellow, from a different era.”

When Landweber died in 1998, it was a loss that profoundly shook the entire IIHR family. Stern memorialized Landweber at the funeral: “[It is] a pain that is deep, unending, and without explanation, but somehow accompanied by simultaneous feelings of happiness, joy, and pride for having known—as a close friend, surrogate father, and mentor—such a man as Lou Landweber.”

---

Louis Landweber is remembered as a master of mathematics and physics, but he also had a gift for poetry. His verse reveals a gentle, wry humor and a talent for taking life lightly.

To the Boss

Attributed to Louis Landweber

I wonder what the porpoise knows of viscous flow transition,

Or what the graceful sailfish thinks of Kutta’s edge condition.

Do the schools of pompano who like to swim formational,

Know, at all, the values of derivatives rotational?

Shall we ask the monstrous whale with spout between his eyes,

How to choose a flooding hole of bestest shape and size?

Do the eyeless fish who swim way down where always night is,

Find each other with the aid of secret search devices?

Should you, Boss, go catch some fish and place them in our chairs,

And send us home to eat and sleep devoid of research cares?

Editor’s Note:

Lou Landweber will soon be inducted into the University of Iowa’s Legacy of Iowa Engineering for his exceptional service as an educator, researcher, and engineer.
My Canvas

BY SHIANNE FISHER

Johnathan Culpepper, along with most of his family, was born with a love for art. And he’s quite good at it, even selling paintings to fund his undergraduate education at Medgar Evers College of the City University of New York (MEC-CUNY). However, growing up on the coast in Trinidad and Tobago also helped nurture a love for the environment—and for science.

Artist and Scientist

“All my life, I have heard, ‘You’re a very good artist. Why are you in science?’” says Culpepper. “And I’m like, what do you mean? If you know your own history, if you know the history of what we do—artists and scientists—there’s an overlap. There has always been an overlap. It’s just that in today’s society, it’s not necessarily embraced as much.”

Culpepper, who attributes his passion for science to his parents, remembers being interested in soil at a young age. “I would always tell my mom, ‘I’m investigating the dirt.’ It just so happens that I’m in a geochemistry lab after all of these years.”

A graduate student research assistant at IIHR—Hydroscience & Engineering, he studies the contamination of groundwater aquifers by chlorinated solvents, which have been used in dry cleaning and degreasing since the 1930s. The investigation is led by IIHR researcher Michelle Scherer and funded through the Department of Defense Strategic Environmental Research and Development Program (SERDP), which aims to clean up current and historical military areas.

Culpepper’s work, which focuses on the transformation of these chemicals into benign products in the soil and water, was featured in the National Science Foundation’s spotlight on its graduate research fellows during Black History Month in 2016.

Visualization as Art

While he doesn’t paint as much as he used to, Culpepper says he’s interested in data visualization, which to him is a form of art. “I really believe in getting a good marriage between scientific illustrations and engineering,” he says. “I think some of the concepts that are very abstract can be very difficult for people to visualize, but I cannot learn them if I do not visualize them.”

Eventually, Culpepper also wishes to become a professor and illustrate his own textbooks. For now, though, he’s writing and illustrating books on ethics and manners for his two daughters, with his wife, Ruth.

He has also been invited by Deanne Wortman, the director of the University of Iowa College of Engineering’s NEXUS program, to prepare an art show in the future. He says the plan is to create images that start a conversation about the price of water, which to him is a family business of sorts. “My father, a plumber, is making sure that the water reaches into somebody’s home, and I’m there in the laboratory ensuring that we can clean up some of the mistakes that we have made.” His grandfather also works closely with water in the Port of Spain, Trinidad and Tobago.

Culpepper even bred fish and tended his own garden growing up on the island. He says the connection between life and water is very apparent to him. “We have been devaluing this very precious commodity, and it’s going to get to the point that we’re starting to ration water until we get serious about how we are distributing it and how we are valuing it.”

Love for Ship Hydro

The Mississippi is no ordinary river. Even in her native Italy, Silvia Volpi had heard some of the stories that surround the Mississippi River. From Mark Twain to more modern tales of record-breaking alligators, the Mississippi holds a unique place in American folklore and myth. Volpi says when she arrived in the United States for her studies at IIHR, she was anxious to see the Mississippi with her own eyes.

As a master’s and now a PhD student in the IIHR ship hydrodynamics program, Volpi has had the chance to visit several Iowa cities along the Mississippi and to travel the Great River Road along its banks. Volpi, who grew up near Rome, earned a master’s degree in aeronautical engineering at Università degli Studi Roma Tre in Italy after coming to the University of Iowa to work on her master’s thesis with IIHR’s Fred Stern.

A New Way of Working

Stern invited her to return for a PhD, and Volpi enthusiastically agreed. “I learned so much in those seven months when I was here for my master’s thesis,” she says. It was a way of working that was quite different from what she was used to in Italy. “I really fell in love with this,” Volpi says.

“I thought getting a PhD here would be an amazing experience,” she says. Volpi appreciates the strong motivation here to do good work, and the opportunity to learn how to do research. “Everything I have learned about research has been from my studies here with Professor Stern,” she says.

She especially values the opportunity to work with CFDShip-Iowa, the computational fluid dynamic code developed at IIHR and widely used for U.S. Navy applications. “It’s astonishing how advanced the CFD code developed here is,” Volpi says. “And the fact that I can use it for my research—it’s amazing! Not everyone has the opportunity to use something so powerful for his or her PhD studies.” She has been focusing on optimization and fluid-structure interactions—how a fluid behaves when in contact with a flexible object or structure.

Sweet Corn Culture

While Volpi misses her family and home in Italy, she’s been eagerly experiencing American culture and cuisine. As an avid cook, she enjoys preparing and tasting Iowa food. “I love food,” Volpi says. “I’m obsessed with discovering new flavors and I enjoy eating very much.” Her favorite Iowa food is sweet corn, closely followed by a cheddar cheese from the Milton Creamery she discovered on a road trip in Southern Iowa—Prairie Breeze. She also enjoys biking through the Iowa countryside—“when it’s good weather, of course.”

Volpi considers herself very fortunate. “Having the chance to come here and live this experience—yes, I feel very lucky.”

Silvia Volpi appreciates the opportunity to work with CFDShip-Iowa (an advanced computational fluid dynamic code developed at IIHR) as part of her PhD studies.
Water—it’s all around us, especially here at IIHR. It provides us with everything from drinking water to hydropower to recreation. We asked seven IIHR students to tell us a favorite story about water in their lives.

HENG-WEI (DAVID) TSAI, IOWA CITY, IOWA/TAIPEI, TAIWAN
Research Area: LSPIV, instrumentation, and uncertainty analysis

“I thought solving the Indian water crisis was the highest priority task in India, but I knew I was wrong after seeing locals praying in the Ganges River. To engineers, the Ganges is heavily polluted, but to the worshippers, the water nourishes their soul. I realized that to resolve the problem without invading anyone’s culture is the most important thing to consider.”

MOHAMED ELSAADANI, CAIRO, EGYPT
Research Area: Hydrology and remote-sensing

“After a long day of fieldwork, my research colleagues and I went to the water park at Ames, Iowa. We had a diving competition, which included a lot of back and belly flops.”

REBECCA MATTSON, MINNEAPOLIS, MINN.
Research Area: Removal of nitrates in decentralized wastewater treatment

“On a hot summer day, a steep hill was converted into a waterslide with some hoses and a long plastic tarp. Sliding down Superman style, splashing into a soup of mud and grass, and running back up to do it again, is a blissful childhood memory.”
**YIBING SU, BEIJING, CHINA**  
**Research Area:** Developing a real-time predictive model for stream water temperature in Iowa

“At the age of 10, I went on a fishing trip with my family and accidentally fell into the river while trying to catch fish. I should have realized from that day that I was meant to study water in the future.”

---

**CHAD DRAKE, EAST WENATCHEE, WASH.**  
**Research Area:** Coupled hydrologic and water-quality monitoring

“I participated in the ASCE Concrete Canoe competition as an undergraduate. Our team worked hard throughout the school year to design and build a quality final product. Seeing the canoe float on race day was very satisfying (and a relief)! Trying to navigate it effectively was another story.”

---

**HAOWEN XU, BEIJING, CHINA**  
**Research Area:** Hydroinformatics

“When I was in Mewat, India, for an NGO watershed management project, I saw a river with such high salinity, thirsty children had to rely on rainwater harvesting for drinking water. In some parts of the world, having adequate fresh drinking water is a luxury, and the water resource is always something worth fighting for.”

---

**NANCY BARTH, SACRAMENTO, CALIF.**  
**Research Area:** Flood frequency and climate processes

“In Northern California, our water sports enjoyment is predicated on whether we received our admittedly minimal allotment of annual precipitation. I love water sports. I am grateful to have found my passion for wakeboarding in my latter 30s after being a water skier since my youth.”
Nate Young sat hunched on the open fishing boat, bracing himself against the wind whipping across the million-acre Lake of the Woods in northern Minnesota. The temperature hovered just above freezing, but his fingers felt like blocks of ice, barely able to hold onto the fishing rod. With him in the boat were his two fellow fishermen, IIHR’s Larry Weber and Troy Lyons. They were fishing for walleye in late October.

“I don’t recall who caught the most fish on any given trip, but I’m confident it wasn’t me,” Young says. “It was physically miserable, but a lot of fun at the same time.”

Young actually loves the outdoors, and finds as many excuses as he can to get outside. As the new director of the Lucille A. Carver Mississippi Riverside Environmental Research Station (LACMRERS), Young has plenty of good opportunities to be outdoors on and around the Mississippi River.

On the River
In a way, he’s getting back to his first research love: freshwater mussels. As a graduate student working at IIHR with Tatsuaki Nakato and Weber, Young developed a numerical simulation to study the mussels’ physical habitat characteristics. In creating the model, he spent many months on the river performing a bathymetric survey of the riverbed and collecting sediment and flow data.

Young says these projects gave him the chance to apply hydraulics and fluid mechanics to environmental problems. “Those are the kind of projects I enjoy the most,” he says.

Today, Young hopes to encourage other researchers to take advantage of the research facility at LACMRERS and its proximity to North America’s largest river. “What’s needed is an interest in being on the river and collecting data from the river,” he explains. “I’m hoping to develop that.”

Mapping the Floodplain
As associate director of the Iowa Flood Center, Young led the team that recently successfully completed the Iowa Statewide Floodplain Mapping Project (see story page 2). This six-year effort conducted in collaboration with the Iowa Department of Natural Resources updated floodplain maps for the 85 Iowa counties that were declared Presidential Disaster Areas after the 2008 Iowa floods. The maps, which are available online at www.iihr.uiowa.edu/iowafloodmaps, provide Iowans with good information on flood risk in their communities so they can make informed land-use and land management decisions.

The project was good for Iowans and good for the Iowa Flood Center, Young says. “It broadened the IFC’s impact on the state.” And, he adds, “I think it’s going to be a really useful set of data, helping regulators and managers as well as individuals make good decisions about how to manage our floodplains.”

Young says he has never had a particular plan in mind when it comes to his career. “I have always followed my interests,” he says. “I have been really lucky in the opportunities that have been presented to me.”
After the Storm

On the morning of August 12, 2016, Emad Habib stepped out of his Lafayette, La., home to find two surprising developments. The first was water everywhere—his neighborhood was flooded after a 1,000-year rainstorm dumped more than three times the amount of rain on Louisiana as Hurricane Katrina had. The second development was that all of Habib’s neighbors were outside as well, and they wanted to talk to him.

An alumnus of IIHR—Hydroscience & Engineering, Habib is a professor of civil engineering at the University of Louisiana-Lafayette and a specialist in rainfall estimation and hydrology. Suddenly Habib’s area of expertise—what happens when a lot of rain falls on dynamic ecological areas like Louisiana’s coastal plain—was strikingly relevant.

Everybody is a Hydrologist

The experience was eye-opening to say the least. Not only was his community facing the sort of damage that hadn’t been seen in anyone’s lifetime, but Habib was also able to see, up close, how hydrology concretely impacts people’s lives. “Suddenly, everybody was a hydrologist,” he says. “You’d see people who are not technical at all asking, ‘Is it a 500-year storm or a 1,000-year storm?’ Or, ‘I’m not in the flood zone—why did I get flooded?’” Habib and his colleagues were thrust into the role of public resource, answering questions and providing real-time predictions for community members, schools, energy companies, and the city of Lafayette.

Although being able to see so vividly the effect of hydrology on people’s lives was striking, it was not unprecedented in Habib’s life. As a child in Egypt, he had a front-row seat to a historically significant hydrologic project: his father was one of the 25,000 engineers who helped to build the Aswan high dam. The dam put an end to the devastating annual flooding of the Nile and nearly doubled agricultural yield in the area by redirecting the water to irrigation. Habib remembers his father spreading out huge maps on the kitchen table, showing some of the scale and detail of the project.

Life and Death

In Louisiana, the flooding and its aftermath raised important questions in Habib’s mind. “What do the local communities need from the scientists and hydrologists when it comes to these flood events? We may have the fanciest tools, but I think there is some kind of disconnection between the developers of these tools and the citizens and the businesses and the schools and the companies in these communities.” He has started to reach out to scientists in other fields—disaster specialists, social scientists, business professors—to see how better collaboration can lead to a more responsive, more engaged scientific community.

Hydrologic prediction, a practice Habib honed here in Iowa, is a matter of life and death in Louisiana, where a freshwater system, an inland water system driven by rainfall, and a coastal system are all in close proximity. Where the water will go after a big storm hits is not merely an academic question. In that sense, Habib feels his work is “not just traditional hydrology—it looks at the ecosystem, habitats, and people who live in that area and how hydrology impacts them.”

BY DAVID GOOLBAR

Emad Habib’s (PhD 2001) work as a hydrologist and his personal life recently converged when he found himself living in a flood zone. Photo courtesy of the University of Louisiana-Lafayette.
Creek Stomper

It was a confluence of engineering know-how, Hawkeye spirit, and student enthusiasm. After a three-decade absence, the corn monument—a massive construct of corn, paint, and plywood—had risen again on the Pentacrest to celebrate a Hawkeye homecoming.

Stephanie Then helped make it happen. In 2014, students, faculty, and staff revived this decades-old UI Homecoming tradition. Then, who is now an IIHR alumnus, says it’s one of her favorite memories. “Out of all the amazing opportunities I had because of IIHR, I would have to say that my involvement in the corn monument tradition is what I hold nearest and dearest to my heart,” Then says.

An Iowa Native
Then is a native of Peosta, Iowa, where she grew up imagining a future for herself as a hairstylist. When she got to high school, Then realized she was good at math and science and began to shift her sights to civil engineering. “Looking back,” she says, “I think I always knew I would end up in the environmental/water field because growing up, if I wasn’t at school, you could find me at the pool, exploring the woods, or stomping through creeks.”

As a student at the University of Iowa, Then took a course taught by Professor Allen Bradley, Engineering Problem Solving. She calls Bradley her most significant mentor. “He taught me a lot about leadership,” she says. He also helped her understand how to communicate effectively and how to manage her time. “He was always available to help me and answer questions,” Then says. Bradley even helped her improve her golf game.

Prairie Potholes
As a master’s student, Then worked with IIHR’s Larry Weber and Keith Schilling on a project focusing on farmed wetlands in the prairie pothole region of north central Iowa. She developed a hydrologic model to estimate surface water ponding in these farmed wetlands. It was part of a larger project documenting the hydrology, water-quality, and wildlife value of the drained and farmed wetlands. Then says she hopes agencies and conservation groups will use her research to develop strategies to balance agriculture and ecosystem needs.

Then recently started a new job at HDR Inc. in Des Moines, where she is part of the Water Resources Engineering team. She’s happy to be working with other IIHR graduates at HDR. So far, her work has focused on bridge hydraulics analysis and stormwater conveyance. When she’s not working, Then enjoys golfing and fishing, especially with her dad. She even caught a few fish near the Stanley Hydraulics Lab while she was a student at IIHR.

Then says she benefitted from the support of IIHR in many ways. She especially enjoyed helping to maintain IIHR’s rain-gauge and water-quality sensor networks, and attending STEM festivals to help educate kids about water-quality and flooding issues.

“IHHR will always have a special place in my heart,” Then says.
In 1966, Sedat Sami had just finished his PhD at IIHR and was ready to accept his first teaching job at Southern Illinois University (SIU). His advisor, IIHR Director Hunter Rouse, was appalled. “You cannot go like this,” Rouse told Sami. “You have a tooth missing!” Sami knew he had a gap. But he was about to leave for Illinois, and it took months to get an appointment at the dental college. “You cannot lecture like that,” Rouse insisted. He picked up the phone and called the dean of the University of Iowa School of Dentistry. Sami had an appointment the next day.

“I kept that front tooth for 30 years!” Sami laughs. He was Hunter Rouse’s last PhD student, and Rouse took care of his own. “Once you became a PhD student, especially a student of his, he was very carefully looking after your daily life,” Sami says. “Hunter Rouse was very good to me.”

Crazy for Football
Sami, a native of Istanbul, Turkey, says that as a teenager, he had decided to become an engineer when he learned that one of his favorite soccer stars was also an engineer. “I am a crazy man for soccer,” he says. He attended the Istanbul Technical University and graduated with a degree in engineering. He came to the United States and IIHR in 1956 for a master’s degree. Turkey was in the midst of a building boom, and Sami returned to Turkey and accepted a job with a construction company as a structural engineer, where he eventually rose to vice president.

But by the early ’60s, Turkey’s instability was taking a toll on Sami and his family, which included wife Dagmar; a son, Iskender; and later a daughter, Elisabeth. “We lived in Ankara five years and went through two military coups—one successful, one not successful,” he says. “I said, that’s enough.” Hunter Rouse had asked him to come work on a project with him, so Sami and his family returned to Iowa, where he would earn a PhD in 1966.

While he was a student at Iowa, Sami had the opportunity to know many of the giants of the institute: Rouse, Louis Landweber, Jack Kennedy, Enozo and Matilde Macagno, Philip Hubbard, and more. But it wasn’t just the giants of hydraulics that Sami met in Iowa City. He also became close friends with his next door neighbor, a student at the Iowa Writers’ Workshop who would go on to international acclaim: John Irving. “Maybe you’ve heard of him?” Sami asks with a smile.

A Hawkeye at Heart
After earning his PhD, Sami accepted a position at SIU—against Rouse’s wishes. Rouse would have preferred to see him teach at a Turkish university. But at that time, Sami recalls, the universities in Turkey were battlegrounds—“shooting and killing left and right.” So he and his wife chose to remain in the United States. Within six years, he was a full professor at SIU, and he rose to serve as department chair and also acting dean. He spent his entire teaching career at SIU and retired as a full professor in 1999.

Sami has nothing but praise for the University of Iowa. He still cheers for the Hawkeyes and credits former Iowa football coach Hayden Fry with helping him fully assimilate into American culture. “I like the Iowa attitude,” Sami says.

Because of his warm feelings for IIHR, Sami has made generous financial gifts to the institute and the University of Iowa. Among the many causes he supports, Sami says, IIHR remains at the top. “Hunter Rouse was a second father to me,” he says. “When I mentioned Rouse, all doors opened for me. I know that Iowa was instrumental in my future in many, many ways.”

Sedat Sami (MS ’57, PhD ’66) says his PhD advisor, Hunter Rouse, went above and beyond to take care of his students.
In Memoriam: Tatsuaki Nakato

It is with great sorrow that we share the news of Tatsuaki Nakato’s death on Sept. 3, 2016, surrounded by his family. He was 74 years old.

Nakato, a native of Japan, came to the University of Iowa for PhD studies, completed in 1974. Then-Director John F. Kennedy offered him a position as a postdoc and later as a research scientist at IIHR—Hydroscience & Engineering (then the Iowa Institute of Hydraulic Research). He was also an adjunct faculty member in the UI Department of Civil and Environmental Engineering. Nakato stayed on at IIHR for more than three decades. He was a cherished member of the IIHR family, and will be fondly remembered by all who knew and worked with him.

At Nakato’s suggestion, IIHR built a research station focused on inland rivers on the Mississippi River. He played an important leadership role in developing the research station and served as its first director. Now known as LACMRERS (Lucille A. Carver Mississippi Riverside Environmental Research Station), it opened in May 2002.

As director of LACMRERS, Nakato participated in efforts to reintroduce endangered Higgins Eye mussels to the Mississippi River near the station. He also volunteered with successful mussel propagation projects on several Midwestern rivers.

In 2002, Tatsuaki was awarded the Iowa Board of Regents Staff Excellence Award for his vision and tireless work to make LACMRERS a reality, as well as his service to IIHR, the state of Iowa, the Midwest, and the international community.

After his retirement in 2008, Tatsuaki dedicated much of his time and energy to volunteer work. He also translated a book on Hans Albert Einstein into Japanese.

Although Tatsuaki regularly traveled to Japan, he called Iowa home. “Iowa has been really great for us,” he said. And he was great for Iowa — we will miss his ready smile, his dedication to his work, and his kind heart.

Tatsuaki is survived by his wife, Sharon, and their three children: Ken, Misa, and Kimi. In lieu of flowers, memorial donations may be made at www.gofundme/tnakato.
Our Mission
To be a leader in fluids-related fundamental and applied research; to provide interdisciplinary education for future leaders in science and engineering; and to advance knowledge in support of sustainable natural and engineered systems.

Our Vision
To be an international leader among academic institutions in hydroscience and engineering research recognized for integrating laboratory, field-, and simulation-based experimentation, and participatory interdisciplinary education.

IIHR Advisory Board Members

Joseph Arcano Jr. (2016–20), U.S. Naval Surface Warfare Center, Carderock Division
Randy Beavers (2013–17), Urban and Rural Water Systems (retired)
Paul B. Dierking (2012–16), HDR Engineering Inc.
Robert Libra (2013–17), Iowa State Geologist, Iowa Department of Natural Resources
Harindra Joseph Fernando (2012–16), University of Notre Dame
Scott C. Hagen (2014–18), Louisiana State University
L.D. McMullen (2013–17), Snyder & Associates
Thad Michael (2016–20), U.S. Naval Surface Warfare Center, Carderock Division
Pedro Restrepo (2016–20), National Weather Service/NOAA (retired)

G. Todd Ririe (2013–17), BP America Inc.
Brennan Smith (2015–19), Oak Ridge National Laboratory
Richard H. Stanley (2013–17), The Stanley Foundation
Jinn-Chuang Yang (2014–18), National Chiao Tung University

Ex Officio Members

Alec Scranton, Dean, College of Engineering, University of Iowa
Larry J. Weber, Director, IIHR—Hydroscience & Engineering, University of Iowa
Carmen Langel, Director of Development and Communications IIHR, University of Iowa

In 2015–16, IIHR undertook a self-study, followed by a successful external review. This provided an ideal venue for reflection on recent changes as well as consideration of the range of possibilities for IIHR’s future.

IIHR has had a remarkable record of research and institutional successes since its beginnings. However, from 2004–08, the institute experienced significant growth, from about $10.7M in expenditures in fiscal year 2004 to about $20M in the past several years. This can be accounted for through significant efforts to diversify, grow, and maintain IIHR programs. The most significant growth has occurred since 2008 and included the addition of the Iowa Flood Center in 2009, the commissioning of the wave basin facility in 2010, the addition of all Water Sustainability Initiative faculty to IIHR in 2013, and the transition of the Iowa Geological Survey to IIHR in 2014.

The high level of scholarly productivity and funding among IIHR researchers demonstrates the institute’s ability to nurture and support a wide range of fluids-related research activities under a wide range of sponsors. IIHR has created an environment in which researchers have the freedom to pursue basic or applied research according to their interests and funding opportunities. This flexibility also helps to ensure that IIHR maintains a diverse portfolio of projects and funding streams that fluctuates depending on current economics and trends. This model has allowed IIHR to remain academically relevant and fiscally strong through its nearly 100-year history.
Watching the eagles that congregate near Stanley Hydraulics Lab is a popular pastime in the cold, dark days of winter.