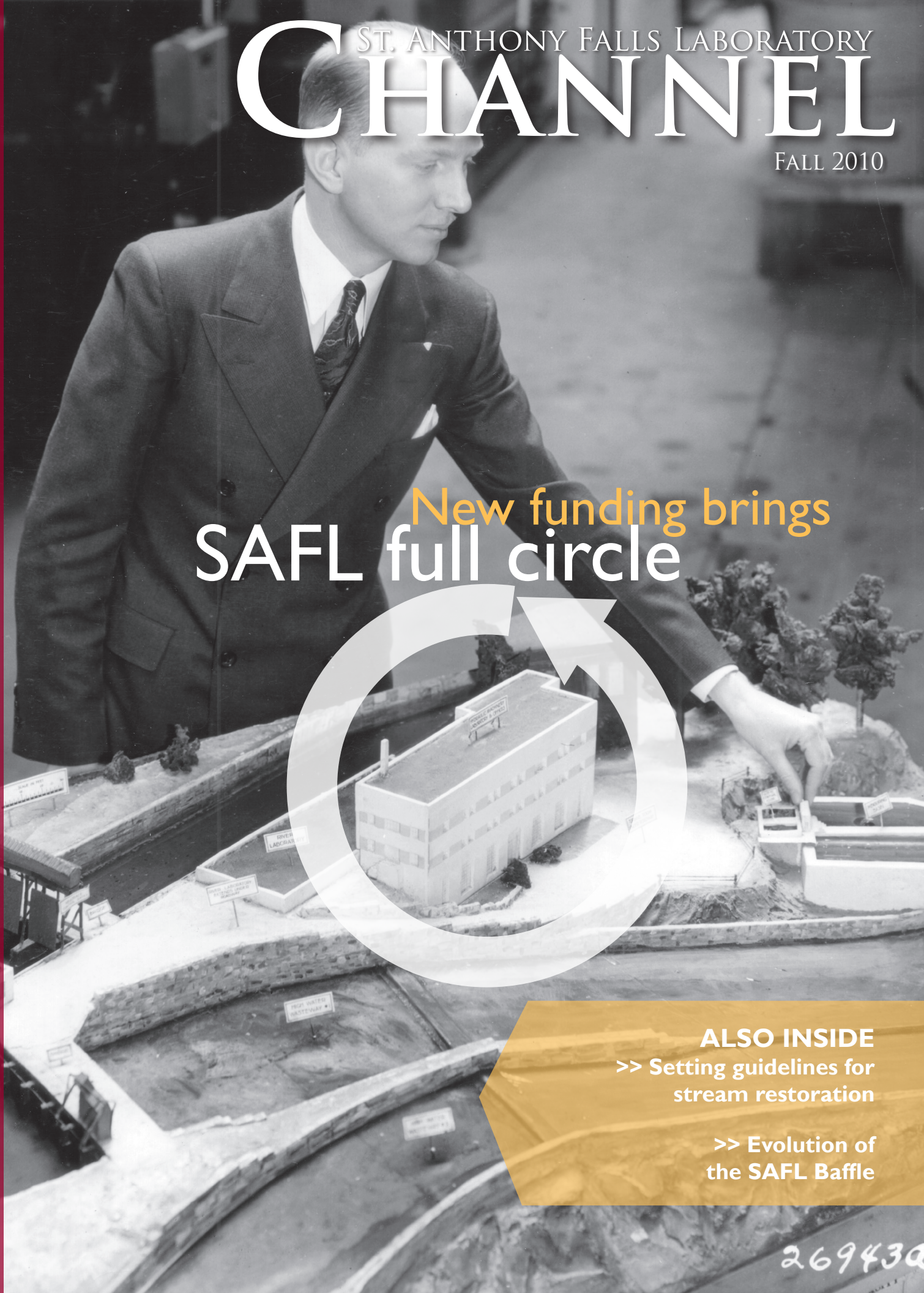
College of Science & Engineering | University of Minnesota

St. Anthony Falls Laboratory

Channel

Fall 2010

New funding brings SAFL full circle



ALSO INSIDE

>> Setting guidelines for stream restoration

>> Evolution of the SAFL Baffle

fall 2010

SAFL CHANNEL

departments

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The St. Anthony Falls Laboratory is a research unit of the University of Minnesota's College of Science and Engineering in the Department of Civil Engineering. The laboratory is also closely affiliated with the Department of Geology and Geophysics, and the Department of Ecology, Evolution, and Behavior.

Cover: SAFL's founder and first director, Lorenz G. Straub, pictured with an architectural model of the lab.

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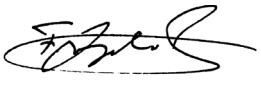
THE DIRECTOR'S PERSPECTIVE

This is a historic time for SAFL and I am very excited to communicate to you the news of the upcoming major renovation of this unique 72-year old national treasure. In the feature story of this issue you will read how SAFL will be able to continue leading the way in research and research training for many decades to come through a major infusion of federal and state funds. In a strange twist of fate, just as the lab was founded via the depression-era Emergency Relief Appropriation Act of 1935 it will now be renovated due to the American Recovery and Reinvestment Act and additional funding from the State of Minnesota. Since 1938 when SAFL opened its doors, the laboratory has been added to but never renovated. Time has taken its toll and the aging infrastructure of this historic facility is now in dire need of a major renovation more than ever. This new funding, totaling $15.8 million, will allow the lab to come full circle, upgrading and expanding its research leadership in areas such as renewable energy and environmental restoration well into the 21st century. A thorough design phase will last through 2011, with construction planned to begin in 2012 and last through October of 2013.

One of the many facilities that will be impacted by this new funding is the Outdoor StreamLab, which will receive a major boost with the development and installation of a new data collection carriage. The new carriage will allow OSL researchers to gather data more quickly and at finer resolution than currently possible. It will thus greatly augment our ability to do cutting edge stream restoration research, like the work described in "StreamLabs Aid Restoration."

As described in "Evolution of the SAFL Baffle," a group of SAFL researchers have recently made exciting advancements in a new filtration device to control stormwater runoff pollution. The SAFL Baffle has been so successful during test runs that the University's Office of Technology Commercialization intends to begin a new company based on the device.

Finally, I'm pleased to announce the organization of a major international symposium to honor the career of Heinz Stefan, who will be retiring at the end of this year. Professor Stefan's pioneering work has defined the field of environmental hydraulics, and I hope that many of you will join us next May to celebrate his prolific career and distinguished record of accomplishment.



—Fotis Sotiropoulos

Professor and Director, SAFL

honors & awards announcements

Professor **Efi Foufoula-Georgiou** was awarded an Institute on the Environment Discovery Grant for her project "Water Crisis in the 21st century: Global challenge, local solutions."

Professor Miki Hondzo is co-PI on a recent NSF award to develop robots that can detect oil spots in the Gulf of Mexico. Called "Aquapods," these robots will help assess and improve the oil spill cleanup progress. Prof. Nikos Papanikolopoulos (Computer Science and Engineering) is the PI for this project.

Professor **John Gulliver,** visiting researcher **Pete Weiss** (Valparaiso University), and research fellow **Andy Erickson** have received a U.S. EPA 319 grant, "Assessing Enhanced Swales for Pollution Prevention."

Eric Hettler (MS '10) was the recipient of the Department of Civil Engineering 2010 Best Master's Thesis for his thesis titled, "A Modified Elutriation Device to Measure Particle Settling Velocity in Urban Stormwater Runoff." His adviser is John Gulliver.

SAFL PhD student **Feng Xiao** was awarded the 2010 Floyd Forsberg Environmental Scholarship. He is the first University of Minnesota student and the first international student to receive this scholarship, which is awarded to someone who has potential to improve environmental quality. His advisor is John Gulliver.

in other news

>> SAFL's new renovation funding highlighted in myScience online (Sept. 21), Finance and Commerce (Sept. 22), the Pioneer Press (Sept. 23), and NSF's ARRA report online.

>> New wind energy consortium meets with town locals to discuss impacts of new turbine. Read about it in the July 30 Star Tribune.

>> *Integrating Coursework and Research*, an article on the establishment of the wind turbine at UMore Park, appears in the March 2 issue of the Minnesota Daily.

The City of Prior Lake has installed an iron-enhanced sand filter in two stormwater ponds based upon the research of research fellow **Andy Erickson**, professor **John Gulliver** and visiting researcher **Pete Weiss** (Valparaiso University). The enhanced sand filters are designed to remove dissolved phosphorus from runoff. The project manager was Ross Bintner.

The Office of Technology Commercialization has applied for a patent on the SAFL Baffle, an invention by adjunct associate professor **Omid Mohseni,** professor **John Gulliver,** and associate engineer **Adam Howard**. The SAFL Baffle was developed to assist in stormwater pollution prevention by retaining sediments that collect in storm sewer sumps and preventing washout during storms. The sumps can then be utilized as a pre-treatment device for more advanced treatment.

We are sad to announce the deaths of Feng Hsiao (Fred Shaw), who was a student at SAFL in the 1940s and founder of Shaw-Lundquist Associates, and former SAFL photographer Karl Wikstrom.

Dr. Frank Schiebe (PhD '71) was honored posthumously with Wayzata High School's distinguished alumni award for his contributions to research in watershed hydrology and environmental quality.

SAFL has partnered with the Institute on the Environment in organizing a workshop focused on wind energy. The event will take place on the second day of the E3 2010 conference (Dec. 1) at the St. Paul River Centre. The workshop will feature keynote speaker Megan McCluer from the U.S. Dept. of Energy, as well as session speakers from across the wind industry, academe, state government, and national labs. For more information, please visit www.environment.umn.edu.

COMING

COMING FULL CIRCLE. IN A WELL-DESERVED AND LONG-AWAITED BOON, THE ST. ANTHONY FALLS LABORATORY RECENTLY RECEIVED $15.8 MILLION FOR MUCH NEEDED RENOVATIONS TO THE AGING FACILITY.

As in the beginning, when SAFL was first envisioned by University of Minnesota leaders, the potential for expansion into new and exciting areas of engineering is palpable. And it is once again with the assistance of federal economic stimulus money, along with a generous infusion of state funds, that the lab is able to become a national leader in these areas.

Originally built in 1938 as a project of the Works Progress Administration, construction of the SAFL building was funded by the Emergency Relief Appropriation Act passed by Congress in 1935.

Based on the ambitious ideals of its first director, Lorenz G. Straub, SAFL was founded as a traditional hydraulics laboratory dedicated to research in hydraulic engineering. This primarily involved model studies of spillways, locks, intakes, piers, and other structures, with a central goal to provide the know-how for building the nation's civil water infrastructure.

Over its lifetime the lab has evolved from a focus on hard structures imposed on the natural environment, to a broader view that emphasizes sustainability research in the energy/environment nexus. After more than seven decades the lab is showing its fair share of wear and tear, but the new funding will bring it full circle, providing the renovation and upgrades SAFL needs to continue to play a leading role in research and research training.

This change in focus has inevitably led to the corresponding changes in personnel and goals of the lab greatly outpacing the evolution of its physical capabilities. Additionally, the explosive growth of interest in alternative energy and environmental science has created unprecedented demand for access to SAFL, but the building lacks the supporting infrastructure to adequately host its rapidly expanding research in these areas.

SAFL's unique range of facilities, from refined water chemistry labs to indoor and outdoor channels that route river water through the building, have made it a world center for quantitative environmental science. On the outside, SAFL is thriving as never before. The original concept of a laboratory located on and supplied by a major river remains as attractive as ever. But the original designers could not have foreseen what it would become, the diverse communities it would need to accommodate, or

FULL CIRCLE

even the severe effects the riverfront environment would have. Unfortunately, as new experimental facilities have been developed, and as generations of students, post-docs, faculty, and visitors have studied and measured and learned in this unique laboratory, the building itself has been slowly decaying around them.

And so what was a modern laboratory in 1938, brilliantly sited to capitalize on the water provided by St. Anthony Falls and fully equipped for scale model experiments, is now strained to the breaking point. In addition, the building's age and exposure to moisture and temperature extremes have led to serious structural deterioration.

Although SAFL has undergone a few additions (namely an elevator in 1959- defunct since 2003, an office wing in 1963, and the wind tunnel in 1987), the building has never been renovated since its construction. Limited by both code restrictions and available funding, upgrades over recent years have mainly consisted of repurposing existing space. These projects have included the ecofluids lab, server room, video conferencing system, conversion of part of the library into office space, updated electrical circuitry, and new exterior signage.

A major transformative change that occurred at SAFL was the creation in 2002 of the National Center for Earth-surface Dynamics (NCED). Although NCED has deeply influenced the culture and activities of SAFL, it has been constrained by its own funding rules from paying for any major infrastructure upgrades of the building.

Over the past decade the lab's administrators have worked to prepare SAFL's physical structure to match its growth in new research areas. Both the Master Plan (completed in 2005), and the Facility Assessment and Improvement Plan (completed in February 2006), were necessary in designating the lab officially "fit for rehabilitation" and therefore sanctioning physical improvements. This led to the replacement of the badly deteriorated upper deck in the fall of 2009, a critical step in allowing future construction work to occur.

These efforts to realize a new future for the lab were rewarded this fall, when SAFL received $7.1 million from NSF's Academic Research Infrastructure program, funded under the American Recovery and Reinvestment Act, to invest in the repair and renovation of existing research facilities. The University of Minnesota will contribute an additional $8.7 million via a Higher Education Asset Preservation and Replacement appropriation from the Minnesota Legislature for critical building repairs.

"WE ARE INSPIRED BY OUR RICH LEGACY AS WE MOVE FORWARD TO TACKLE THE MAJOR SUSTAINABILITY CHALLENGES OF OUR TIME..."

— Fotis Sotiropoulos

The new funding is much like a renewal of the original partnership between the federal government and the University when the lab was first built, and will now enable SAFL to serve society's needs as effectively over the next 70 years as it has over the past 70.

"Today SAFL continues to serve Straub's vision by emphasizing academic excellence and research scholarship, while staying at the cutting-edge of fluid mechanics research," SAFL Director and the NSF grant principal investigator Fotis Sotiropoulos said. "We are inspired by our rich legacy as we move forward to tackle the major sustainability challenges of our time, adding new pages to the history of this unique research facility."

Prior to receiving the award(s), the lab was required to undergo a rigorous NEPA (National Environmental Policy Act of 1969) environmental assessment, ensuring that structural, historical, and aesthetic considerations were thoroughly addressed before any changes were made to the building.

In addition to addressing basic infrastructure deficiencies, the new funding will allow upgrades to the research facilities necessary for supporting SAFL's new programs in renewable energy systems, environmental restoration, and collaboration— an agenda which contributes to the larger University commitment to environmental education.

Specific changes will result in upgrades to the building's utilities (electrical service, plumbing, city water supply, and HVAC will be brought up to code compliance); accessibility (the building will be brought up to ADA standards, including new door handles, elevator, stairways, security and access); and fire safety (a sprinkler system will be added throughout the building).

SAFL will also use the funding to enhance existing facilities and expertise toward improving wind-power efficiency and reliability; optimizing water-power energy devices and assessing their environmental impact; expanding biofuels research focusing on algal bioreactors; enhancing environmental restoration and management, including streams, rivers and deltas; and allowing researchers, practitioners, and a broad spectrum of learners to participate in SAFL through cyber-collaboration and virtual experiments.

Six main research facilities have been identified for renovations: the wind tunnel, main channel, ecofluids lab, delta basin, XES basin, and the Outdoor StreamLab. In support of SAFL's new endeavors in wind energy research, the wind tunnel is slated to receive improved insulation, upgrades to the turning vanes, and greater humidity control. In support of the lab's new projects in hydrokinetic power, the main channel will receive repairs

SIX MAIN RESEARCH AREAS HAVE BEEN IDENTIFIED FOR RENOVATION:

WIND TUNNEL

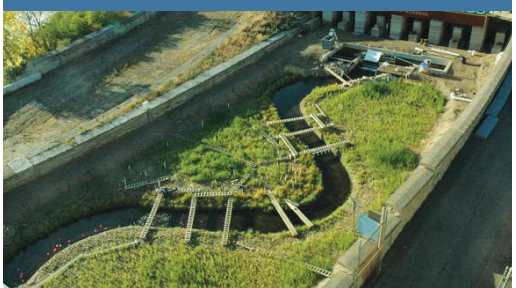
MAIN CHANNEL

ECOFLUIDS LAB

DELTA BASIN(S)

XES BASIN

OUTDOOR STREAMLAB

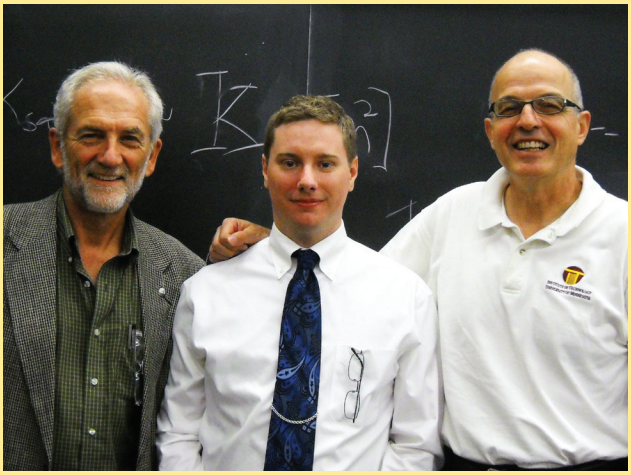


to the gate house and material handling cranes, renovation of the volumetric tanks, upgrades to the wave generator system, and general repairs to the facility. In support of ongoing work in the area of biofuels, the ecofluids lab is slated to expand into the turbine test stand, and a transparent flume will be constructed for use in growing algal populations. A separate inorganic wet chemistry laboratory will be built to reduce congestion. In support of research in the area of delta restoration, a wave and tidal generator will be added to the XES basin (Jurassic Tank), which will be expanded to a full basin. All general space will receive renovations to electrical, structural, and plumbing systems.

The lab's renovation will transform all research and research training conducted at SAFL by rejuvenating a building that has deteriorated to the point where, if nothing is done, infrastructure alone will bring SAFL's operation to a halt. These physical changes mean a major step in the transition of SAFL from a hydraulics laboratory to an interdisciplinary laboratory in engineering, environmental, biological, and geophysical fluid dynamics, with a focus on renewable energy and environmental restoration and management. Advances in remote sensing and monitoring will aid in this transformation, greatly expanding the opportunities for collaboration and education across disciplines and locations.

"This is a historic moment for SAFL and the University of Minnesota," said Sotiropoulos. "Since its inception, the laboratory has been a leader in science-based solutions to major environmental and energy related problems through research, education, and outreach. This renovation will enable us to continue and expand our leadership role well into the 21st century."

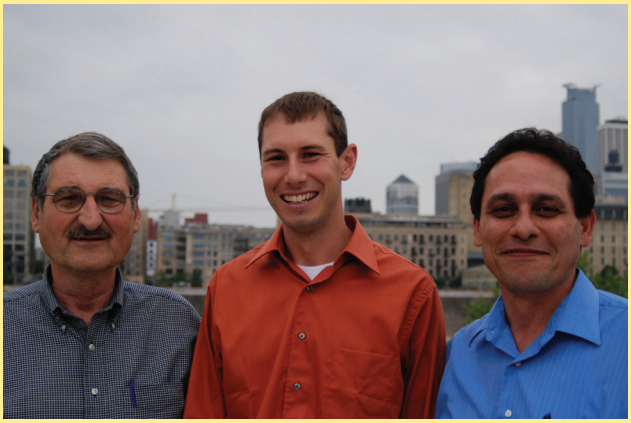
congrats grads



Nick Olson (MS '10) with advisors John Nieber (left) and John Gulliver (right)

Eric Hettler (MS '10) with advisor John Gulliver

David Saddoris (MS '10) (Advisors John Gulliver and Omid Mohseni not shown.)



Adam Howard (MS '10) with advisors Heinz Stefan (left) and Omid Mohseni (right)

Seokkoo Kang (PhD '10) with advisor Fotis Sotiropoulos

STREAMLABS AID RESTORATION

ABOVE
In-stream structures in the Outdoor Streamlab.

THE VALUE OF ENVIRONMENTAL HEALTH MAY BE IMPOSSIBLE TO PUT A PRICE ON, BUT THERE'S NO DOUBT THAT STREAM RESTORATION IS AN EXPENSIVE BUSINESS. ACCORDING TO A 2005 STUDY REPORTED IN THE JOURNAL SCIENCE, OVER $14 BILLION WAS SPENT ON RESTORATION ACTIVITIES IN THE U.S. ALONE BETWEEN1990-2005. TYPICALLY THESE PROJECTS AIM TO IMPROVE WATER QUALITY, AQUATIC ENVIRONMENT, AND BANK STABILITY. UNFORTUNATELY, ALTHOUGH THEY ARE OFTEN COSTLY, THEY ARE NOT ALWAYS SUCCESSFUL. RESEARCHERS AT SAFL ARE WORKING TO CHANGE THOSE STATISTICS WITH A COLLABORATIVE PROJECT FUNDED BY THE NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM AND THE NATIONAL CENTER FOR EARTH-SURFACE DYNAMICS.

This past May, Outdoor StreamLab (OSL) manager Jessica Kozarek and a team of five student interns hauled heavy rocks into the OSL. One by one the rocks were deposited in the stream channel as Kozarek and the interns dutifully erected three sets of structures commonly used in stream restoration projects. In this case however, the structures were not intended to remedy bank erosion or improve deteriorating fish habitat. Instead, Kozarek and her research team were installing the structures to help develop guidelines for their future use.

Man-made, in-stream structures such as those built by Kozarek in the OSL are ubiquitous components of stream restoration projects throughout the United States. They are commonly employed with the intention of stabilizing beds and banks, preventing lateral migration, and improving aquatic habitat diversity. Despite their widespread use however, quantitative engineering standards for the design and installation of the structures do not currently exist, a dearth which the three components of the SAFL StreamLabs—indoor (ISL), outdoor (OSL), and virtual (VSL)—are ideally suited to address.

"In order to succeed in restoring streams we need to accurately predict flow patterns around in-stream structures and understand the underlying flow physics," said Kozarek.

The StreamLabs project brings together Kozarek, former OSL manager Anne Lightbody, Principal

Investigator Fotis Sotiropoulos, and Virginia Tech Professor Panos Diplos, in a joint effort to establish guidelines that can be used in real-life restoration projects.

The group is combining the OSL research with field studies, indoor experiments, and numerical modeling to develop quantitative, comprehensive engineering guidelines, design methods, and specifications for installation, monitoring, and maintenance of in-stream structures.

After assembling three sets of three types of structures—J-hooks, rock vanes, and bendway weirs—in the OSL this past summer, Kozarek and visiting Virginia Tech student Read Plott worked with interns to map their effects on patterns of flow velocity, scour, and deposition within the stream channel. The preliminary results of the work indicate that different structures create different patterns of scour and deposition, and that the effects of the structures vary depending on their location within the stream's bend. The size and location of scour has implications for structure stability and secondary benefits such as fish habitat.

"IN ORDER TO SUCCEED IN RESTORING STREAMS WE NEED TO ACCURATELY PREDICT FLOW PATTERNS AROUND IN-STREAM STRUCTURES AND UNDERSTAND THE UNDERLYING FLOW PHYSICS."

— Jessica Kozarek

The data from the OSL will be combined with that collected through field and Indoor StreamLab investigations by SAFL researcher Craig Hill, and used within Sotiropoulos' numerical stream model, the Virtual StreamLab, to test many different scenarios of structure installation and stream flow. The goal is to understand the unsteady, three-dimensional character of the flow in the vicinity of structures and the complex and poorly understood interaction between the flow and the bed.

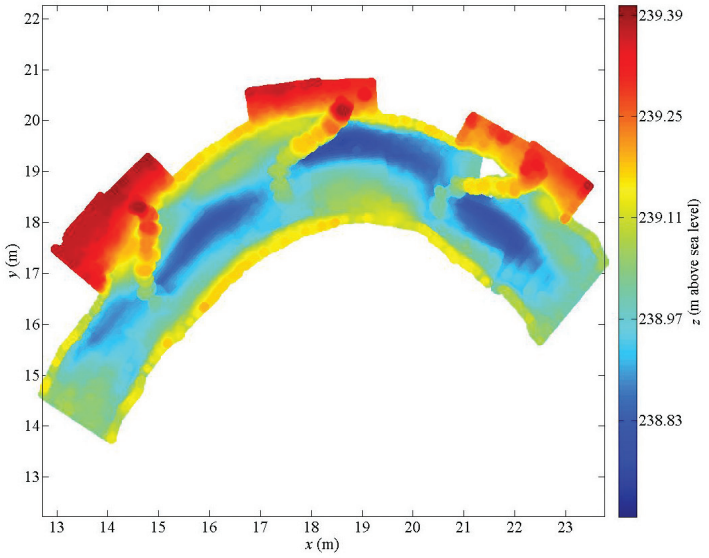
OSL manager Jessica Kozarek working with summer interns Thomas Wangerin and Chris Milliren to install a rock vane

INDOOR STREAMLAB

The Indoor StreamLab data was collected during a series of small-scale physical model experiments in SAFL's tilting bed flume designed to measure three-dimensional flow velocities downstream of flow control structures. There were two phases to the ISL experiments: The first phase focused on collecting three dimensional velocity data downstream of structures installed over a non-mobile gravel bed. The second phase focused more on the spatial and temporal evolution of the scour hole and deposition downstream of structures installed over a mobile bed.

"One of the advantages to using SAFL's tilting bed flume was its built-in data acquisition cart, which enabled us to gather highly precise data throughout the experiments. Another potential benefit is that we can set various bed slopes in this flume, and study how that might affect structure performance," said Hill.

Researchers are also able to use this data to compare effects from structures in the tilting bed flume's straight channel versus effects found in the meander bend in the OSL. These experiments served as a way to test many different structure types and arrangements, and provide high resolution topography data and downstream turbulence characteristics for comparison against the results from the Virtual StreamLab numerical modeling.



VIRTUAL STREAMLAB

The Virtual StreamLab component has been led by Seokkoo Kang and Ali Khosronejad, postdoctoral associates working with PI Fotis Sotiropoulos. The team has developed a novel numerical model to simulate turbulent flows and sediment transport in natural meandering streams with arbitrarily complex nature and man-made structures. By applying it to carry out LES and URANS simulations in the Outdoor StreamLab, at a resolution that can capture vortex shedding from centimeter-scale roughness on the stream bed, this model can address the geometric complexity of natural streams and the turbulent flows found around in-stream structures.

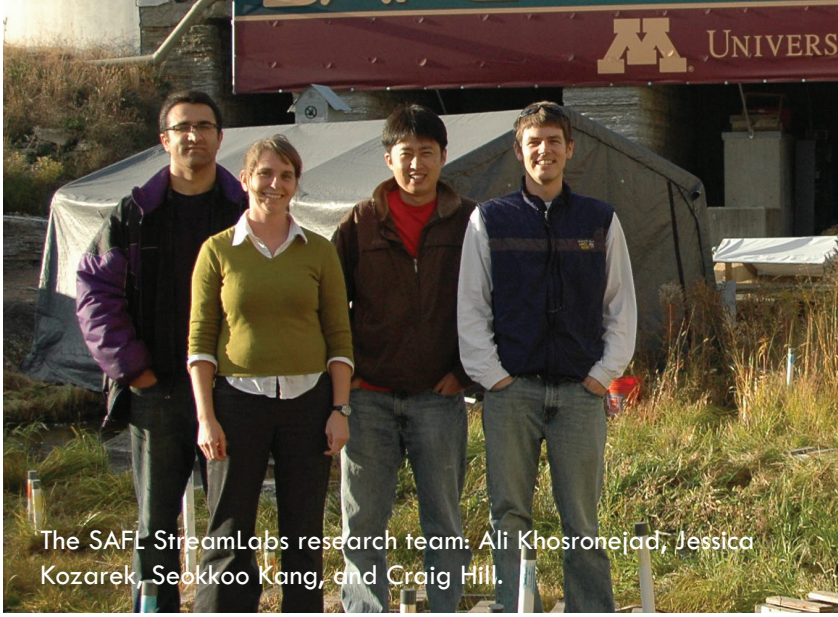
Providing new insights into the role of large-scale roughness in flow behavior, these simulations have specifically led to a greater understanding in the three-dimensional structure, interactions, and governing mechanisms of the inner and outer bank secondary flow cells and recirculation zones in the pools.

"These simulations have provided us with unprecedented insights into the structure of turbulence in a natural waterway, and suggest important links between stream hydrodynamics and morphodynamics," said Sotiropoulos.

"The experimental capabilities generated through the use of all three components of StreamLabs are really exciting," explained Kozarek. "Putting data from the Indoor and Outdoor StreamLabs into the Virtual StreamLab will give us insight into the flow fields around each structure at a much finer scale than we can measure in the field. The VSL will also allow us to test many more scenarios than would be practical using one facility alone. The breadth of the results of this study will have a big impact on the use of these structures and therefore the practice of stream restoration."

FUTURE PLANS

Although these studies have led to great strides toward improving restoration guidelines, more work is needed to continue developing accurate models. SAFL's recent $7.1 million grant from the National Science Foundation Academic Research Infrastructure program, and the additional $8.7 million award for renovations from



The SAFL StreamLabs research team: Ali Khosronejad, Jessica Kozarek, Seokkoo Kang, and Craig Hill.

the University of Minnesota, will allow the lab to elevate its efforts in collaborative stream restoration research to an unprecedented level.

A portion of the funding will be used to design and fabricate an instrumentation carriage capable of accurately positioning sensors anywhere in the basin. The carriage will provide non-disruptive access while taking high resolution measurements (sub-mm to cm scale) of both the channel and floodplain, in a fraction of the time it currently takes to scan the channel. This will enable researchers to examine ecogeomorphic processes at a finer temporal and spatial scale over a wide range of flow conditions, contributing greatly to well-informed guidelines for future restoration projects.

DEBORAH HUDLESTON & MAIA HOMSTAD


Flow visualized in the OSL with the use of confetti showing no in-stream structures (right) and with three J-hooks installed (left).

UNIVERSITY OF MINNESOTA

COLLEGE OF Science & Engineering

Gift Form

Nels Nelson

1951–2010

Nels Nelson was a highly-respected leader in the water resources field. He was also a man of great intellect and vision, widely known and admired for his broad knowledge and graceful leadership. A product of the University of Minnesota's graduate program at the St. Anthony Falls Laboratory, Nels spent his 30-year career at Barr Engineering Company. There he became a friend and mentor to countless Barr employees. His untimely death from brain cancer in January 2010 was both a personal and professional loss to his many friends and colleagues in the community.

Barr has established the Nels P. Nelson Fellowship Fund, an endowment for graduate students at the St. Anthony Falls Laboratory. Your contributions are greatly appreciated.

Please contact Sally Euson at 612-625-6035 or euson@umn.edu for additional information on options for giving.

Gift Designation

Your gift will go to the Nels Nelson Fellowship Fund, (fund # 8261), established at the University of Minnesota by Barr Engineering Company. The impact of your gift will be doubled; we are pleased to note that your gift will be matched on a dollar-for-dollar basis through the University's 21st Century Graduate Endowment Fund.

Giving Method

❑ Check

Enclosed is a check for $ _____ payable to the University of Minnesota Foundation/Nels Nelson Fellowship Fund.

❑ Pledge

I (we) pledge $ _____ .
I (we) will make payments in the amount of
$_____over_____ years,
beginning _____(month) of _____ (year).

❑ Enclosed is my first pledge payment of $ _____ .
❑ Please send annual reminders in _____ (month).
❑ Please do not send reminders.

_____ _____
Signature Date

❑ Credit Card

Charge my gift of $_____ to
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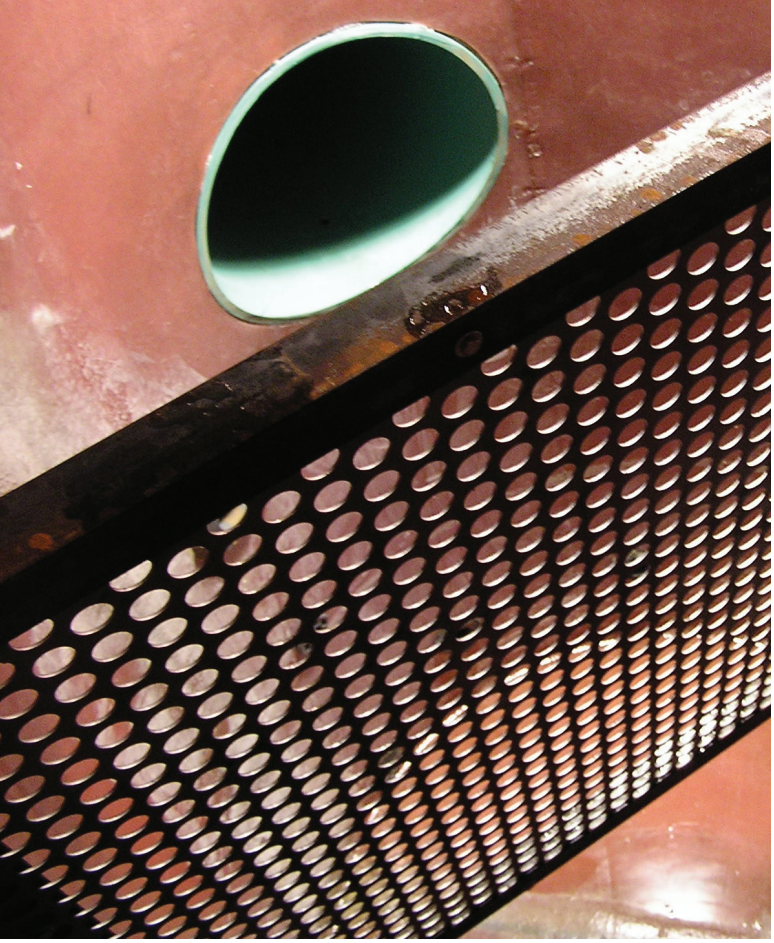
ANNUAL PICNIC

PHOTOGRAPHY BY MAN LIANG



EVOLUTION OF THE SAFL BAFFLE

From standard sumps to pollution preventers

LIKE OTHER GREAT IDEAS AT SAFL, IT BEGAN AS A SPARK IN THE DARK BASEMENT OF THE LAB'S UNDERBELLY. IT WAS IN THIS FAR CORNER OF THE LOWEST LEVEL– NOT FAR FROM THE LINE ON THE WALL THAT MARKS THE FLOOD OF '65 – WHERE A TEAM OF RESEARCHERS TESTING STORMWATER FILTRATION DEVICES DEVELOPED AN IDEA TO CONTROL RUNOFF POLLUTION.

Between 60-180 pounds of debris per acre collects in stormwater sumps across the U.S. annually. Although standard stormwater sumps perform fine under "normal" circumstances, successfully capturing suspended sediment during small storms, flooding causes the previously settled sediment and debris to wash out into nearby rivers and lakes. The inability to retain captured sediment under high flows is especially evident in shallow sumps, and as sediment accumulates at the bottom of the sumps, more and more debris washes out. Over time, as these washouts accumulate, the efficiency of the devices plummets.

Based on a series of washout tests developed in part by former graduate student David Saddoris (MS '10), associate engineer Adam Howard (MS '10) noted that sediment deposited at the bottom of the sump was moved upstream and deposited by a large vortex in the lower portion of the sump. At the end of a washout experiment the sediment surface developed a strong slope from a high elevation just below the inlet pipe to a low elevation below the outlet pipe. This vortex flow pattern demonstrated the rotation induced by downstream flow at the water surface, and the associated flow in upstream direction along the sediment bed. The research team (led by advisors John Gulliver and Omid Mohseni) concluded that this circulation pattern was enabling captured sediment to wash out of the sump, making the device essentially ineffective.

LIMITED OPTIONS

Those in charge of managing urban stormwater runoff are inevitably faced with devices that eventually lose their ability to function as well as they once did. One option is for managers to increase maintenance, manually removing the debris more frequently to help keep the devices functioning. Unfortunately, this would add additional costs to often strained municipal budgets.

Another alternative is to install (or replace existing sumps with) hydrodynamic separators— a higher-tech and more efficient proprietary version of a sump.

To investigate this option, SAFL researchers ran comparison tests on a series of hydrodynamic separators, and concluded that standard sumps have two main advantages over their proprietary counterparts: since they don't require any internal components, they're much less expensive to purchase and maintain. In addition, many standard sumps already exist in urban stormwater collection systems, and replacing them would be cost-prohibitive.

A BREAKTHROUGH

Since the standard sump has already proven effective at capturing sediment, the research team concluded that a retrofit to help retain the sediment during high flows would be the most efficient and cost-effective solution. Lab engineers set out to design such a device and rate its performance during high flow conditions.

Over the course of a year, tests were performed on sumps preloaded with sediment. A breakthrough was reached when the team successfully designed a simple porous baffle to break the circulation pattern and dissipate the energy of the plunging inflow to a sump. The

results showed that with the right dimensions and porosity, they could design a baffle that eliminated up to 90% of the washing out that usually occurs.

They named it the "SAFL Baffle," and the final design resulted in a 46% porosity flow-through plate positioned perpendicular to the flow and extending above and below the inlet pipe crown and invert. It was first evaluated in a 1:4.17 Froude scale model, and then installed for prototype testing. The results of the full scale tests showed that the SAFL Baffle improves sediment capture by 10 to 15% and can decrease effluent concentrations from 800mg/L to 50mg/L (or less) for sediment washout.

Performance functions were used to predict yearly removal efficiencies for retrofitted sumps. For example, studies show that in Minneapolis, where the 10-year design storm is 4.2 inches in 24 hours, installation of the Baffle could result in nearly complete elimination of sediment scour. The data collected clearly shows that standard sumps retrofitted with the flow-through SAFL Baffle can be used to successfully treat stormwater runoff.

FUTURE DIRECTIONS

Despite such promising sediment retention results, the research team was still faced with the real-life issue of floating debris. Floating items, like leaves, wood, and plastic block the sump's exits, clogging up the whole system and making it much less efficient. With funds from the Minnesota Department of Transportation, the SAFL team simulated trash and vegetation collection in a sump with a Baffle, and quantified the device's performance at varying flow rates. Graduate student Kurt McIntire ran a series of tests simulating this debris, and similar to the sediment tests, results confirmed the SAFL Baffle is an inexpensive method to turn a standard sump into a pollution prevention device.

In a little under one year since the Baffle was released to the public, it has already been placed in the specifications for multiple local metro projects. In addition, the University of Minnesota's Office of Technology Commercialization has identified a large U.S. and international market for the SAFL Baffle, and plans to begin a new company based on the device. Investors and manufacturers have already demonstrated a strong interest; patent procedures are in progress, and the new company is on track to launch in January 2011.

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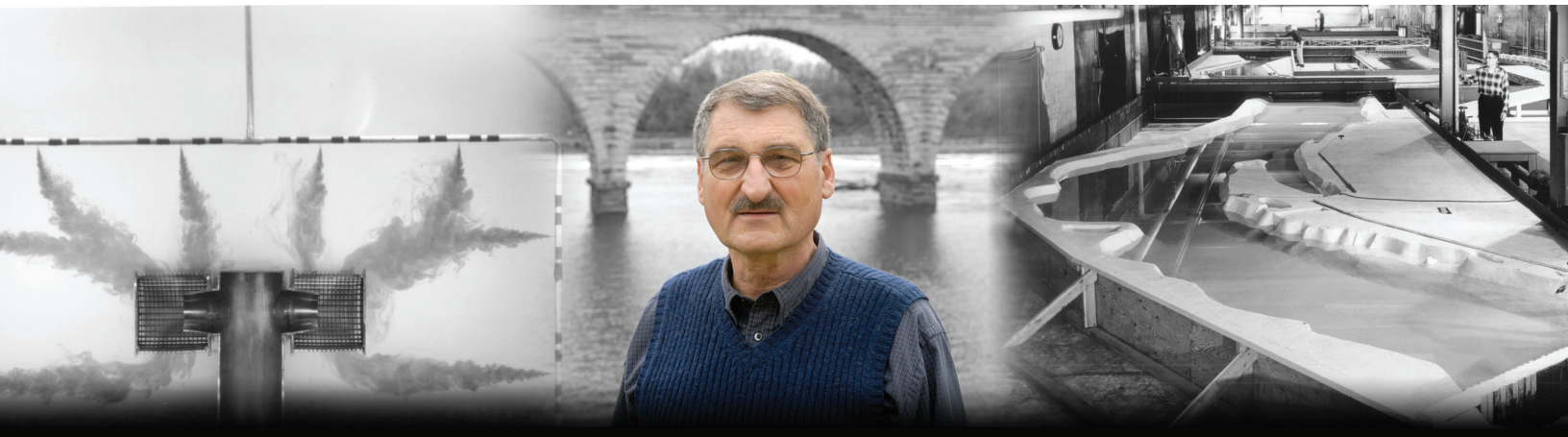

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