STORMS, ANIMALS AND SMARTER BUILDINGS

MICHEL BOUFADEL'S RESEARCH ON HOW HURRICANE SANDY AFFECTED THE NEW JERSEY SHORELINE WILL HELP OFFICIALS CHART THE BEST PATH TO RECOVERY.

ERIC FORTUNE'S RESEARCH ON ANIMAL BEHAVIOR COULD HELP UNLOCK THE MYSTERIES OF THE HUMAN BRAIN.

MARTINA DECKER'S INVESTIGATION OF NEW, SMARTER BUILDING MATERIALS COULD CREATE A MORE SUSTAINABLE ENVIRONMENT.

All three are new faculty members at NJIT and each personifies the university's commitment to leading-edge research. Altogether in the fall of 2012, NJIT hired more than 20 new faculty members – among the best and the brightest in their fields – whose research falls into three broad categories: "digital everyware" (ubiquitous computing), life and healthcare science and engineering, and sustainable systems. These three faculty focus on sustainability and the life sciences. Highlighted on September 13 at a special symposium preceding NJIT President Joel Bloom's inauguration, their research holds the promise of improving the environment as well as the quality of life for residents of New Jersey and the nation.

Consider, for instance, the work of Boufadel, a professor of civil and environmental engineering. A few days after Hurricane Sandy hit, the National Science Foundation (NSF) awarded him a Rapid Response Research Grant. That grant allowed him to immediately take a team of researchers to the beaches of Raritan Bay. The team, which included two NJIT faculty colleagues and five students as well as Boufadel, fanned out over the shoreline to gather data on the area's delicate ecosystems.

The team is evaluating the shift and erosion of the sand. It is also measuring the runoff of fertilizers, pesticides and other compounds into the Bay. Wetlands surround the Raritan Bay, moreover, and the team is measuring the impact of the storm on the wetlands. Closer to campus, the team is also observing how the storm-related influx of seawater into the Passaic River affected the fish population.

Boufadel is working with Professor Nancy Jackson, a coastal expert whose research focuses on beaches and dunes, and Assistant Professor Liping Wei, a biochemist who studies water pollution and bioremediation. *[continued on page 18]*

RIGHT: Professor Michel Boufadel traveled to the New Jersey shore to survey the impact of Hurricane Sandy.

PHOTO: MARKETA VODICKOVA

Jackson and Wei are members of the Department of Chemistry and Environmental Science. The team also includes NJIT undergraduate and graduate students.

"In essence we are evaluating the resilience of these ecosystems," says Boufadel, who directs the Center for Natural Resources Development and Protection at NJIT. "If any of the ecosystems were impaired by the hurricane, we'll monitor their ability to recover."

The National Science Foundation grant extends for one year, Boufadel says, after which he'll send his research findings to the NSF as well as to municipal and state officials in New Jersey. He hopes the officials will use his team's findings to "chart the best path to recovery to restore our beaches and coastline."

The NSF awards Rapid Response Grants to well-established researchers who can help the nation contend with emergencies. Boufadel is a nationally-known water expert with a distinguished history of publication and research. He has investigated the Exxon Valdez spill and the BP Deepwater Horizon blowout in the Gulf of Mexico and served on the National Academies committee that evaluated the blowout's impact on the Gulf of Mexico's ecosystem. He's also served on the Environmental Protection Agency's advisory board for natural gas extraction and shale formations and has studied floodplain delineation and contamination of urban streams for the Federal Emergency Management Agency (FEMA). In terms of scholarship, he has published more than 80 articles in journals such as *Nature, Geoscience* and *Water Resources Research.*

Boufadel's goal at NJIT is to continue to collaborate with fellow investigators on publishable research that furthers science while also improving the public good. "Our current research will help officials respond to a storm that wreaked havoc on the shoreline," Boufadel adds. "NJIT has the technological expertise to become the steward of the Jersey shoreline – and that's precisely what we intend to become."

Associate Professor Eric Fortune at the Tiputini River in Ecuador, where he has recorded data from weakly electric fish that could yield insights into human neural activity.

SEEKING NEURAL INSIGHTS

Whereas Boufadel focuses on the environment, Eric Fortune, who studies the brain, focuses on how animals control their behavior. His research on animal behavior could help scientists understand the human brain and also help engineers learn how to build better robots.

Currently, Fortune is studying duetting in plain-tailed wrens and the coordination of movement in weakly electric fishes. The wren's brain is wired to allow it to sing amazing cooperative duets with other wrens. Similarly, he studies the movements and social behaviors of weakly electric fish as they cooperatively control their sensory world. And it is those socially coded aspects of behavior that fascinate Fortune, who travels to Andean cloud forests, including sites on the sides of volcanoes, and the Amazon River basin in Ecuador to study these remarkable animals.

"I study how the brains of animals control their behavior," says Fortune, an associate professor of biological sciences. "Generally speaking, animals use the same neural strategies as humans do. The animals I study may seem esoteric – humans certainly do not have an electric sense like electric eels or electric fishes – but these animals have unique features that permit sophisticated experiments to address questions that are difficult if not impossible to study in humans or other animals. My research addresses fundamental questions about brain function that will help us better understand how human brains control our own behavior."

Fortune has written articles for many peer-reviewed journals, including the prominent journal *Science*. That paper described his research on the plain-tailed wren. He has also published papers in the *Journal of Neuroscience, PLOS Computational Biology,* and the *Journal of Experimental Biology*.

Fortune is a neurophysiologist by training, but he calls upon engineering techniques in his research. Teaming up with engineers, he says, "has been the most transformative thing that has happened to me in the last ten years."

Fortune co-wrote a chapter of a book with an engineer, a former colleague who is a robotics expert. The chapter discussed what roboticists could learn from animal behavior, and how robots can be used to better understand biology. Robots can execute repetitive behaviors with extreme precision, he says, and they generate forces far beyond the capacity of animals. Animal behavior, however, is far more flexible and robust than robotic behavior.

"Animals have evolved to be fault tolerant and to achieve a behavioral outcome using an array of strategies that are only partially predetermined," he says. "Learning how the control systems of animals are built – literally their neural circuits in the context of the whole organism – has and will continue to inspire design features that can improve the flexibility and robustness of engineered systems."

What Fortune enjoys most about research are the intellectual puzzles that must be solved to produce scientific results. His study of cooperative singing in plain-tailed wrens has been the most scientifically popular of his projects as well as one of the most enjoyable. "There is only one way to describe what it's like to study wrens that live on the side of a volcano," he says. "It's a blast."

"I'LL WORK CLOSELY WITH RESEARCHERS HERE AS AN EXAMPLE OF HOW NJIT UNITES SCIENCE AND TECHNOLOGY WITH ARCHITECTURE AND DESIGN TO DEVELOP NEW SUSTAINABLE TECHNOLOGIES." *– Assistant Professor Martina Decker*

SMARTER SUSTAINABLE BUILDINGS

Most architects are content to use existing building materials, but Martina Decker, an environmentally-concerned designer with a keen interest in technology, wants to create new building materials.

Decker, an assistant professor in the College of Architecture and Design (COAD), has partnered with scientists to create new building materials that have the potential to make buildings more sustainable. She has, for instance, fabricated a prototype "smart screen" that, once installed within glass building facades, could moderate temperature and light.

"Before I arrived here, NJIT researchers like Zafar Iqbal shaped my understanding of certain materials," says Decker, who adds that creating new materials can be accomplished only through collaboration. "NJIT professors are doing amazing things and it's very exciting for me to be here."

Prior to NJIT, Decker was a visiting critic in the Architecture Department at Cornell University, and taught art and design at the Rhode Island School of Design, as well as at Parsons in Manhattan. She is a frequent guest critic at universities where she has lectured on the use of new materials. She co-founded Decker Yeadon LLC, a Brooklyn-based architectural practice, in 2006.

Assistant Professor Martina Decker is integrating new materials technology and architectural design for sustainable building.

PHOTO: RICKY KHARAWALA

The collaborative design studio taught by Decker at NJIT has attracted industrial design, digital design and interior design majors. One unusually interesting challenge presented to her students has been to design a modern circus. For designers, the circus permits one of the broadest opportunities for collaboration, from the graphics and clothes of the performers to product design, media and lights, says Decker.

While the interior design majors have led the discussion on the spatial organization of the circus and sets, the industrial designers focus on the props, products, and materials needed for a variety of circus performances. "Digital design students, meanwhile, will consider mediated experiences between the audience and the performers, creating and manipulating the spectator's perception of an altered reality," Decker says.

She is also setting up a Material Dynamics Laboratory, where she intends to work with faculty and students to research new building materials. The lab will be part of COAD's Idea Factory, initiated to encourage individuals and teams to generate innovative concepts, products and proprietary designs, and to develop intellectual property.

Smart materials are among the material groups Decker plans to investigate in the lab. She's especially interested in polymorphic smart materials that can change shape in response to an external stimulus. These materials operate like artificial muscles and as such can be used in various ways to promote sustainable building.

The smart screen Decker has designed is engineered from "memory alloys" that can temporarily change shape as a result of changes in temperature. The concept is simple: if it's cold inside a building, the screen opens to allow more sunlight to enter. Conversely, on hot days the screen closes to block the solar heat. No electricity is needed for the screen to change shape, since the material is both a sensor and a motor. Though the concept is simple, the science involved in creating the screen is complex.

COURTESY OF DECKER YEADON LLC

In this conceptual illustration, the building on the right has a homeostatic facade that saves energy by incorporating smart screening which expands and contracts to regulate the amount of light entering the interior in response to temperature changes.

She'll also assess new materials for architectural applications and work on adapting the materials for actual use in building. "This is the point in my research when collaboration with scientists is essential," she says. "Designers know the particular performance requirements of materials, but scientists know exactly how to modify the performance of materials."

She has only been at NJIT for a short time, yet Decker says it's a perfect environment for a designer such as herself, one who wants to collaborate with researchers to invent new materials.

NJIT is a close-knit university that excels in design and architecture as well as in the STEM – science, technology, engineering and math – fields, she says. Researchers in all of these fields work in proximity to each other, which makes a perfect environment for innovation. "I'll work closely with researchers here as an example of how NJIT unites science and technology with architecture and design to develop new sustainable technologies." ■

Author: Robert Florida is a staff writer in the Office of Strategic Communications.