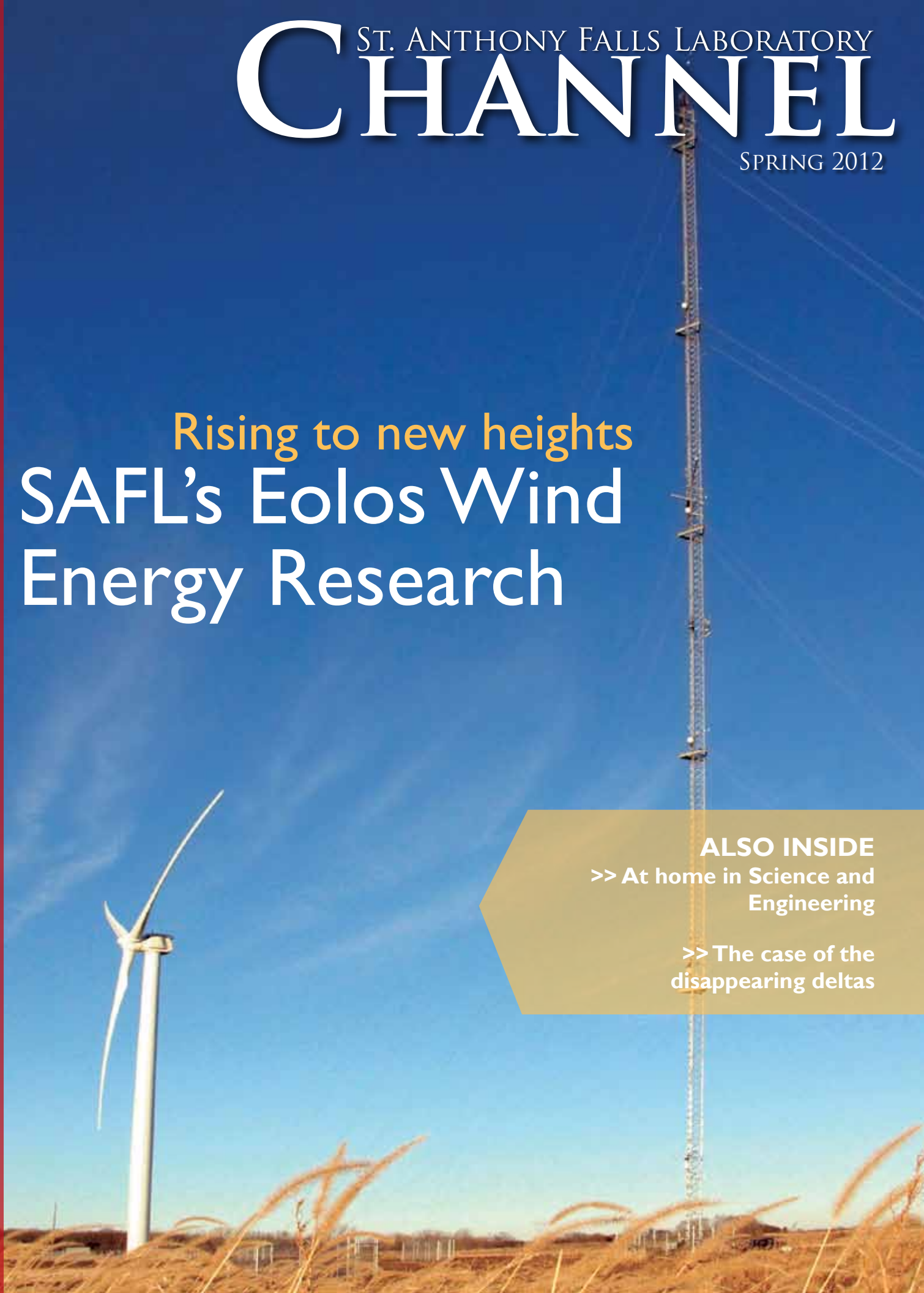
College of Science & Engineering | University of Minnesota

St. Anthony Falls Laboratory
Channel
Spring 2012

Rising to new heights
SAFL's Eolos Wind Energy Research



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The St. Anthony Falls Laboratory is a research center of the University of Minnesota's College of Science and Engineering. Affiliated departments include the Departments of Civil Engineering, Earth Sciences and Mechanical Engineering, College of Science and Engineering; and the Department of Ecology, Evolution and Behavior, College of Biological Sciences.

Cover: SAFL's Eolos Wind Energy Research Field Station at UMore Park in Rosemount, Minnnesota. Photo by Chris Milliren.

THE DIRECTOR'S PERSPECTIVE

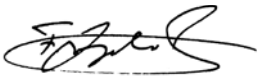
As we come to the close of another academic semester, St. Anthony Falls Laboratory (SAFL) rings with a new sound that brings excitement and anticipation for the future—hammers and saws. The long-awaited renovation, supported by a National Science Foundation (NSF) Academic Research Infrastructure-Recovery and Reinvestment grant and funding from the State of Minnesota has finally started. The nearly $16 million project, which will strengthen and enhance the physical and research infrastructure of this unique facility, is anticipated to last through August 2013. We look forward to welcoming you to visit the improved laboratory for a special ribbon-cutting ceremony in the fall of 2013.

Another major development in the transformation of SAFL is the recent administrative restructuring of the laboratory from a facility of the Department of Civil Engineering to a research center of the College of Science and Engineering. In its new role, SAFL is better positioned to interact with departments across the college and the University of Minnesota system. The change is accompanied by a new budget model for SAFL that is designed to benefit all departments affiliated with the laboratory and set up an environment within which interdisciplinary research and education can flourish.

And SAFL recently celebrated the commissioning of the Eolos Wind Energy Research Field Station at UMore Park in Rosemount. This 80-acre, field-scale research and education facility consists of a 2.5 megawatt Clipper *Liberty* wind turbine and 425-foot-tall meteorological tower for cutting-edge design, demonstration and investigation of wind power technologies. This issue includes an introduction to the field station and a brief overview of the innovative research and education initiatives underway.

In this issue, you will also read about recent exciting advances in our delta restoration research. SAFL has pioneered the area of experimental stratigraphy and our unique delta basin facilities are continuing to produce stunning new insights into the mysteries of delta formation and evolution.

Finally, it is with great sadness that we share in this issue the news of the passing of Professor Edward Silberman. Ed has been a towering figure in the history of the laboratory and his impact has been profound and lasting. His passing marked the end of an era for the laboratory but his legacy and spirit will continue to live on and inspire us all.



—Fotis Sotiropoulos
Professor and Director, SAFL

honors & awards

Professor Emeritus **Roger Arndt** will present a keynote lecture, "Cavitation Research from an International Perspective" at the 26th International Association for Hydro-Environment Engineering and Research Symposium on Hydraulic Machinery and Systems in Beijing, China (August 19-23).

Professor Emeritus **Roger Arndt** is the principal investigator on a recent grant from the Office of Naval Research for "Development of Control Strategies for Very High Speed Cavity-Running Bodies: Simulations and Small-Scale Experiments."

Professor **Jacques Finlay** received a Sea Grant award for an "Estuary Hotspots for Microbes Reflect Water Chemistry" study of the St. Louis Estuary in cooperation with the Lake Superior National Estuarine Research Reserve.

In April 2012, Professor **Efi Foufoula-Georgiou** was appointed for a two-year term to the National Research Council's Standing Committee on Earth Science and Applications from Space.

Professors **Efi Foufoula-Georgiou**, **Michele Guala** and **Fotis Sotiropoulos** were awarded $40,000 from NSF to organize a workshop on "Basic Research at the Intersection of Marine/Hydrokinetic Energy and the Aquatic Environment." The workshop, held in October 2011, attracted a broad range of researchers from academia and U.S. Department of Energy laboratories.

Recognizing his lifetime of achievement in the field of engineering and contributions to the profession, Professor **John Gulliver** was awarded the 2012 Charles M. Britzius Distinguished Engineer Award by the Minnesota Federation of Engineering, Science and Technology Societies.

Post-doctoral researcher **Trung Le** and Professor **Fotis Sotiropoulos** were among the winners of the 2011 American Physical Society Division of Fluid Dynamics Gallery of Fluid Motion Contest for their video, "Vortex Formation and Instability in the Left Ventricle." PhD student Dane Coffey and Professor Daniel Keefe (Computer Science and Engineering) contributed to the video.

PhD student **Man Liang** (Advisors: Vaughan Voller and Chris Paola) received the 2011 Community Surface Dynamics Modeling System Student Modeler Award for her research titled, "A Reduced-Complexity Channel-Resolving Model for Delta Formation."

Professor **Fotis Sotiropoulos** was appointed associate editor of the American Society of Mechanical Engineers *Journal of Biomechanical Engineering* and to the editorial advisory board of *Computers & Fluids*.

Professor **Fotis Sotiropoulos** presented a keynote lecture at the 2011 High Performance Computing Symposium in Montreal, Canada. He also presented the keynote lecture at the 2011 Centennial Celebration of the Hydraulic and Environmental Engineering Department of the Catholic University of Santiago, Chile.

Lead author, Professor **Vaughan Voller's** recently published paper, "Does the Flow of Information in a Landscape Have Direction?" (Geophysical Research Letters, 2012) was selected as a research highlight by the American Geophysical Union. SAFL PhD student **Vamsi Ganti** and Professors **Chris Paola** and **Efi Foufoula-Georgiou** are co-authors of the paper.

COLLEGE OF Science & Engineering

PUBLIC LECTURE | JUNE 20

The Low Life of River Deltas: How Mud Can Save (Part of) the World
Wednesday, June 20, 7 p.m.
Room 150, Tate Laboratory of Physics, Minneapolis campus
SAFL Professor of Earth Sciences **Chris Paola** will be the guest lecturer.
Learn more and register at:
http://www.cse.umn.edu/publiclecture

in other news

>>SAFL PhD student Adam Witt is highlighted in an interview on the University homepage regarding his work on sustainable water solutions for developing nations.

>> Carp bubble barrier research at SAFL is featured March 12 on Kare11, Star Tribune, WCCO and KSTP. These follow a special news conference hosted at SAFL by Senator Amy Klobuchar and Congressman Erik Paulsen regarding new legislative efforts to stop the spread of Asian carp.

>> A February story in the University news highlights the success of the industry-academy partnerships in the Eolos Wind Energy Research Consortium.

At in the COLLEGE OF Science & Engineering

A SCIENCE AND ENGINEERING RESEARCH UNIT. WITH NEW INITIATIVES, EXPANSION INTO ADDITIONAL RESEARCH AREAS, AND STRENGTHENED RELATIONSHIPS ACROSS DISCIPLINES, THE UNIVERSITY OF MINNESOTA ST. ANTHONY FALLS LABORATORY (SAFL) IS NOW A RESEARCH FACILITY OF THE COLLEGE OF SCIENCE AND ENGINEERING. THE CHANGE WAS EFFECTIVE JULY 1, 2011.

Historically, SAFL had been part of the Department of Civil Engineering and affiliated with the Department of Earth Sciences (formerly the Department of Geology and Geophysics) as well as the Department of Ecology, Evolution and Behavior in the College of Biological Sciences. Now as part of the College of Science and Engineering, a new administrative structure provides many more opportunities for faculty from all College of Science and Engineering departments and the entire University to interact with and become part of the laboratory.

"We're excited by the opportunity for the laboratory's unique resources and expertise to be used to strengthen research collaborations and create new opportunities within the college and the University," said Fotis Sotiropoulos, director of SAFL. "This transition is the result of the hard work and academic excellence of our faculty, staff and students. They are the ones who helped establish the lab as a major hub for research in energy and environment within the University of Minnesota."

Founded in the 1930s as a hydraulics lab, the role of SAFL has expanded significantly during recent years. SAFL has been able to increase its affiliations with other departments at the University of Minnesota due to major initiatives such as the NSF-funded National Center for Earth-surface Dynamics (NCED) and the Department of Energy-funded Eolos Wind Energy Research Consortium, as well as expansion into new research in areas such as biofuels, marine and hydrokinetic energy, and medical devices.

"This is a new chapter in SAFL's history," said Steve Crouch, the dean of the College of Science and Engineering. "It will not only help sustain and expand the research activities of this historic research facility but it will also create exciting new interdisciplinary research and educational opportunities for many of our students and faculty."

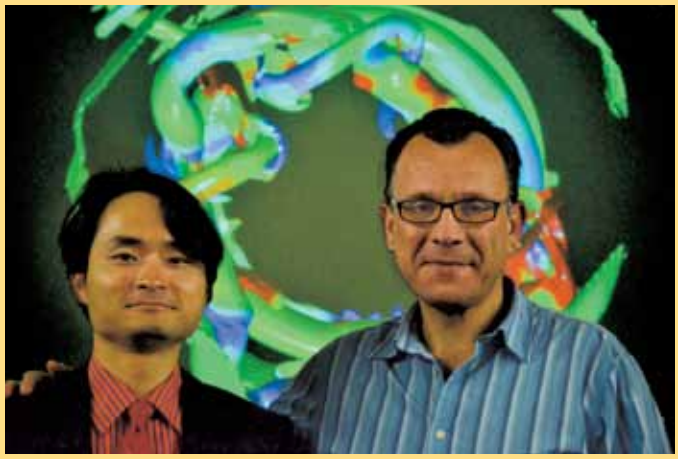
"WE'RE EXCITED BY THE OPPORTUNITY FOR THE LABORATORY'S UNIQUE RESOURCES AND EXPERTISE TO BE USED TO STRENGTHEN RESEARCH COLLABORATIONS AND CREATE NEW OPPORTUNITIES WITHIN THE COLLEGE AND THE UNIVERSITY." — Fotis Sotiropoulos

congrats grads

Amy Hansen (PhD '11) with advisors Jacques Finlay (left) and Miki Hondzo (right).

Kurt McIntire (MS '11) with advisors Omid Mohseni (left) and John Gulliver (right).

Jorge Lorenzo-Trueba (PhD '12) with advisors Vaughan Voller (left) and Chris Paola (right).



Trung Le (PhD '11) with advisor Fotis Sotiropoulos.

Arvind Singh (PhD '11) (Advisor Efi Foufoula-Georgiou not shown).

Olga Belyae-Baxtin (MS '11) (Advisors Miki Hondzo, Ray Hozalski and Michael Semmens not shown).

Joel Morgan (MS '11) (Advisor John Gulliver not shown).

Travis Hanson (MS '11) (Advisor Miki Hondzo not shown).

Photo by Patrick O'Leary

RISING TO NEW HEIGHTS

SAFL'S EOLOS WIND ENERGY RESEARCH

AS ONE OF THREE UNIVERSITY CONSORTIA TO RECEIVE A U.S. DEPARTMENT OF ENERGY (DOE) WIND ENERGY RESEARCH GRANT IN 2009, THE UNIVERSITY OF MINNESOTA'S $7.9 MILLION AWARD SUPPORTS THE ESTABLISHMENT OF AN ACADEMY-INDUSTRY CONSORTIUM FOCUSED ON WIND ENERGY RESEARCH AND EDUCATION.

The focal point of the University's Eolos Wind Energy Research Consortium is its 80-acre field research station, located 25 miles southeast of the Twin Cities campus on the University of Minnesota Outreach, Research and Education (UMore) Park property. In October 2011, the St. Anthony Falls Laboratory completed the construction of the field-scale, wind energy research station, consisting of a 2.5 megawatt Clipper *Liberty* wind turbine, a 425-foot-tall meteorological tower, and related facilities.

At a public commissioning event, University President Eric Kaler described the research and field station as a hallmark of the University's commitment to renewable

Photo by Rhonda Zurn

ABOVE
The 262-foot-tall Clipper *Liberty* wind turbine at the Eolos Wind Energy Research Field Station.

RIGHT
University President Eric Kaler (front right), College of Science and Engineering Dean Steven Crouch (front left) and guests watch as the signal is given to commission the turbine.

energy, to interdisciplinary research and education, and to collaboration with government agencies and industry partners for innovation and discovery. Kaler joined U.S. Department of Energy officials, energy industry partners, wind energy researchers, political leaders, University administrators, and hundreds of local school children to watch as the turbine blades began to spin.

In January 2012, the field station hosted U.S. Deputy Secretary for Energy Daniel Poneman and Senator Al Franken for a special visit, one of a handful of national stops by senior DOE administrators, to highlight federal investments in clean energy research and technology development following President Obama's State of the Union address. Eolos Consortium Director Fotis Sotiropoulos provided a technical briefing on current and planned industry-academy research collaboration for development of novel technologies and enhancements that can improve the functionality and efficiency of wind turbines. Following a tour of the Eolos field station, Deputy Secretary Poneman and Senator Franken shared brief remarks on the visit and reflected on goals and opportunities for wind and other renewable energy.

CONSORTIUM PARTNERSHIPS

To realize the mission of Eolos and to fully utilize the field station for advancing wind energy technology, the University is working to formalize and broaden the consortium of industry, government and academic collaborators. The goal of this work is to establish new research collaborations and identify targeted research projects. "The broad interest in the Eolos effort is exciting." said Jeff Marr, Eolos Consortium associate director. "We are currently working with a variety of organizations including small and large companies, agencies and non-profits with a range of interests in wind energy—from education, training and basic research to applied technology deployment. Developing these relationships and research interests into funded research efforts is the reason that the Eolos Consortium exists. It's a thrill to work toward this goal."

ABOVE
Senator Al Franken, Fotis Sotiropoulos, Deputy Secretary Daniel Poneman and Jeff Marr (left to right) at the Field Station.

MONITORING TURBINE PERFORMANCE

The facility is equipped with state-of-the-art instruments and sensors to measure weather conditions, wind speed and turbulence and the impact they have on the turbine structure and ability to capture wind energy, including:

- Blade sensors. Each of the turbine's three blades is instrumented with fiber-optic gauges to measure the strain and temperature of the blade material.
- Meteorological tower instrumentation. Instruments are installed at different heights on the tower (see top right image) to measure wind speed and turbulence, as well as temperature, barometric pressure and humidity.
- Foundation sensors. A series of strain gauges and settlement plates are installed in the turbine foundation to measure the tower's response to different wind loads and settlement of the foundation over time.
- WindCube LIDAR. The WindCube LIDAR device (see bottom right image) can be deployed anywhere at the field site to measure the wind speed and direction at elevations up to 200 meters.

The turbine's Supervisory Control and Data Acquisition System (SCADA) offers operational and performance data from the research turbine and is carefully time-synchronized with foundation, meteorological tower and blade sensor data.

Eolos will unveil its formal membership structure at the end of May 2012. The first collaborative research projects involving industry and University researchers and engineers will begin in early June 2012 focusing on turbine acoustic noise. The unique combination of collaboration among consortium members, use of a field-scale wind research station and turbine, and access to detailed research data is expected to produce innovations in technologies that advance the field of wind energy.

PROPELLING FORWARD: RESEARCH AND EDUCATION

Eolos researchers are currently focused on collecting a data set that describes the turbine in its baseline, unmodified state. This data contributes to ongoing and future objectives for both laboratory and field-scale research to explore ways to capture more energy from the wind, improve wind farm design, minimize turbine interaction with radar, reduce noise and improve turbine blade structure.

The University and its consortium partners are also developing new wind energy curricula to train the next generation of power-industry professionals. Ninety students enrolled in the fall 2011 Wind Energy Essentials course which utilized the field station to demonstrate wind energy technologies. University faculty members are exploring ways to integrate the Eolos field station and associated research into additional undergraduate- and graduate-level courses.

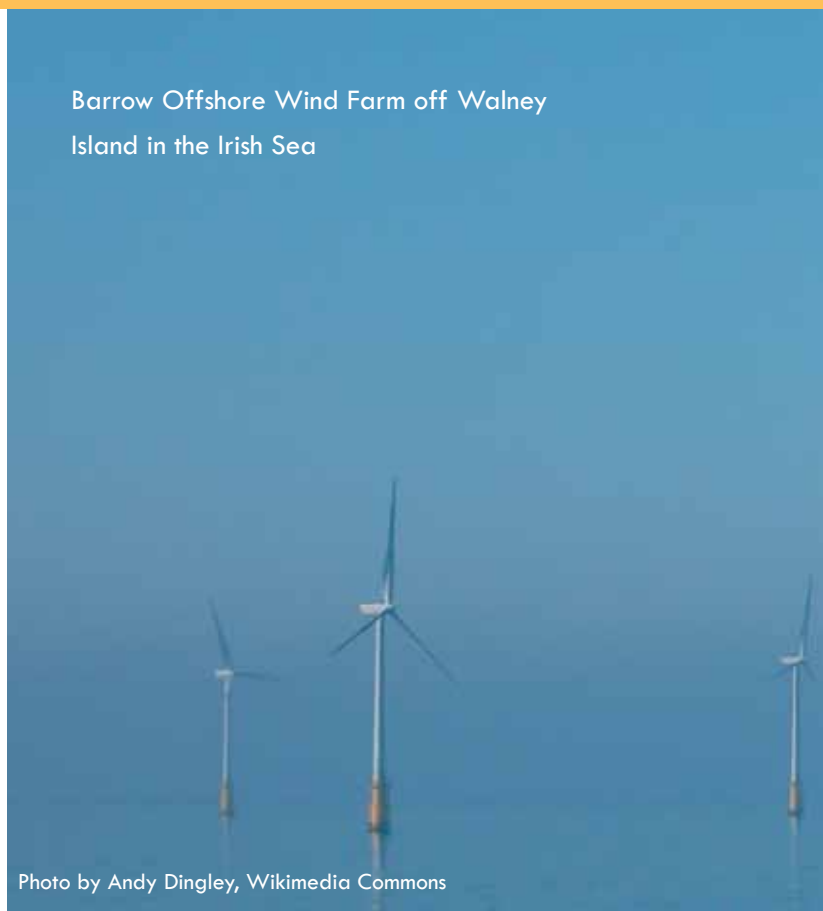
RIGHT
Students from the University's Wind Energy Essentials course at the Field Station.

ENHANCING OFFSHORE WIND ENERGY USING HIGH PERFORMANCE COMPUTING

THE UNIVERSITY OF MINNESOTA WAS AWARDED A $1.2 MILLION GRANT FROM THE U.S. DEPARTMENT OF ENERGY (DOE) TO DEVELOP HIGH-RESOLUTION COMPUTATIONAL ALGORITHMS FOR SIMULATING OFFSHORE WIND TURBINES AND FARMS.

The project is a collaborative effort between Sandia National Laboratories and the University of Minnesota Eolos Wind Energy Research Consortium, established by the Department of Energy's Office for Energy Efficiency and Renewable Energy.

The grant is part of a total of $43 million awarded by the DOE to spur offshore wind energy over the next five years. As part of developing a national energy strategy, the DOE seeks to reduce the cost of wind energy through technology development to ensure competitiveness with other sources of electrical generation. In addition, the agency strives to reduce deployment times and uncertainties that currently limit the development of offshore wind projects.



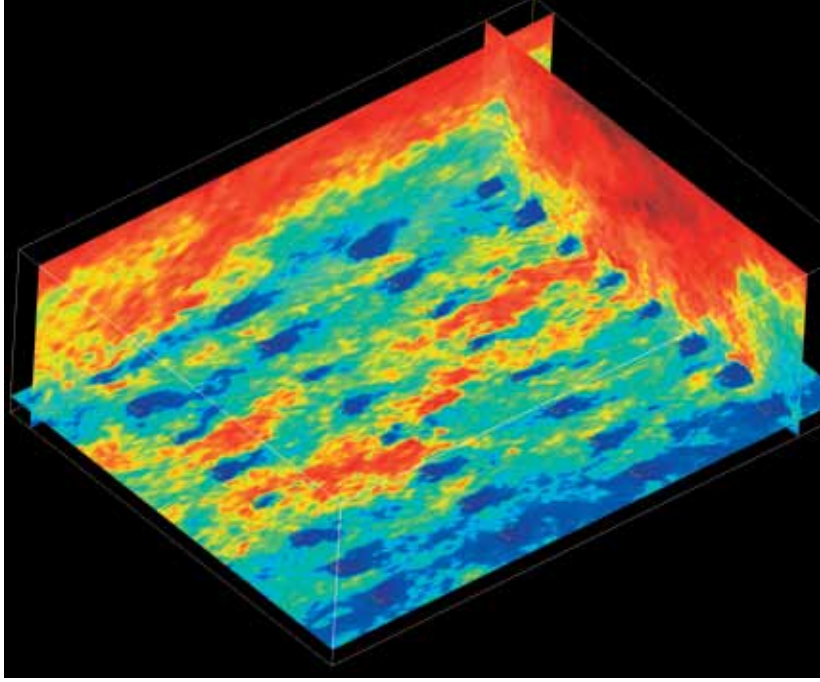
Barrow Offshore Wind Farm off Walney Island in the Irish Sea

Photo by Andy Dingley, Wikimedia Commons

"Until now, wind energy research by St. Anthony Falls Laboratory and the Eolos Consortium has centered around land-based wind energy. This project expands our research into offshore wind," said Fotis Sotiropoulos, St. Anthony Falls Laboratory (SAFL) director and Eolos Consortium director. "This is significant because offshore wind is a critical piece of the puzzle for reaching the national goal of 20 percent of electricity from wind by 2030."

Over the next three years, the project seeks to develop and validate state-of-the-art computational tools capable of simulating atmospheric turbulence and wave effects in offshore wind farms. It will provide the industry with powerful computational tools for improving the design of offshore turbines and floating platforms, and for optimizing the layout of offshore wind farms. "Ultimately our computational tools will help reduce the cost of energy and enhance the reliability of offshore wind projects," said Sotiropoulos.

Sotiropoulos is the principal investigator of the project, working in collaboration with Department of Civil Engineering Professor Michele Guala, and SAFL postdoctoral associates Leonardo Chamorro, Seokkoo Kang and Xiaolei Yang. Dr. Kelley Rhuel is the lead investigator from Sandia National Laboratories.



ABOVE
Large-eddy simulation of atmospheric turbulence past a large wind turbine array.

"This was an extremely competitive national award," said Sotiropoulos of the $1.2 million DOE grant. "Getting selected is a testament to the computational excellence of SAFL and that of our partner, Sandia National Laboratories." It also highlights the impact SAFL's unique laboratory facilities, such as the main channel and wind tunnel, as well as the new Eolos wind turbine field site in Rosemount, Minnesota, can make when coupled with state-of-the-art simulation-based research.

In addition to the DOE funds, $120,000 of additional funding is being contributed by the University of Minnesota Institute on the Environment's Initiative for Renewable Energy and the Environment (IREE). SAFL and the College of Science and Engineering will also contribute funds toward the purchase of a massively parallel computer cluster that will be used to run the numerical simulations. Additional computational resources will be provided by the Minnesota Supercomputing Institute.

For more information on the Eolos Wind Energy Research Consortium, visit www.eolos.umn.edu.

THE CASE OF THE DISAPPEARING DELTAS

SAFL's Delta Research (Un)Covers New Ground

Ganges River Delta, Bangladesh

NASA LANDSAT Image

THE WORLD'S DELTAS ARE INCREASINGLY AT RISK FOR DISAPPEARANCE DUE TO A VARIETY OF FACTORS INCLUDING A RISE IN GLOBAL SEA LEVELS, AND COMPACTION AND DOWNWARD SHIFT IN THE WETLAND AND DELTA FLOORS DUE TO NATURAL AND HUMAN-INDUCED INFLUENCES.

Deltas are distributary channel networks, meaning that as a river flows downstream, it forks into numerous, smaller channels to distribute water and sediment over a broad area. However, constructed features on deltas such as levees and control works can create superefficient channels that transport sediments into the sea, rather than allowing them to flow into the wetlands during floods. In fact, sediments that are deposited in the larger channels are often dredged in order to maintain the use of the channel for shipping. This means that the sediment that once allowed the wetlands to keep pace with sea level is no longer delivered to these areas, resulting in the increasing disappearance of wetlands underwater. Where possible, delta restoration efforts are needed to reverse land loss and restore wetlands by diverting sediment from the river onto the drowned wetlands. Equally important is a broader understanding of delta processes that can aid practitioners in managing human interaction with these complex systems.

Researchers at the St. Anthony Falls Laboratory (SAFL) are exploring the natural, self-sustaining processes of delta growth to better identify successful approaches for restoration and management efforts. Funded by the St. Anthony Falls Laboratory Industrial Consortium and the National Science Foundation, SAFL collaborators on deltaic systems research include Professors Chris Paola and Vaughan Voller, graduate students Man Liang, Antoinette Abeyta, Sarah Baumgardner and Dan Cazanacli, as well as post-doctoral researchers Nathanael Geleynse and Andy Petter. Using a combination

of theoretical modeling and experimental studies, this group seeks to understand the growth dynamics of deltas to help predict rates of growth, the shapes and elevations that delta growth will produce, and the overarching impacts in the delta ecosystem.

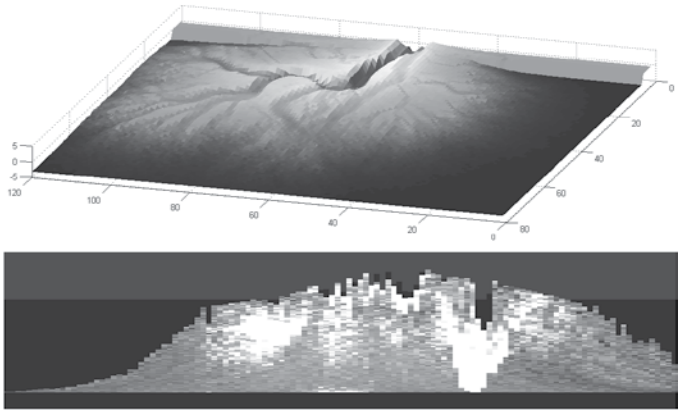
ABOVE
The SAFL delta research group including, from left, Antoinette Abeyta, Jorge Lorenzo-Trueba, Ted Fuller, Professor Chris Paola, Stephanie Day, Sarah Baumgardner, Ryan Littlewood, Andy Petter and Man Liang.

ISOLATING VARIABLES IN DELTA GROWTH PATTERNS

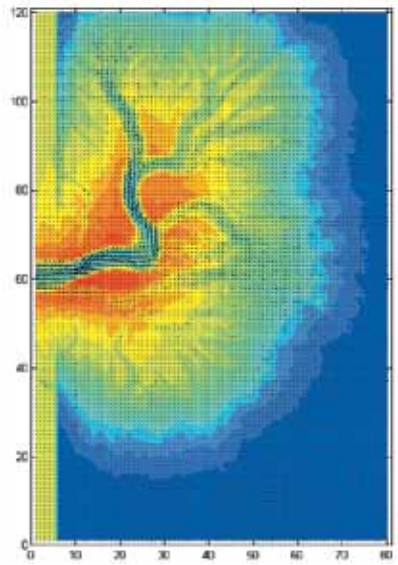
Given the complexity of deltaic systems, developing successful theoretical models that can predict the effects of various delta management inputs can be challenging. An important research initiative that has risen to the surface at SAFL is the development of a computational model that isolates and explores the most significant variables for large-scale pattern growth. This so-called *Reduced-Complexity Model* approach uses educated assumptions and process-based equations for fluid flow and sediment transport in delta channels. This establishes a framework for predicting delta evolution, including the effects of waves and tides.

The initial results produced from the SAFL model provide a reasonable reproduction of the features seen in existing deltas, and its dynamic processes such as abandonment of existing channels, formation of new channels, and bifurcation of a single channel. The model is also able to generate stratigraphy with coarse and fine sediment.

Next steps for this research project include rigorous comparison of the model against more detailed theoretical models, as well as against field and laboratory observation. Developing and testing this type of model can enhance understanding of how the processes in delta geomorphology interact with one another. The flexible structure and reduced complexity of these models can also better support hypothesis testing and education.



ABOVE
This image shows a slice of the stratigraphy in the strike direction (white - coarse sediment, gray - fine sediment).



LEFT
This image produced by the model demonstrates surface features such as contour of bed topography and flow vectors.

UNDERSTANDING AND PREDICTING UNDERWATER LANDSLIDES ON THE DELTA FRONT

Another significant aspect of delta research at SAFL explores how fine sediments create the morphology—form and structure—of deltas and how they are transported in freshwater delta systems, with special focus on the dynamics that create the front wall of the delta that slopes to the marine floor. This wall, called the delta front or foreset, builds up with sediment deposited from the river channel. Mass failures of the delta foreset, in which a body of sediment breaks away and avalanch-

es down the slope, can cause damage to underwater infrastructure such as pipes, turbines and communication lines, and can generate huge waves or tsunamis. This research provides new insight on how these failures develop on the delta foreset, what the conditions are just prior to a failure, and what causes the large landslides down the delta front.

Current experimental studies at SAFL have taken a novel approach to explore these unique sediment failures by creating a system that is characteristic of marine delta fronts. One important strategy is the development of new sediment mixes that act more like the clay-based sediments found in physical deltas to introduce into experimental trials. As a result, researchers have produced natural, self-organizing flows that are characteristic of the flows and deposits found on the delta front. Using research facilities at SAFL with experiments over multiple time scales, the team reproduced a series of delta front build-up and landslide events.

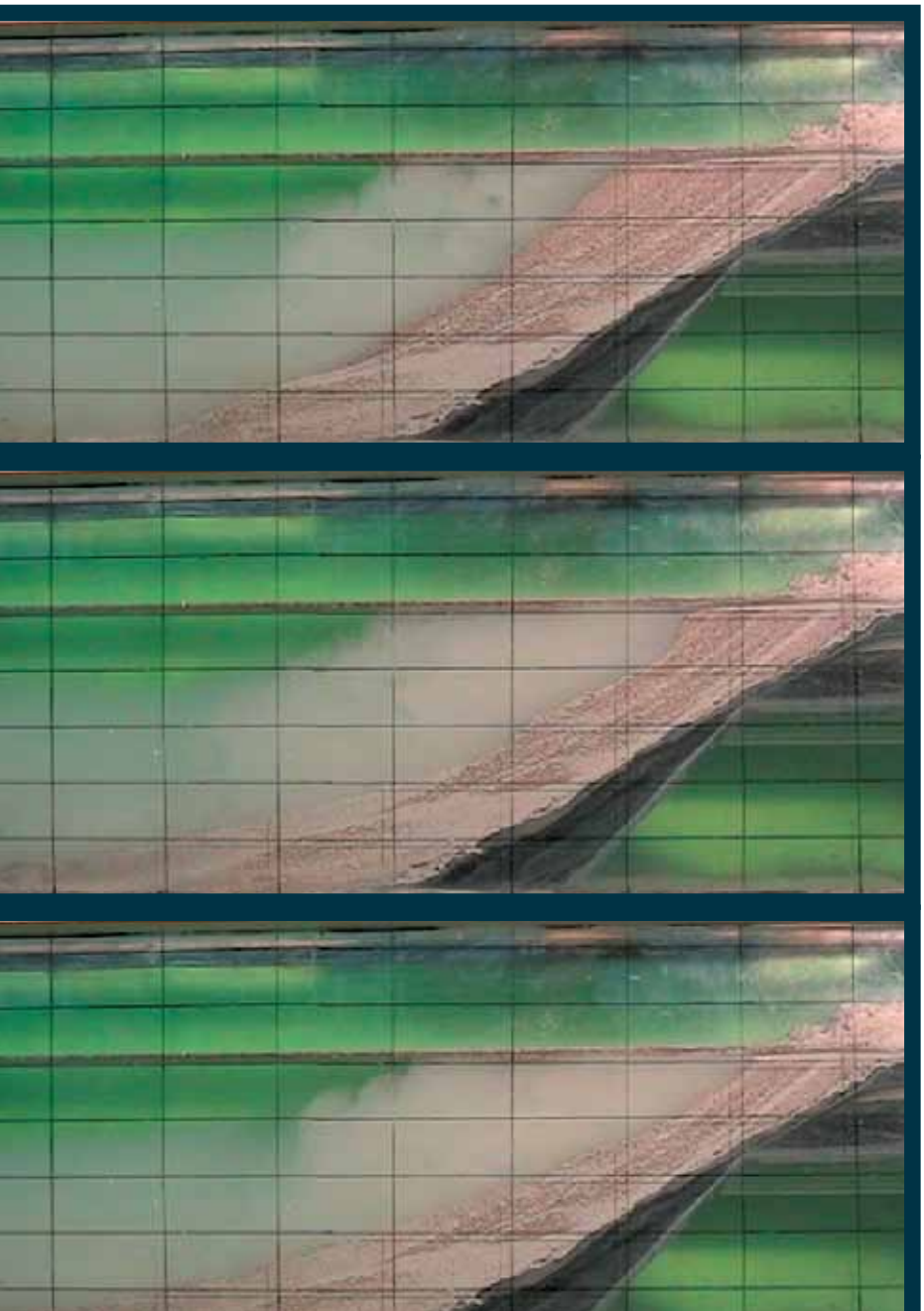
Now that initial experimental studies are completed, researchers are reviewing the data captured to pinpoint the precise times at which landslides occurred and the frequency and size of the failures. The results generated from examination of these experimental studies can help researchers and delta restoration and management practitioners identify the characteristics that signal an impending failure. Knowing what to look for can support early prediction of where and when these failures are likely to occur.

INFLUENCE OF WAVES AND TIDES ON DELTA SYSTEMS

Experimental studies are also delving into the relative roles of the river, waves and tides on delta morphology, using basic wave- and tide-generation equipment in SAFL's delta research facilities to produce small waves and rapid, shallow tidal cycles.

The team first builds a delta in ambient water over a period of approximately 550 hours, then introduces fluctuations in the water levels to simulate the movement of tides. Throughout the entire laboratory experiment, images capture the shape, size and changes of the delta. In addition, researchers scan the delta top with a SAFL-designed and built data acquisition carriage to show the networks and topography of the delta at the conclusion of the building phase, then again after the tidal phase is completed.

Although produced on a small scale, initial results from these experimental studies show the formation of tidal channel networks in deltaic systems. The research group first seeks to measure the shape and size of the delta at build out, and then examine and quantify any changes based on the introduction of tidal flows. Data gathered from these experiments about the relative impact of tides and waves on an experimental delta will help to identify the degree of influence each process has over the shape of deltas and coasts the world over. Combined with global wave and tide data and a data-



LEFT
Laboratory experiments demonstrating delta-front landslide events.
TOP: Before landslide
MIDDLE: During landslide
BOTTOM: After landslide

An experiment in SAFL's delta basin facilities investigating the effects of waves and tides on delta evolution.

base of river information, this research can help to predict which areas are most vulnerable to changes in wind and storm strength and direction resulting from global climate shifts.

LABORATORY AND COMPUTATIONAL RESEARCH

As human influence on deltas grows worldwide, researchers, policymakers and practitioners will be charged with making significant choices regarding delta restoration and management. If researchers can predict delta growth, shapes and elevations, and the ecosystem effects, delta management organizations can better manage human interaction with these complicated systems. As SAFL researchers continue to develop new computational models and groundbreaking experimental studies, new information can be gathered to demystify the numerous processes interacting simultaneously across deltaic systems. "Deltas are fascinating landscapes - at once vulnerable and resilient, home to extremely productive wetlands and millions of people, and capable of recording their own history through sedimentation," said Chris Paola, professor of Earth Sciences. "The better we understand them, the better we can live with them."

Future studies include exploration of the morphologic features that catch and trap sediments as they move through a channel; determining the mechanisms by which rivers, waves, and tides interact to shape deltas and their channel networks; quantification of the shoreline and channel patterns; and prediction of how the channel patterns and shoreline evolve in time and respond dynamically to changes such as rising sea level.

"DELTAS ARE FASCINATING LANDSCAPES - AT ONCE VULNERABLE AND RESILIENT, HOME TO EXTREMELY PRODUCTIVE WETLANDS AND MILLIONS OF PEOPLE, AND CAPABLE OF RECORDING THEIR OWN HISTORY THROUGH SEDIMENTATION. THE BETTER WE UNDERSTAND THEM, THE BETTER WE CAN LIVE WITH THEM." — Chris Paola

Remembering Ed Silberman

THE ST. ANTHONY FALLS LABORATORY FACULTY, STUDENTS AND STAFF ACKNOWLEDGE THE PROFOUND LOSS OF RENOWNED PROFESSOR AND FORMER DIRECTOR OF THE LABORATORY, EDWARD SILBERMAN, WHO PASSED AWAY UNEXPECTEDLY IN JULY 2011. PROFESSOR SILBERMAN WAS A PILLAR OF THE ST. ANTHONY FALLS LABORATORY, ENCOURAGING STUDENTS AND PARTICIPATING IN LABORATORY ACTIVITIES AND EVENTS LONG AFTER HIS RETIREMENT.

As a child in Streeter, North Dakota, Silberman's fascination with engineering and hydrology was evident in his play, as he created channels and networks for redirecting water. Silberman attended the University of Minnesota, earning his Bachelor's and Master's Degrees in Civil Engineering with high distinction. His Master's Degree was completed under the guidance of St. Anthony Falls Laboratory Founder Lorenz G. Straub.

After serving active duty in the U.S. Army Corps of Engineers during World War II, Silberman returned to the University of Minnesota, joining the St. Anthony Falls Laboratory as a research associate. His career flourished at the laboratory, where he rose through the ranks to the position of full professor in 1957. Professor Silberman served as director of the laboratory following the death of its founder, Lorenz Straub, from 1963 to 1974. Although formally retiring in 1981, Silberman continued to teach in an adjunct role for many years, and serve as a mentor and supporter for students in his role as professor emeritus until shortly before his death.

His long career included significant professional recognition, including honorary and lifetime memberships in the American Society of Civil Engineers (ASCE) and the Society of American Military Engineers (SAME). Silberman received the Charles W. Britzius Distinguished Engineer Award in 2008 by the Minnesota Federation of Engineering, Science and Technology Societies for his significant contributions and dedication to the field of engineering over his career and lifetime.

In recognition of his commitment to the laboratory and in celebration of his ninetieth birthday, the Silberman family established the Edward Silberman Fellowship Fund in 2004 to endow a lasting legacy in his name and to provide fellowships to students of the University of Minnesota's St. Anthony Falls Laboratory. Since its inception, the fellowship has supported ten exceptional graduate students as they pursue their studies in the field of engineering and hydrology.

Since retirement, Professor Silberman regularly attended the SAFL seminars, illuminating seminar topics with his astute observations and insightful questions. In April 2012, SAFL hosted members of the Silberman family for the Silberman Fellowship awards ceremony to honor this year's recipients. Professor Silberman's warm presence was missed by SAFL faculty, students, staff and guests alike.

To contribute towards the Edward Silberman Fellowship Fund, in honor of the legacy of Professor Silberman and his contributions to SAFL, send your gift, indicating Fund 7176 to the University of Minnesota Foundation, C-M 3854, P.O. Box 70870, St. Paul, MN 55170-3854. Or contact Sally Euson at (612) 625-6035 or euson@umn.edu.

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