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NYUAD

RESEARCH REPORT 2012

RESEARCH REPORT 2012

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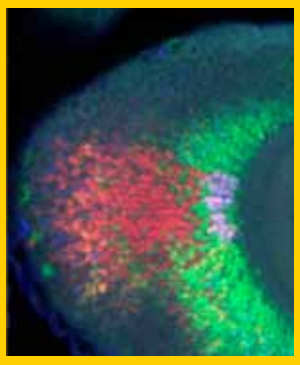

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ABU DHABI
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In just a few short years, NYU Abu Dhabi has emerged as a global center of research, scholarship, and artistic creativity, stimulating the creation of knowledge and promoting innovation in Abu Dhabi, across the region, and increasingly around the world.

Research is at the heart of any of the world's great universities and indeed, at NYUAD, research infuses the entire University, animated further by the scholarly energy and activities of NYU's global network, in which NYUAD plays an increasingly galvanizing role.

The NYUAD Institute has begun to roll out world-class projects, which, across the humanities, social sciences, natural sciences, and engineering, at once define new intellectual frontiers and respond to critical issues of regional and global relevance. These include cultural preservation in the Islamic world, applications of technological innovation in the developing world, modeling global climate change, analyses of pressing regional and global public health concerns, and novel approaches to computer security and privacy.

At the same time, the College recruits faculty who are among the world's most distinguished researchers and scholars, and exceptional teachers, able and resolved to transform their students into colleagues pursuing the production of knowledge aimed at shaping a better world. Our students are selected not only because they are among the world's brightest and most talented, but also because they are eager — through research experience under the guidance of faculty mentors — to develop the confidence and the rigorous, sensitive, and complex imagination that world-serving innovation requires.

The quality and the vitality of our research environment act as powerful magnets for regional and world talent and set global benchmarks for educational and intellectual excellence. We take particular pride in the extent to which NYUAD's research endeavor advances Abu Dhabi as a capital of ideas, education, and research in this century.

Al Bloom
Vice Chancellor


UNITED
BREAKWATER

NYU Abu Dhabi has taken strong steps in its first two years to develop a world-class research university in Abu Dhabi.

Together with four remarkable scholars who serve as our divisional deans — Judith Miller, Arts and Humanities; Sunil Kumar, Engineering; David Scicchitano, Science; and Ivan Szelenyi, Social Sciences — we have recruited excellent, research-active faculty across all disciplines as well as creative artists at the forefront of their respective fields.

Significant investments have been made in research equipment and instrumentation at the Center for Science and Engineering (CSE), with core facilities established in areas including molecular characterization, imaging and microscopy, genetic sequencing, and digital and materials science. In addition, the largest high-performance computer in the UAE is now operational and is supporting computational research in astrophysics, climate modeling, and genomics.

To provide a focus for advanced research and scholarship and to build on the research strengths of NYU's global network, NYUAD has established 13 centers, labs, and special projects through the NYUAD Institute. These initiatives address issues of local, regional, and global significance, including global climate and sea-level change, diabetes and the public health of Emiratis, the genomics of organisms surviving in the harsh local environment, and information security and privacy.

NYUAD faculty and researchers have established meaningful local collaborations with other universities, industry, and government. To name a few examples, the NYUAD Neuroscience of Language Lab is formally collaborating with faculty in the United Arab Emirates University Department of Linguistics for the study of brain activity during language acquisition; the Center for Technology and Economic Development (CTED) is working with UAE Exchange in the study of remittances to developing countries; research on the Arabian Gulf's coral reefs is taking place in collaboration with the Environment Agency — Abu Dhabi; and funding for semiconductor research at the University's Design for Excellence Lab has been awarded by the Advanced Technology Investment Company. We will continue to develop these collaborations and seek new ones.

The next two years will see NYUAD's research program continue to grow through an increase in faculty and continued development of the research of the University's laboratories and centers, thus helping Abu Dhabi become a recognized world center of learning and creativity.

Fabio Piano
Provost

NYUAD INSTITUTE RESEARCH PROJECTS

NYU Abu Dhabi's research projects have been selected based on their promise to contribute significantly to scientific understanding and for the role they will play in advancing Abu Dhabi as a capital of ideas, research, and education in the 21st century. Indeed, through its research initiatives and public programming, the NYUAD Institute has already begun to make its mark as a vital intellectual center of this region — and increasingly of the world.

INSTITUTE OVERVIEW

The NYU Abu Dhabi Institute is a world-class center of cutting-edge research, scholarship, and cultural activity that creates singular opportunities for leading faculty members from across the arts, humanities, social sciences, sciences, and engineering to carry out creative scholarship and conduct research on issues of major disciplinary, multidisciplinary, and global significance. The Institute also serves as a forum for intellectual enrichment, bringing together members of industry, government, and the global academic community to participate in spirited events that are open to public audiences in both Abu Dhabi and New York.

The NYUAD Institute offers sustained funding to support high-level research being conducted in the research centers, laboratories, and projects directed by faculty members within NYU's global network, establishing a critical connection between NYU New York and NYUAD. It also strives to establish research collaborations, academic partnerships, and cooperative ventures with institutions in the UAE and throughout the region.

NYUAD Institute grant recipients are selected following extensive evaluation of their research proposals by the Research Review Council, composed of members of the senior leadership from the New York and Abu Dhabi campuses. The Institute announced its first round of grant recipients in February 2010, providing funding for five-year projects in the humanities, social sciences, and science and technology. The initial grant recipients were the Library of Arabic Literature, the Neuroscience of Language Laboratory, and the Center for Technology and Economic Development — all of which have made significant progress in their initial years of operation. An additional three projects received grants in 2011: the Center for Prototype Climate Modeling, the Center for Interdisciplinary Studies in Security and Privacy in Abu Dhabi, and the Data Center and Cloud Computing Laboratory. In 2012, the Institute awarded funding for the Center for Genomics and Systems Biology, the Project on Global Sea-level Change, Computational Modeling of Normal and Abnormal Cortical Processing, and the Public Health Research Institute and Diabetes Research Center. The Institute has also funded development of a high-performance computing cluster, which is the fastest supercomputer in the UAE. Finally, new projects studying the determinants of successful transition of Emirati youth into adulthood, as well as the development of a multi-media platform to express Emirati cultural heritage, are being developed.

By supporting research on critical problems in and across disciplines and attracting an international cohort of scholars, scientists, and creative leaders, the NYUAD Institute is in the process of building an innovative research capacity in Abu Dhabi, fully interconnected with NYUNY, which will catalyze the development of Abu Dhabi as a capital of ideas, research, and education.


DISCOVERING
THE NEURAL
PROCESSES
OF LANGUAGE

NYU Abu Dhabi's Neuroscience of Language Laboratory, which opened its doors in April 2012, was designed with a unique proposition — to integrate linguistic theory and psycholinguistic models with observed neurological activity of the brain in an effort to better understand the way that the brain processes language. The fields of linguistics, psycholinguistics, and neurolinguistics are currently considered quasi-independent fields with different goals and methods of study; however, investigators at NYUAD's Neuroscience of Language Laboratory believe that these fields cannot be fully successful in isolation. As such, the Lab's experiments will be set up to test specific hypotheses and linguistic models while comparing the brain's response on a millisecond by millisecond basis.

Principal investigators of the Lab, NYU New York professors in the fields of linguistics and psychology Alec Marantz, David Poeppel, and Liina Pylkkänen, are well suited to the task with decades of experience between them in the field of neurolinguistics. Poeppel focuses on understanding how a physical signal is organized in the brain and how it then contacts the language system; Marantz primarily investigates the construction of words; while Pylkkänen's work is primarily in the area of sentence composition — thus the team collectively provides a comprehensive range of expertise in the area.

The Lab features a state-of-the-art Magneto-encephalography (MEG) machine — a non-invasive brain scanner that is the most sensitive device that currently exists to monitor the human brain. The system is able to detect minute magnetic fluctuations in the brain with extreme sensitivity at millisecond resolution. A thermally insulated head casing is fitted with 208 superconducting quantum interference device (SQUID) sensors, which can measure extremely subtle magnetic fields emitted from neural reactions in the brain, allowing for detection of both the level and region of brain activity associated with specific tasks. The system is operated in a magnetically shielded room that blocks out interfering external and ambient electromagnetic noise. NYUAD's MEG system, the first of its kind in the Gulf region, was custom built by Japan's Kanazawa Institute of Technology according to the Lab's specifications.

Before a subject lies down to place his or her head in the system, a digital representation of the shape of the head is taken using a laser device to help align the location of brain activity picked up by sensors to the corresponding area of the brain. The digital laser system was specially designed so that it would not require the removal of a subject's head scarf.

"There are a number of special things about the machine here that are not available in other similar instruments," Marantz said. "One is that we'll be monitoring the position of the subject's head throughout the experiment; usually you get the position once, and you hope the subject stays still. By monitoring continuously, we can adjust for the movement of the head — which makes it much easier when studying children."

The Lab will run experiments ranging from studying subjects' auditory and visual processing through passive listening of stories or viewing of images to more active question-and-answer-based experiments. The aim is to better understand how the brain performs communication-related tasks from understanding incoming signals to constructing outgoing words and sentences.

"In your head, you have stored a bunch of words — it's like a dictionary in your head," Poeppel explained. "When I'm talking to you, you recognize those words, but the information that comes in is just mechanical vibrations in your ear. You have to translate that, which is a physical signal, into some kind of neural code that can look things up inside your head and that can be used, for instance, to combine words and say words."

Abu Dhabi is a good environment for the MEG machine, according to Marantz. The lab's location in the NYUAD Center for Science and Engineering (CSE) is relatively peaceful, without the external disturbances and vibrations that can be found in other cities. However, even more enticing is the opportunity to study languages that are generally understudied and even some that have never been previously studied. The study of Arabic in the field of neurolinguistics, for example, tends to focus on standardized Arabic, making specific dialects, such as Emirati Arabic, uncharted territory.

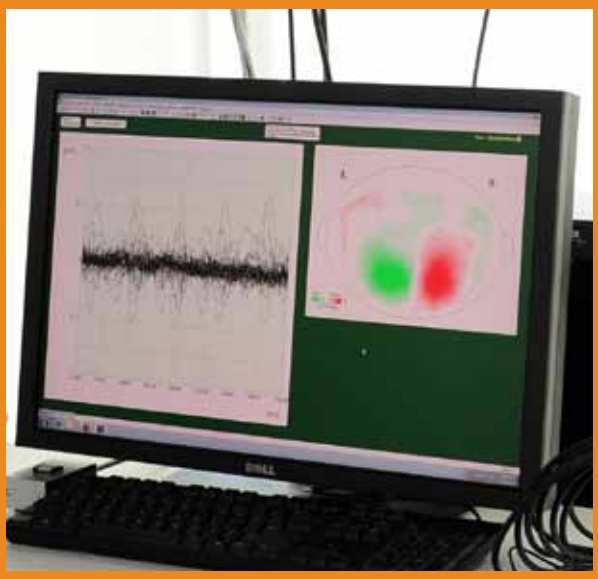
Studying a range of languages that have different forms and structures will also allow the research team to compare the similarities and differences in how the brain processes these languages. So far, they have found that, despite the differences in language form, the neural processes used in subjects for language communication are very similar — an intriguing area to further investigate.

The research team will collaborate with members of the United Arab Emirates University's (UAEU) Neuroscience of Language Laboratory on research projects. Having committed to sharing resources and technical expertise, this agreement will particularly support NYUAD's lab with projects related to Arabic-language study. Current NYUNY PhD student Meera Al Kaabi is an Emirati who will also be a part of the research team. Students at both NYUAD and UAEU will be encouraged to participate in research initiatives in a range of capacities.

In addition to advancing society's knowledge of language and the brain, there are a number of specific applications that could benefit from this research. Clinical applications include individualized speech diagnosis and therapy for those with developmental language disorders or for those recovering from stroke or injury. Learning how humans process language can also help with improved engineering of devices related to automatic speech recognition.

But above all, researching this subject may provide greater insights into our self-identity and humanity. According to Poeppel, "One of the most essential things that makes you human is your ability to use language, so understanding that is exciting in its own right."

THE STUDY OF ARABIC IN THE FIELD OF NEUROLINGUISTICS, FOR EXAMPLE, TENDS TO FOCUS ON STANDARDIZED ARABIC, MAKING SPECIFIC DIALECTS, SUCH AS EMIRATI ARABIC, UNCHARTED TERRITORY.



TOP: The MEG system records brain activity on a millisecond basis to provide insight into the way the brain processes language. **ABOVE:** (from left to right) NYUNY PhD student Meera Al Kaabi and Principal Investigators of the Neuroscience of Language Lab David Poeppel and Alec Marantz with NYUAD's MEG system.

PROJECTING GLOBAL SEA-LEVEL CHANGE

Along the low-lying beachfront of the city of Abu Dhabi stands a skyline punctuated with high-rise towers, beach clubs, restaurants, and cafes. As with many of the world's leading cities, much of Abu Dhabi's development sits at just above sea level, making the question of rising global seas a matter of critical self-interest for the city.

According to the World Bank, nearly one half of the world's population lives in coastal environments, many of which would be impacted by changes in coastal sea levels as ocean temperatures warm and ice sheets near Greenland and Antarctica melt. This is a very real concern; over the last century, the global sea level has risen by approximately 30 centimeters and the atmosphere has warmed by approximately one degree Centigrade, according to a report by the Intergovernmental Panel on Climate Change. Yet for all of the potential consequence on urban developments across the world — most of which were planned within the context of present-day sea levels — credible projections on future sea-level change are not currently available.

David Holland, professor of Mathematics at NYU New York's Center for Atmosphere Ocean Science (CAOS) and principal investigator of the Project on Global Sea-level Change at NYU Abu Dhabi, aims to change this.

"The behavior of the climate system on our planet is far more complex than I had ever imagined," he said. "Only through observation of the natural system, coupled with theoretical developments implanted in computer models, can we come to an understanding and projective capability of sea-level change."

The complexity of such projective modeling stems from the range of causes for climate change — natural variation and forced (human-caused) variation. Separating these two factors as they impact the environment simultaneously will require a significant amount of data and resources, Holland said.

Breaking down this problem requires an understanding of the chain of events that impact sea-level change, he explained. "The ice is affected by the ocean temperature, and ocean temperature is affected by the atmosphere. The question really is, 'why does the atmosphere change?' It changes because of natural variation, greenhouse gases, ozone changes, and unanticipated natural causes such as volcanoes — and all of these signals are progressing in an interrelated pattern."

The Project on Global Sea-level Change team has already started to make strides in contributing to the record of reliable observational data through field research in the Ilulissat and Helheim ice fjords in Greenland, where a team of nine deployed three times over the course of 12 weeks in 2012. Holland was joined by Logistical Coordinator of Research and Project Leader at NYUAD Denise Holland (also his wife), one postdoctoral fellow from NYUAD, one postdoctoral fellow from NYUNY's CAOS, and four NYUNY graduate students.

During its expeditions, the team positioned a range of meteorological, glaciological, and oceanographic monitoring devices to record several types of metrics that relate to the two principal causes of rising sea levels: glacial melting and changing ocean temperatures due to atmospheric warming. These two factors are "the lynchpins upon which future global sea level rests," according to Holland.

Through the placement of automatic weather stations — masts with weatherproof enclosures and meteorological sensors — the team is now able to monitor atmospheric data such as air temperature, air pressure, wind speed, and radiation, in addition to keeping a photographic record of calving (or melting) glaciers. Meanwhile, oceanographic data is collected through CTD (conductivity, temperature,

depth) instruments that can be deployed in a number of ways, resulting in versatility of the information provided. They can be slung over the side of a ship to provide a vertical profile of the ocean's appearance and to help reveal the location of areas of warm water that are melting glaciers. Autonomous underwater vehicles, known as AUVs, can be used to carry CTD instruments as they travel throughout the ocean collecting data. Perhaps the most inventive solution to effectively deploy CTDs has been through the assistance of marine mammals, such as ringed seals, which can serve as CTD carriers to gather information in previously uncharted territory. When the seal dives, the instrument records data, and when it surfaces, a portable satellite telephone attached to the seal places a call to a satellite and transmits the recorded data to a research center in New York. The device simply drops off the animal when it molts. Whether carried by AUV or seal, the CTDs remain active for the duration of approximately one year.

The team will conduct a similar exercise in Antarctica in 2013 and will continue the expeditions on an annual basis in both locations to gather repeated data over a five-year timespan.

Holland describes the endeavor as a significant contribution to a global resource of data that is being collected. Computer modeling of the earth started in the 1950s and observations about the earth are tracked back to approximately a century ago. However, given the long-scale nature of tracking changes in climate and water temperatures, continuing the process of recording data is important both for developing projective models and for enabling future generations to continue this work.

"It's a global problem that is going to require enormous global resources," he said.

Holland has been investigating issues of climate and sea-level change for more than a decade; he made his first trip to Greenland and Antarctica in 2007 and has been returning ever since. During these expeditions, Holland said he was at first struck by the breathtaking beauty of the landscapes, characterized by expansive open land, endless horizons, and massive icebergs. However, the harsh environment also creates significant challenges; despite months of planning, on occasion, decisions have to be made on a moment's notice due to unpredictable weather conditions.

"If, for example, the weather changes and a helicopter cannot fly, you are stranded on the ice; or a storm might come in and your ship has to seek harbor," he explained. "Our team always has this in mind, and so we learn to adapt and remain flexible in our plans."

This field research is just one element of the ambitions of the Project on Global Sea-level Change team; back on dry ground in New York and Abu Dhabi, members of the team will work on theoretical and computational components of the project. This will include developing new theory or building upon existing theory that is underdeveloped. Ice sheet behavior, for example, is not well understood scientifically and will be an important area of theoretical focus. The research team will also work on combining field observations with climate-change theory to develop sophisticated, predictive computational models. This will be approached by taking an existing global climate model, such as one used for projecting future air temperatures, and building in a sea-level projective capability.

Currently, the absence of concrete, scientifically sound models makes appropriate management and planning for this issue a difficult endeavor. The impact of having reliable projections will be considerable; science-based recommendations will help policymakers target the causes for sea-level change and make more informed decisions about safeguarding existing developments.

Holland recognizes that this is a long-term project. Given both the massive scale and long periods over which environmental changes incrementally appear, it will take a considerable amount of time to understand the impact of human causes in isolation of natural changes. Reliable computational projections may be a long-term ambition, but the Project on Global Sea-level Change is taking important steps to tackling this challenging issue, making Abu Dhabi a new global hub for research in climate-change modeling.

"ONLY THROUGH OBSERVATION OF THE NATURAL SYSTEM, COUPLED WITH THEORETICAL DEVELOPMENTS IMPLANTED IN COMPUTER MODELS, CAN WE COME TO AN UNDERSTANDING AND PROJECTIVE CAPABILITY OF SEA-LEVEL CHANGE."

TOP LEFT: David Holland, principal investigator of NYUAD's Project on Global Sea-level Change. **TOP RIGHT:** A helicopter lifts off from east Greenland and heads toward the massive ice stream of the Helheim Glacier during a 2011 expedition, during which the research team placed equipment designed to record ice movements. **ABOVE**: David Holland's research team at the Jakobshavn Fjord in Greenland in 2011, tagging seals with transmitters to record oceanographic data.

LOOKING TO THE CLOUDS TO PREDICT FUTURE CLIMATE

Credit: Jacques Descloitres, MODIS Rapid Response Team, NASA/GSFC

"Right now, we're using only 1 percent of the current data available from satellites to help us understand climate change," said Andrew Majda, founder and principal investigator of NYU Abu Dhabi's Center for Prototype Climate Modeling (CPCM). "The data sets are so massive that people don't know what to do with them, or how to explore them." Additionally, explained Majda, "many scientists feel that the 18 climate-change models by the Intergovernmental Panel on Climate Change currently being used have major deficiencies." This is precisely where the CPCM comes in.

With a primary mission to bridge the gap between modern applied mathematics, climate theory, modeling, and observation in order to improve climate forecasting, scientists and researchers at the CPCM will explore, test, and implement ideas in climate prediction to build new interfaces between theoretical ideas and practical models, something that hasn't been done before. According to Majda, "There wasn't a center for having new ideas from theory make immediate impact in these complex models."

Working with Co-principal Investigators Shafer Smith and Olivier Pauluis, both associate professors of mathematics at NYU New York's Center for Atmosphere Ocean Science (CAOS), Majda—also the Samuel FB Morse Professor of Arts and Science in NYUNY's Mathematics department and CAOS—will continue to develop new approaches and ideas for using theory to understand computational models. The CPCM will utilize NYUAD's high-performance computer, currently the fastest supercomputer in the UAE, to advance its atmospheric and oceanographic studies.

Targeting what Majda calls "the 800-pound gorillas of climate change," the team's research will center on clouds, specifically those in the tropics. "People may think of clouds as one object, but clouds act very differently in different parts of the world," he said. "We don't care so much what one cloud is doing, we care about their collective impact." As Majda explained, atmospheric conditions in Indonesia, for example, can profoundly affect the weather in the US two weeks later. A singular event, he said, "can affect the extent of the deserts, the extent of how extreme our summers and winters will be, how many hurricanes we're likely to have…they're all tied together in a complex way." And because these events often have negative societal and economic impacts, focusing on the cumulative impact of clouds to improve climate modeling and long-range weather forecasting, especially considering the impacts of global warming, is something of a hot topic for climate, atmosphere, and ocean scientists worldwide.

The Center will also focus on the factors of midlatitude and subtropical impacts in forming desert and transporting moisture and—because many of these factors involve how the ocean interacts with the atmosphere—the features of the ocean, such as turbulence, to discover the effects on the clouds and the birth of giant cloud patterns.

As this research depends on data gathering and computer modeling, the team will also work on new approaches for computer model diagnostics, or, as Majda explained, "ways for us to use theory

to help us understand the computer model, which will result in new and different ways for what we call parameterization; that is, representing all the things you don't see." As he said, "even the world's largest supercomputers, when they run climate problems, represent all of the weather over a 100-square-kilometer distance with just a single point — so, looking at a climate model, you can't describe all of the elements of the climate system," elements including the mobility, unpredictability, and apparent randomness of the clouds. "A lot of the parameterization that has been developed doesn't have a random element," said Majda, "so one thing we are very interested in doing is using parameterization with fluctuation and the randomness that we see in nature. We're trying to capture coherent disorder." In addition to this, the team will work to improve active data gathering and the processing of complex data sets.

This improvement in the understanding of and ability to predict climate in the tropics and subtropics will have tremendous impact on the countries in those regions, including the UAE. "We feel that, societally, around the world, the impacts of climate change in the tropics and subtropics are important for an enormous population of people," said Majda. "It is very relevant to have a center here in Abu Dhabi." Additionally, when considering global warming and temperature increases, "people often don't realize that the most profound effect will be on the water cycle, where it rains and how much," explained Majda. "In a sense, we know that Abu Dhabi is a place where water is important, so it's a natural center for our research." Add to that the occurrence of the tropical intraseasonal oscillation, which is triggered in the Indian Ocean, not far from the Arabian Sea, and the fact that the CPCM will be working to improve the ability to predict severe droughts in the subtropics, and the Center's location in Abu Dhabi is a perfect fit.

Looking forward, the Center will comprise up to three senior scientists, up to six postdoctoral researchers, and a few technicians. It envisions that its research will be a collective effort with faculty members at CAOS and collaborators at other universities and modeling centers. As such, the Center will provide a valuable link between individual university researchers — who often do not have the resources to run large climate models — and large modeling centers that are unable to devote sufficient time to fundamental research.

It also hopes to count NYUAD students as part of the research team. As Majda said, "It's an interesting area for undergraduates who are interested in continuing with a PhD. There's a lot of need for good undergraduate students and there are many research opportunities related to the issue of climate change."

"It's well known that we're facing a lot of complex challenges worldwide in our globally warming world," said Majda. "We care now about how climate will change in the next 10 years, the next 20 years, the next 50 years, as well as what extreme events will happen and how they will influence tropical, subtropical, and midlatitude weather. We know we're working on hard problems. Part of the fun is waiting and trying to figure out what the challenges will be."

THE UNDERSTANDING OF AND ABILITY TO PREDICT CLIMATE IN THE TROPICS AND SUBTROPICS WILL HAVE TREMENDOUS IMPACT ON THE COUNTRIES IN THOSE REGIONS, INCLUDING THE UAE.

WORKSHOP HIGHLIGHT

With the goal of gathering together cloud experts from around the world, NYUAD's Center for Prototype Climate Modeling (CPCM) kicked off its series of annual workshops in March 2012 with Tropical and Extratropical Interactions in Climate. While the core of the workshop was intended for technical discussion, one of the organizers' hopes was to create awareness in the cloud research community of the opportunity for collaboration with the CPCM team. "This workshop in particular was focused on that community," said Andrew Majda, founder and principal investigator of the CPCM, and Samuel FB Morse Professor of Arts and Science in NYUNY's Mathematics department and the Center for Atmosphere Ocean Science (CAOS). Indeed, 17 cloud experts from all corners of the globe converged in Abu Dhabi for the three-day workshop, which focused on atmospheric interactions between the tropics and the midlatitudes.

According to the Center, meteorology traditionally separates the atmosphere between the tropics, where variations in weather are tied to convective processes and planetary-scale circulation, and the midlatitudes, where synoptic systems dominate day-to-day weather. However, interactions between these two regions are key to many aspects of the climate system. Thus, during the workshop, the group of researchers—with expertise in observation, theory, and computer models—came together to discuss how new observations and modeling approaches can provide new insights on the nature of these interactions.

The workshop was accompanied by a public lecture, The Climate Mosaic: Understanding the Hidden Patterns of Clouds, Winds, and Weather, given by Olivier Pauluis, co-principal investigator of the CPCM and associate professor of Mathematics at NYUNY's CAOS. He spoke of the atmosphere's well-defined pattern, despite the seemingly unpredictable and chaotic nature of wind, and the critical role this pattern plays in the climate system—transporting energy and water across latitudes and preventing the poles from becoming too cold and the equatorial regions from becoming too warm.

TOP: Founder and Principal Investigator of NYUAD's Center for Prototype Climate Modeling Andrew Majda addresses the workshop attendees. **BELOW:** During the workshop, the participants (pictured below) focused on atmospheric interactions between the tropics and the midlatitudes.


USING MULTI-
LEVEL GENOMIC
APPROACHES
TO TACKLE
REGIONAL ISSUES

"Among the most fundamental questions in the life sciences are those of how molecular systems are built from the interaction of molecular genetic elements," said NYU New York Silver Professor of Biology Claude Desplan. "How such networks adapt to new conditions, when and how they break down — as in diseases — and how natural selection works at the network level to enable living systems to adapt to very different environments," added Michael Purugganan, dean of science and Dorothy Schiff Professor of Genomics at NYUNY's Faculty of Arts and Science (FAS). These are the questions that lie at the heart of NYU Abu Dhabi's Center for Genomics and Systems Biology (CGSB), said Fabio Piano, NYUAD's provost and founding director of the New York CGSB. Established in 2012 to investigate and address such broadly and regionally based biological matters, the Center's team includes Piano, Desplan, and Purugganan.

As Kourosh Salehi-Ashtiani, NYUAD associate professor of Biology and the Center's co-director, explained, "Over the last decade, the complete genome sequences for thousands of organisms, including humans, have been elucidated, opening new horizons for biological research." For scientists at the Center, this development has enabled them to focus on the next phase of biological research: to identify the mechanisms that underlie the evolution of these genomes and that transform genetic information into cellular and organismal behaviors using a global or systems-level view.

While genomics provides the necessary tools for the generation and interpretation of large-scale datasets, systems biology investigates multiple facets of molecular complexity across the entire genome of an organism. According to Piano, by bringing together both data production and data analysis, the Center will not only be able to focus on a wide range of research, but also allow researchers to connect disparate data to decipher the link from genotype — the genetic constitution of an individual organism — to phenotype — the set of observable characteristics of an individual, including the interaction of genotype with the environment.

Created as a sister center to NYUNY's CGSB — and to which several NYUNY faculty, graduate students, and researchers continue to establish connections — the NYUAD CGSB will use modern genomics and systems biology techniques, such as next-generation sequencing, proteomics, imaging, and computational science. Using these methods, it will focus on model species (*Chlamydomonas reinhardtii*, *Caenorhabditis elegans*, *Drosophila*, and mice), as well as non-model organisms of regional interest (date palms, marine algae, and environmental microbes), and examine living processes across different biological levels, from cells to organisms to populations/species to ecosystems. By doing so, it will help tackle regional issues in human health, energy, agriculture, and the environment.

The Center is working on three research programs with an emphasis on key areas of renewable resources and regional biodiversity, cancer cell systems and disease-related chemical genomics, and neuronal systems. Each uses genomics, or, as Desplan, also the director of the Center for Developmental Genetics at NYUNY's FAS and an affiliate of the NYUNY CGSB, explained, "high-throughput sequencing

to analyze the entire set of genes expressed in different situations."

The first program focuses on environmental genomics, algal systems biology, and renewable resources and includes four research projects that study genomic variation at the within- and between-species level. One of the four projects, the date palm project, spearheaded by Purugganan — who was also the associate director of NYUNY's CGSB from 2010 to 2012 — seeks to understand the evolution of domesticated plant species. By studying genomic variation in species and strains that are of regional importance, such as the date palm *(Phoenix dactylifera)*, researchers are able to trace the origin and spread of crop species and to develop new ways of identifying agriculturally important genes. As Purugganan explained, despite the abundance of date palms in the region, "there is very little known about their genetics, preventing concerted efforts at breeding and also leaving unanswered several questions on the origin and spread of the species. Moreover, breeding efforts in date palms are hampered by their relatively long generation times and large sizes, which make it difficult to perform conventional genetic crosses."

During the project, the team will re-sequence 100 date palm varieties (including 30 from the UAE and the rest from the Middle East and North Africa) to perform a comprehensive study of their evolution and develop a whole-genome haplotype map for use in genome-wide association studies in date palms. The team will also develop a single nucleotide polymorphism (SNP) — the variation in a single base pair in a DNA sequence — mapping chip for deeper genotyping of a larger pool of date palm germplasm and use the SNP data to examine the origin and spread of date palms. To further their research, the team hopes to collaborate with private nurseries and breeders in the UAE.

A second project in this program is the development of a model biofuel organism for systems-level studies and the exploration of local marine algal species for their biofuel potential. Directed by Salehi-Ashtiani, also a co-principal investigator on the team, researchers use *C. reinhardtii* as a model algal species to identify, isolate, and optimize species native to the UAE for biofuel applications. "*C. reinhardtii* can produce hydrogen gas as a by-product of photosynthesis under oxygen and sulfur deprivation," said Salehi-Ashtiani, "which makes it an attractive model system for biofuel production." The team will also examine the genomic diversity of the algae by sequencing the genomes of approximately 30 natural strains of the species found worldwide in order to, among other things, associate the biofuel production capacity of the strains with specific genes, their natural allelic variants (genetic variants that arise by mutation, found at the same place on a chromosome), and epigenetic modifications (those resulting from external rather than genetic influences).

The second program will use nematode model organisms — namely *C. elegans*, or roundworm, the first animal to have its genome completely sequenced, and of which scientists at the center recently created the first genetic blueprint — to identify small molecules that are relevant to mechanisms of human disease, such as cancer and diabetes, or potential anti-helminthic (anti-nematode) agents. "While *C. elegans* is a free-living, non-pathogenic nematode, related pathogenic species are estimated to infect a staggering 2 billion people worldwide, leading to diseases including ascariasis, trichuriasis, filariasis (elephantiasis), and onchocerciasis (river blindness)," explained Kristin Gunsalus, NYUAD CGSB co-principal investigator, NYUNY associate professor of Biology, and researcher at NYUNY's CGSB. According to Gunsalus, nematodes that parasitize livestock and plant crops cause billions of dollars in economic damage each year. Thus, in this project, researchers will use *C. elegans* — ideal due to its small size, rapid lifecycle, and ease of propagation and manipulation — to identify bioactive compounds and their molecular targets in vivo using high-throughput screening (HTP) to examine new drugs affecting pathological processes.

Last but certainly not least, Desplan will direct a team of scientists in the Center's third program: mapping the complexity of neurons in the vertebrate and invertebrate brain with the goal of understanding how each neuron acquires its specific properties and connects with its correct targets. "The huge diversity of cell types and the numbers of neuronal connections

in the brain are a daunting problem that must be understood in order to comprehend neural circuit function," Desplan, a developmental neurobiologist, said. By charting the complete transcriptional profile of neurons in different parts of the vertebrate and invertebrate and using this molecular characterization to manipulate neuronal function in vivo, researchers will open a path to assessing their role in brain function, as well as be able to create models of neurological disease. As Desplan explained, "These will provide the basis for unbiased screens aimed at discovering drugs that activate or suppress activity in specific interneuron populations and may lead to the development of treatments for currently intractable diseases such as autism."

All of these projects require a robust and state-of-the-art bioinformatic infrastructure. Gunsalus and Richard Bonneau, NYUNY associate professor of Biology and Computer Science and faculty director of Bioinformatics, are leading the development of that effort.

Looking to the future, the Center hopes to commence large-scale chemical genetic screening and plans to have an environmental sample collection, assays, and sequencing from multiple terrestrial and aquatic Gulf-region habitats well under way. It is also the Center's goal to initiate an undergraduate research program and involve NYUAD students in the projects well before the Campus moves to Saadiyat Island. "They are all anxious to start Capstone projects at the NYUAD Institute," Desplan said. Additionally, collaborations between the Center and other NYUAD faculty, as well as local and regional scientists and organizations, are already in the works.

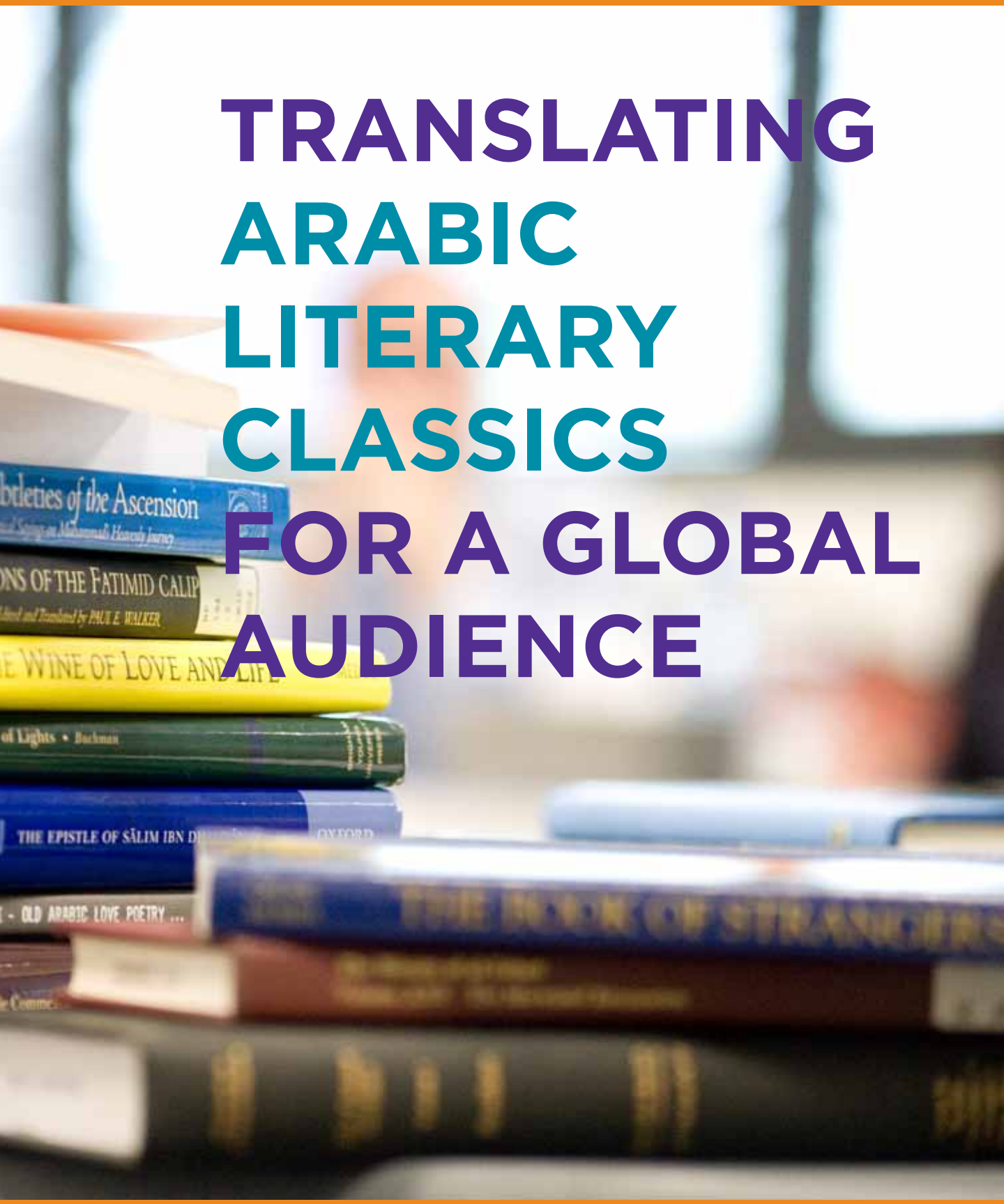
With these collaborations, the Center will be poised to address biological, behavioral, environmental, and even conceptually complex cultural questions. "The research we propose will not only enable NYUAD to advance the general understanding of biological systems, but the Center will provide a focal point for leading biological research in the Emirates," said Piano. "It will serve to transform a locationally constrained research enterprise into an open organizational structure that will foster research projects around the world."

CONFERENCE HIGHLIGHT

Organized by Claude Desplan, NYUNY Silver Professor of Biology, and Michael Purugganan, NYUNY professor of Biology and director of NYUNY's CGSB, the Abu Dhabi Conference on Genomics and Systems Biology II was held in February 2012. Because biology now focuses on global and systems-level views to identify the mechanisms that transform genomic information into diverse cellular and organismal phenotypes, the conference explored state-of-the-art, multi-level genomic approaches to topics including cell and cancer systems biology, algal systems and biofuels, biodiversity genomics, neural systems biology, and bioinformatics. The meeting involved 30 NYU faculty and speakers from around the world and helped launch the NYUAD CGSB.

Kristin Gunsalus, NYUAD CGSB co-principal investigator, NYUNY associate professor of Biology, and researcher at NYUNY's CGSB, gives a presentation at the second annual conference of the CGSB at NYUAD.

TRANSLATING ARABIC LITERARY CLASSICS FOR A GLOBAL AUDIENCE



For many literary enthusiasts it might be considered criminal to compile a list of the great classics without including among them the translated works of authors like Tolstoy or Cervantes. Yet, excepting the *Arabian Nights*, most would struggle to note any significant number of classics representing the Arab literary tradition. It is not for any lack of achievement of Arab writers, storytellers, philosophers, and poets during the pre-modern period—but simply that English-language readers remain unaware of the very existence of works that comprise the great body of classical Arabic literature.

Not only is there a dearth of translations from the "treasure of medieval Arabic," as Philip Kennedy, general editor of NYU Abu Dhabi's Library of Arabic Literature (LAL), calls it, it is also exceptionally inaccessible and dispersed.

"If you look at the pre-modern period from the 19th century backwards to pre-Islamic, sixth-century Arabia, there's virtually nothing translated relative to what exists in this huge corpus of literature across genres. There are a lot of translated versions of the Quran and *Arabian Nights*, and then there are translations of the canonical collections of the Sunna, which are the traditions of the Prophet Muhammad, but there is very little else," said Kennedy, who is also associate professor of Middle Eastern and Islamic Studies and Comparative Literature at NYU New York. "There might be a translation of anecdotes collected by Ibn al-Jawzi, which you have to go to a 1920s fascicle of the *Journal of the Royal Asiatic Society* to get a hold of; you have to look here and there, and even then, you find quite a shallow representation of what exists available in English."

LAL, one of the earliest recipients of an NYUAD Institute research grant, is a five-year project that aims to translate, edit, and publish 35 works of classical Arabic literature. The works will be produced in parallel-text format, with Arabic and English text on facing pages, in order to "create the opportunity of dialogue between the original and the translation." Bringing together Arabic literary scholars from around the world, LAL creates a vehicle for those in the field to converge, discuss, and collaborate in the collective effort of creating a central repository of high-quality, trustworthy, and readable English-language iterations of Arabic texts, catering both to academics and general readers. The selected translations will traverse a full range of genres, focusing not only on creative work, but also on literary texts at large, including poetry, fiction, religion, philosophy, law, science, history, and historiography. LAL works in partnership with NYU Press, which will publish the translated works in both print and searchable e-book formats.

"The vision is for this to have a broad readership; from the diehard scholar, to the student at the graduate and undergraduate levels, to the curious reader in the street, to also the Muslims in the world who can't read Arabic very well," Kennedy said. "One of the first works we're publishing, *Al-Shāfiʿī's al-Risālah (The Epistle on Legal Theory)*, is one of the founding

works of Islamic law—to have this in translation in parallel text will be of enormous interest on all sorts of instructional levels."

Creating a strong operating foundation for the library was important, as was ensuring a significant degree of quality control. "If a work has a complex textual history, using lots of different manuscripts from lots of different periods, you have to be able to present some kind of sense of an integral whole that is trustworthy as a reference work and that explains the nature of the textual complexity and layers," Kennedy said. However, there is an important balance to strike in appealing to a general audience, and LAL places significant emphasis on the need for translations to be written in modern English. "We don't want to produce editions that overwhelm the reader with a critical apparatus, where for each line you have ten lines of footnotes," Kennedy explained. "We want the reader to be able to read the text and be able to trust it, and for it to point in the direction of further reading if he or she is interested in the textual criticism. This is where there is a silent interface between the academic world and the lay audience."

In addition to the careful selection of collaborators, who are requested to submit samples for review, LAL's editorial board plays an important role in reviewing the stylistics of each text. The eight editors on the board, alongside LAL's Managing Editor Chip Rossetti, are involved in the selection of the texts, the commissioning of translations, the review of manuscripts, and the vetting of the final translations. They are supported by a 26-member International Advisory Board, which provides additional guidance as needed. The editorial board meets twice a year, during which time all work in progress is evaluated, taking into account peer reviews, and review is undertaken of all aspects of LAL's editorial structure and operations.

"When you think of translation, you think of one sole academic stuck in his or her room producing this manuscript and it just gets published—but the reality is that it's an enterprise," Kennedy explained.

The library presently has 20 works under contract, with the first three completed translations due for publication by the spring of 2013.

Al-Shāfiʿī's al-Risālah (The Epistle on Legal Theory), which was translated by Joseph E. Lowry from the University of Pennsylvania, is the oldest surviving work on Islamic legal theory and the foundational document of Islamic jurisprudence. The text will serve as a valuable resource for legal scholars on the historical foundations of Sharia law.

Al-Qāḍī al-Quḍāʿī (A Treasury of Virtues: Sayings, Sermons and Teachings of ʿAlī), which is being translated by University of Chicago Professor Tahera Qutbuddin, is a collection of sayings, sermons, and teachings attributed to ʿAlī ibn Abī Ṭālib, cousin and son-in-law of the Prophet Muhammad, fourth caliph, and a renowned sage of Islamic wisdom.

In addition to publishing single- and multi-volume works, LAL will also publish anthologies of shorter works. *Classical Arabic Literature: A Library of Arabic Literature Anthology* represents an assortment of classical Arabic poems and literary prose from pre-Islamic times to the 18th century, selected and translated by Geert Jan van Gelder from Oxford University.

Along with these three works, translation has commenced on seven other titles that are due for release in future seasons.

As this project presents classic literary work from the region to a global audience, LAL identifies with the vision of NYU's global network university, which compels its students to be an active part of a multicultural and cosmopolitan world. The project is also significant to the vision of Abu Dhabi, which strives to maintain its cultural roots throughout the process of development.

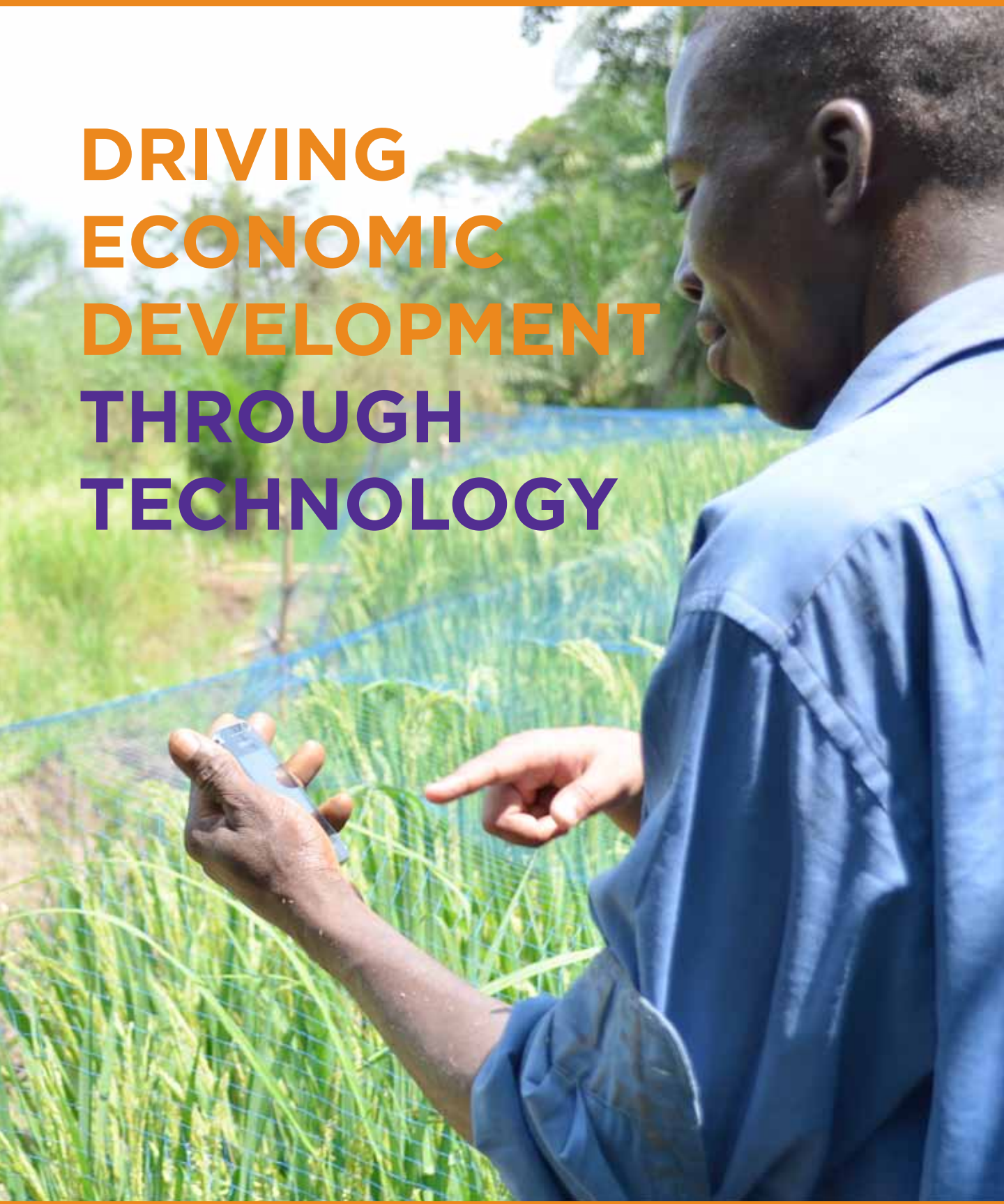
"As an ambitious project, it is lucky that it has found someone with the vision to sponsor it," Kennedy said, musing, "once these things happen, you wonder why it hasn't happened before."

LAL's editorial board comprises: General Editor Philip Kennedy; Executive Editors James E. Montgomery of Cambridge University and Shawkat M. Toorawa of Cornell University; and board members Julia Bray from the University of Paris VIII, Michael Cooperson from UCLA, Joseph E. Lowry from the University of Pennsylvania, Tahera Qutbuddin from the University of Chicago, and Devin Stewart from Emory University.

CONFERENCE HIGHLIGHT

In December 2011, some 25 scholars, translators, editors, publishers, and writers involved in the work of translating global literature participated in a two-day NYUAD Institute workshop to discuss the interplay of translation and world literature, including questions about the movement of literature through markets of readership and translation. The workshop featured roundtable discussions on topics that addressed how translation networks operated in the pre-modern world from Baghdad to Venice, what it means for *Oedipus Rex* or *Hamlet* to be rewritten in an Arab context, and how it might be useful to frame European and Middle Eastern literatures through the lens of the Mediterranean. The workshop also featured three public events: Translating Ahmad Faris al-Shidyaq's *Leg over Leg*, a guest lecture by prominent Arabic translator Humphrey Davies; European Representations of Islam in the Era of Crusade, a lecture by University of Toronto Professor Suzanne Akbari; and a reading of original works of Emirati poetry, co-hosted by the literary publication *Banipal 42*.

TOP: Philip Kennedy, general editor of NYUAD's Library of Arabic Literature. **ABOVE:** Emirati poet Adel Khozam and writer Alice Johnson read poetry during a public NYUAD Institute event, co-hosted by the literary publication *Banipal 42*.


DRIVING
ECONOMIC
DEVELOPMENT
THROUGH
TECHNOLOGY

When NYU Abu Dhabi Professor of Economics Yaw Nyarko met Lakshminarayanan Subramanian, assistant professor at NYU New York's Courant Institute of Mathematical Sciences, they quickly realized they were working on different sides of the same puzzle. In addressing significant issues facing the developing world — Nyarko from the perspective of an economist and Subramanian through the lens of a computer scientist — they recognized that their areas of expertise were deeply interlinked.

"Really the problem comes at the interface of economics on one end and technology on the other. Economics dictates the constraints, and we have to determine if we can we build something transformative within those constraints," Subramanian said. "Once a technology starts working, scalability and sustainability is another round when economics comes into play. You have to ask how you can make it work on a really large scale. If you truly want to achieve sustainability, you want to get to the point where the solution is running itself, and you need the right economic models to achieve this."

The Center for Technology and Economic Development (CTED) was created in 2010 with the understanding that "it's the culmination of the two fields that can really accomplish things," Nyarko explained. Through CTED, Nyarko and Subramanian lead a team of academics in pioneering innovative solutions and assessing the impact of technological tools in the development of poor and rural communities with a focus on the areas of energy, education, financial services, food security, and health.

Technology, now more so than ever, has the potential to create profound and positive impacts in the lives of the poor. "If you look at the last two decades as an example, the Internet has transformed lives and the way we interact with the world," Subramanian said. "Mobile phones in particular have been transformative because everyone, even the poorest of individuals, has a mobile phone — it's a game changer."

Indeed, it is this prevalence of mobile phone technology in the developing world in particular that creates the opportunity to "leapfrog" over existing technologies and overcome infrastructural barriers. In areas with limited or no network connectivity or computer hardware, mobile phones can behave like mini computers in your hand, as Nyarko explained. With tailor-made applications, basic 2G phones with SMS technology can be used to overcome challenges in information distribution and data management by supporting an expansive range of unconventional functions.

Esoko is one such application that was established in 2005 with the aim to support rural farmers in Africa with making more informed trading, marketing, and farming decisions. The concept is that farmers, who would often sell their products in the nearest village without established knowledge of the market value of their goods, could now benefit from a market information system that provides current and relevant information on the latest market prices through an SMS-based service. In its first few years the service received positive anecdotal reviews; however, there was little research to determine the actual impact of this resource on farmers' decisions. As one of CTED's earliest projects, the research team

designed a randomized control trial of Esoko service in Ghana to assess the extent to which it allows farmers to realize higher prices and to identify the mechanisms through which these price increases take place.

"We want to know, do these market information systems really work? That is the fundamental question," Nyarko said. "Users say they do things differently, but do they really do things differently? And what do they do with this information? Do they speculate and wait for a good price, or do they go to the next town over?"

The project officially kicked off in the summer of 2011, when researchers established a baseline survey that asked approximately 1,000 farmers about their agricultural decisions, ranging from the crops they choose to plant and how much they sell and where, to access to and current use of mobile phones and their existing sources for market information. Shortly after, half of these farmers received Esoko's service and began receiving market information on their phones every few days, while the other 500 remained as a control sample. To ensure that the control group was not infiltrated with information through word of mouth by those receiving the Esoko service, CTED researchers first mapped out villages and their connection points, such as roads, to understand existing interaction levels and patterns of communication. Monthly surveys were conducted in addition to a more extensive field survey during the summer of 2012, revisiting both groups to determine any changes in negotiation and bargaining tactics, farming choices, and overall livelihoods. The project is expected to conclude in 2013; however, from initial information, Nyarko noted that usability and training to use the application are important concerns.

Esoko represents just one of many possible ways mobile phones can be used as a tool for economic development. "The number of people who have tried to create SMS-based applications is enormous because of the potential to be able to cater to large populations where this is the only connectivity medium that people have," Subramanian said.

To support this endeavor, CTED created UjU, a straightforward mobile phone platform that enables users to develop their own SMS-based applications. Taking into account the data limitations of the SMS channel, UjU — the Swahili word for "sent" — provides a tool to design database-structured formats. CTED has configured and tested UjU for a number of real-world SMS-based applications in the areas of mobile microfinance and mobile health care, four of which have been piloted in Ghana and Mexico.

"The goal of UjU was to build something like an app store that would work on SMS, but this was a challenge because each SMS allows only 140 characters and each message costs money. To overcome this, UjU has a compression layer that enables users to compress a lot of information within 140 characters — so, for example, a three-page health form can be compressed into a simple message," Subramanian said.

These types of SMS-based applications can result in practical solutions for some of the infrastructural challenges faced across different industries in the developing world. Take for example another CTED project called Epothocary, which established a cost-effective system using midlevel mobile phones to track and verify the authenticity of pharmaceutical goods. The counterfeiting of pharmaceutical products is a widespread problem that poses a considerable health hazard to third-world countries that lack the resources to implement expensive tracking mechanisms. Under the system, a unique bar code is provided for each pharmaceutical package, which is then scanned using mobile phone cameras at every step of the supply chain distribution process by verified individuals, thus tracking legal goods and preventing the introduction of counterfeited products into the system.

SMSFind is another CTED prototype — one that uses mobile technology to answer search queries, providing similar functionality to that of a search engine, but within the limited space and data constraints of text messaging. Unlike existing services that hire people to answer these requests, CTED has developed an automated process to search for possible results and identify the most appropriate 140-character response. Unstructured

TOP: CTED participates in Esoko training in Ghana. **CENTER:** Lakshminarayanan Subramanian, principal investigator of CTED, does field research in Hohoe, Ghana. **ABOVE:** CTED collaborator Dr. James London (left) with Yaw Nyarko (right), principal investigator of CTED, in Kumawu, Ghana.

and uncommon questions can make this a difficult task; however, the query can often provide a hint as to what the user is looking for. Using a back-end search engine, the SMSFind technology has been designed to extract segments of text around the hint term, and ranks them on relevance across a number of metrics. The technology, which is currently being piloted in conjunction with Nokia in Kenya, was found to be able to answer roughly 57 percent of questions in an automated fashion faced by an existing, manual SMS search provider. This marks a significant achievement in automated technology that can decipher long-form questions.

While mobile phone applications are a principal area of research for CTED, other significant projects are under way in the fields of finance, computer science, and energy. Through an established partnership with the money transfer company UAE Exchange, researchers are studying data to create a better understanding of the remittance market in the UAE. Similarly, an agreement with the Ethiopia Commodity Exchange enables CTED researchers to analyze the impact of the four-year-old exchange and to develop improved systems and information flow. CTED is also developing working computer science prototypes that support greater Internet connectivity or provide related information services in rural areas. In those areas with limited or no access to the Internet, inventive solutions have proven to be effective in creating greater information dissemination for general use, and in particular for educational institutions.

In just a few years, CTED has made significant inroads into investigating, developing, and deploying innovative technologies in rural and developing regions — an endeavor that is expected to have significant results. "If you're able to develop the right types of technologies, it can be transformative," Subramanian said. "We're looking at how this can transform people's lives on a day-to-day basis, whether it supports better energy, education, or food. For a lot of people that alters the poverty line."

For Nyarko, who grew up in Ghana, and Subramanian, who was raised in India, the prospect of making a difference in the lives of those from underdeveloped regions is more than just a research project; it's a passion.

"I grew up in a very rural area and it impacted my research interests in many ways," Nyarko said. "My goal for CTED is to be a center that facilitates innovative research in this vital area of technology and economic development. Being located at NYU Abu Dhabi gives us a unique platform and location to contribute to this burgeoning field of research. At the same time, my hope is to make an impact on the lives of people in underdeveloped regions around the world."

ADDRESSING THE PUBLIC HEALTH CHALLENGES OF THE GULF

With more than 20 years of tobacco control research experience in the US under his belt, Scott Sherman, associate professor of Medicine and Psychiatry at the NYU Langone Medical Center, turned his eyes to the global public health landscape with the realization that "most smokers aren't in the US." While there exists more than 50 years of research profiling cigarette smokers, mostly within Western cultures, there remain a lot of unknowns with regard to smokers and their behaviors in places like the UAE that have both higher incidences of smoking and different forms of tobacco inhalation — such as shisha and medwakh — than the US.

The opportunity to investigate uncharted territory in public health issues prompted Sherman and his colleagues at the NYU Langone Medical Center — Professor of Environmental Medicine and Population Health Richard Hayes; Professor of Medicine, Biochemistry, and Molecular Pharmacology and Pathology Ann Marie Schmidt; and Associate Professor of Medicine, Biochemistry, and Molecular Pharmacology Ravichandran Ramasamy — to establish a comprehensive Public Health Research Institute (PHRI) at NYU Abu Dhabi dedicated to investigating those issues that most seriously affect the UAE community: cardiovascular disease, obesity, diabetes, and tobacco use.

"There are so many questions we're finding that nobody knows the answers to, like what kinds of interventions for hookah smoking are culturally effective," Sherman said. "We've tried scouring the literature for valid, reliable measures to assess what people are eating in the UAE, but there are none. It's hard to intervene at a policy level if you don't know what people are eating; you can't assess a change if you don't know what you're starting with."

The public health landscape in the UAE and the Gulf region is unique, made up of distinct genetic, environmental, and societal factors and influences. Project investigators hope that a greater understanding of these factors will in turn inform the creation of more effective prevention and intervention policies.

The PHRI will consist of four individual centers that target specific and prominent public health concerns in the UAE: the Diabetes Research Center, the Center on Obesity and Genetic Susceptibility, the Human Oral Microbiome Research Center, and the Smoking Cessation Research Center.

Researchers at the centers hope to draw upon a shared resource of a central "Special Studies Cohort" to support the collection of raw data from a sample of 5,000 UAE Nationals in Abu Dhabi. The project investigators are currently working with the Health Authority — Abu Dhabi to develop a mechanism to gather the required information through questionnaires and biological tests from a sample representative of the population across age and gender. Through this access to primary data, the centers will identify environmental and genetic factors involved in public health issues, test novel interventions, and create a strong information resource in the Emirates on public health issues.

The Diabetes Research Center aims to discover mechanisms leading to metabolic and cardiovascular dysfunction in order to identify therapeutic targets to improve the problem, with a specific focus on the processes of microbiome and amino acid metabolism and glycation (which is the process through which sugar molecules like glucose bond with a protein or lipid molecule without the catalyst of an enzyme). Both factors have been shown to play a key role in metabolic dysfunction and may influence the development of insulin resistance, obesity, and diabetes. In addition to looking at biochemical markers, the research team will also survey eating and physical activity behaviors. By investigating the importance of a range of different factors — some that are modifiable and others that are not — to weight gain and diabetes, the group hopes to deliver practical information that can inform public health interventions that are most relevant to the local population.

The Center on Obesity and Genetic Susceptibility will focus on genetic factors at play in the development of obesity through performing genome sequencing to identify genetic risk factors and associations with Type 2 diabetes. Through a comparison of the genetic makeup of high- and low-risk groups, the team aims to identify certain genetic risk factors that may elucidate the role of genetic factors in the extremely high rates of obesity and Type 2 diabetes in the UAE.

The Human Oral Microbiome Research Center will look into the relationship between periodontal disease (a condition caused by oral bacteria) and cardiovascular disease, a leading cause of death in the UAE. A number of studies have shown a correlation between the two, with periodontal disease believed to play a role in the vascular inflammation that causes a buildup of plaque in the walls of the arteries. Previous studies have shown that reduction in oral pathogenic bacteria leads to a regression of preclinical cardiovascular disease. This center will be the first in the UAE to comprehensively examine the role of oral microbiome in preclinical cardiovascular disease by identifying whether specific human oral microbiome profiles are correlated with levels of intima-media thickness, a specific indicator of arterial wall thickness that is an established preclinical marker of cardiovascular disease.

The Smoking Cessation Research Center will explore some of the unique characteristics of smokers in the UAE, assess the effectiveness of tobacco control policy in the UAE, and test novel treatments that have proven effective in other parts of the world. The research team will also look more closely into the forms of tobacco consumed in the UAE, such as shisha and dokha, which are currently understudied and not well understood both in terms of their health impacts and in terms of health interventions that would be culturally effective.

While focused on the UAE population in particular, the Institute's findings will likely provide broader insights that may "serve as a lighthouse for the rest of the world," project investigators said. "The UAE is without a doubt a country that has been undergoing profound transformation over the past 40 years," Sherman said. "It can be a challenge to have the health catch up with the impact of prosperity. As we move from an agricultural society to one based on international business, the range of cultural and lifestyle changes that have taken place in the UAE are applicable to many other countries not only in the region, but to the rest of the world."

THE ABU DHABI NEW GENERATION SURVEY

In what will be the first-ever youth-to-adulthood panel study in the Middle East, the Abu Dhabi New Generation Survey aims to discover the determinants of successful transitions into adulthood for Emiratis in the areas of education, career, family, and health.

By surveying a group of Emirati youth residing in Abu Dhabi, Principal Investigator Paula England, NYU Abu Dhabi affiliated faculty and NYU New York professor of Sociology, and her four co-principal investigators will assess early life predictors of various types of adult outcomes.

"In Abu Dhabi, those in the new generation of youth are coming of age in a completely different environment, unknown to their grandparents," England explained. "This study will allow us to answer such questions as: What kind of university training leads young adults into the global private sector? What are causes of the gender disparities in university attendance whereby women are graduating at higher rates? Does high income encourage having more children, or is there a tradeoff between a woman's education and her fertility?"

Using a probability sample of families with children aged 15 to 16, the team will survey one parent, and a youth 15 to 16 years of age in each family — as well as a sibling youth between the ages of 13 and 18, if one exists. "We hope to be able to continue the study after Wave I so that youths will then be surveyed every year or two until reaching age 25 or more," said England.

Currently in its first year, the study includes a pilot survey that is being conducted in NYUAD's 2012–13 academic year. In addition to survey questions, biomarkers will also be collected from a buccal swab (a non-invasive method of DNA collection using cells from the inside of an individual's cheek) and body mass index will be measured to allow researchers to explore gene/environment interactions.

Principal Investigator of the Abu Dhabi New Generation Survey Paula England.

COMPUTATIONAL MODELING OF CORTICAL PROCESSING

David Cai, principal investigator of NYU Abu Dhabi's Computational Modeling of Normal and Abnormal Cortical Processing Project and professor of Mathematics and Neural Science at NYU's Courant Institute, has proposed research that will develop theoretical and computational models of neuronal processing in the normal and abnormal brain and contribute to the understanding of how the brain operates in such states.

The computational neuroscience research group, headed by Cai, will conduct this research in a two-project plan. Using a large-scale computational model pioneered by members of the research group, Project I will focus on the functioning of the early visual pathway, in particular, the primary visual cortex. In dysfunctional visual processing, the aim is to understand the effects of the diminished functioning of the NMDA receptor — a cellular receptor that plays an important role in both the way that neurons transmit signals and in memory function — on the early stages of visual perception, with a focus on this hypofunction being one of the possible neuronal disorders underlying schizophrenia.

Project II will explore the theoretical foundation of the nonlinear dynamical analysis and functional connectivity of brain processing, and, in particular, its relationship to noninvasive measurements such as electroencephalography (EEG), which records the electrical activity along the scalp. As Cai explained, "Particularly intriguing questions concern the reduction of the chaotic dynamics and dimensionality and the loss of small world attributes in the EEG signals measured in Alzheimer's disease patients."

A central feature of the proposed research is to use computational modeling of cortical dynamics to rationalize experimental observations in subjects that cannot be easily studied by invasive methods under normal conditions. By doing so, the team aims to advance the computational approach in neuroscience to a new level so that it will become a truly powerful methodology capable of unifying invasive and noninvasive observations in healthy and abnormal brain states through a mechanistic understanding of cortical network dynamics. It also has significant potential to enhance current theoretical understanding and benefit important practical applications in areas such as mental health studies.

David Cai, principal investigator of the Computational Modeling of Normal and Abnormal Cortical Processing Project.

STUDIES IN SECURITY AND PRIVACY IN ABU DHABI

With the long-term goal of "establishing a world-class research center for cyber security in Abu Dhabi that serves the needs of the region," said NYU Abu Dhabi Affiliated Faculty and NYU-Poly Professor of Computer Science and Engineering Nasir Memon, the CenteR for Interdisciplinary Studies in Security and Privacy in Abu Dhabi (CRISSP-AD) is the NYUAD counterpart to the existing CRISSP organization at NYU New York.

In addition to conducting interdisciplinary research and building new approaches to computer security and privacy that recognize that technology alone cannot provide the information security and privacy solutions needed in today's interconnected world, the Center will take into account the impact of business, legal, policy, human behavior, and cultural environments of the region — all of which strongly influence how this technology is and can be used — to engineer trustworthy global information systems.

With a team of four co-principal investigators, Memon — who is the Center's principal investigator — currently has five projects underway: the development of file carving techniques for digital evidence recovery; tracing a digital picture to a specific camera; large-scale fingerprinting for image forensics, that is, developing techniques that can identify pictures taken from the same camera from a large database; securing the hardware root of trust against hardware Trojans, piracy, and backdoors using logic encryption that leverages fault analysis principles from VLSI testing; and developing potential alternatives to passwords on multi-touch interfaces, which, said Memon, "capture a user's biometric and can reliably distinguish between users."

Nasir Memon, principal investigator of CRISSP-AD.

THE DATA CENTER AND CLOUD COMPUTING LABORATORY

Data center and cloud computing, as closely coupling technologies, have evolved to become two of the most critical components of the modern Internet.

Almost all major large-scale Internet services, including those offered by Google, Facebook, Microsoft, and Amazon, now rely on large data center and cloud computing frameworks for efficient service provisioning to millions of users. Due to their importance, data center and cloud computing technologies are now the focus of major research and development efforts by companies, governments, and academic and research institutions.

NYU Abu Dhabi's Data Center and Cloud Computing Laboratory has been established to consolidate the efforts of multiple research groups to promote creativity, innovation, education, and entrepreneurship in the field. In one research area, the Lab focuses on system-level research to design future data center and cloud computing platforms that provide improved performance in the aspects of security, resilience, scalability, and flexibility, among others. The Lab also focuses on research challenges and opportunities related to a new generation of data-intensive applications that collect and exploit terabytes, even petabytes, of data.

The Lab will strive to develop human capital talent in the UAE, and develop a mechanism to effectively implement its research findings in the marketplace.

"As part of the UAE's 2030 vision, the country has identified development of local IT infrastructure as a key priority," Jonathan Chao, principal investigator of the Laboratory and professor of Electrical and Computer Engineering at NYU-Poly, said. "Data center and cloud computing technology will play a significant role in the UAE as it continues to serve as a business hub for the region."

Since its establishment, the Lab has generated seven scientific publications involving TCP incast, data center security, scalability and resilience, load balancing, and congestion control. The Lab has also submitted two patent applications on hash data structure design. These research activities have led to the development of new data center and cloud computing technologies, including a new design on TCP incast control that has been proven to outperform existing solutions and has been presented to industry experts.

The research group has already begun to provide a forum to foster strategic dialogue and idea exchange in the region, and in collaboration with Injazat, a leading UAE-based IT and business process services provider, hosted more than 120 research and industry experts during a two-day public conference in March 2012.

FACULTY RESEARCH HIGHLIGHTS

The sustained strength of research and scholarship at NYU Abu Dhabi lies in its outstanding faculty. Attracted to Abu Dhabi from around the world, the University's faculty are leaders in the scholarship of their disciplines and are committed to developing NYUAD into a leading world center of research, scholarship, and artistic work.

UNDERSTANDING THE BEHAVIORAL FORCES AT WORK IN SHAPING THE MACROECONOMY

As a specialist in macroeconomics and econometrics — the application of mathematics and statistical methods to economic data — NYU Abu Dhabi Assistant Professor of Economics Chetan Dave enjoys the precision of his discipline. "It is precise about assumptions and their implications, and about what it can and cannot do," he said. "It's a practical study of a very complicated, possibly dismal, constrained reality."

Be that as it may, Dave continues his attempt to make discoveries within the boundaries of that constraint. As he explained, "Modern economics cleanly delineates tools and methods, and the topics to which it applies those tools and methods. If one is well trained in the tools, then anything that qualifies as human decision-making under constraints is up for grabs to be analyzed by an economist. It's why economics is a pre-eminent social science discipline — because it is precise when it can be, precisely tells you when it cannot and requires more study, and gives practical solutions to surprisingly complex problems."

A history enthusiast interested in the economic aspects of the rise and fall of civilizations around the world, Dave enjoys studying national-level factors that help economies grow or shrink, as well as factors that motivate learning in order to improve economic outcomes. "All of this constitutes the substance of what research macroeconomists are often interested in," he said. "The tools we use are interesting in their own right, and while I have an independent research interest in developing those tools, they only illuminate the path to the answers."

In addition to several journal article revisions, Dave is working on papers that deal primarily with various aspects of learning in economics — more specifically, modeling aspects of economic theories of learning in macroeconomic models, and, on the side, modeling the behavioral bases of normative economics. His research is almost entirely empirical and includes one main field and two secondary fields within economics: structural macroeconometrics, an area that focuses on the empirical evaluation of macroeconomic models of economic growth and business cycle activity; behavioral and experimental economics, the incorporation of ideas and theories from psychology into formal economic modeling, particularly in the empirical evaluation of experimental data; and applied econometrics, in which Dave uses models, data, and econometric analyses to answer a variety of research questions across the social sciences. In short, he is interested in the sophisticated use of economic models and data to answer questions, and, he said, "developing a deeper understanding of economic and other behavioral forces at work in shaping the macroeconomy."

Concerning structural macroeconometrics, one paper, "Lattice Filtering and Rational Inattention," attempts to develop the notion of lattice-adaptive learning. "In such a model, the idea is that a policymaker learns about the state of the economy adaptively using a very particular filter, known in engineering as a lattice filter," Dave explained. "The advantages of this filter are several, and so it makes for a good assumption when modeling learning. But the key advantage is that the speed and perhaps the information capacity of the filter can, in a sense, be controlled. This is of interest to me, as

"ECONOMICS IS A PRE-EMINENT SOCIAL SCIENCE DISCIPLINE — BECAUSE IT IS PRECISE WHEN IT CAN BE, PRECISELY TELLS YOU WHEN IT CANNOT AND REQUIRES MORE STUDY, AND GIVES PRACTICAL SOLUTIONS TO SURPRISINGLY COMPLEX PROBLEMS."

I would like to bridge two ways of thinking about information processing by a policymaker." Currently in the early stages of this research, Dave looks forward to potential insights and seeing where lattice-adaptive learning takes him.

According to Dave, for a macroeconomist, increasingly accurate descriptions of individual decision-making enable models to better describe aggregate data. As such, better macroeconomic models can be formulated if care is taken to base the model on microfoundations that reflect consistency with microeconomic theory and how people really behave. These microfoundations can be built using discoveries in the field of psychology and economics. For instance, macroeconomists often assume that expectations can be characterized by costless signal extraction and the implementation of Bayes' Law — which expresses how a subjective degree of belief should rationally change to account for evidence — and so are always correct on average. However, Dave explained, "Previous work in psychology has identified biases in how individuals form expectations, so that they deviate from some of the classical assumptions that economists make. These important insights have to be investigated in economic contexts."

Consequently, in "Confirmation Bias and Strategic Signal Extraction," Dave — along with co-author Gary Charness of the University of California Santa Barbara — investigates whether strategic pressures to update beliefs correctly (as per Bayes' Law) can mitigate a bias known as confirmation bias, that is, an individual's tendency to seek, interpret, and use evidence in a manner that is biased toward confirming existing beliefs or hypotheses. "I examine whether individuals exhibit confirmation bias in environments where information is costless, like those assumed in some macroeconomic models," said Dave. "We implement a unique experimental design and find evidence that they do, but, over time, the bias can be mitigated by strategic pressures to update beliefs — even inadvertently — in a manner more consistent with Bayes' Law."

A third paper, "Time is (Not) Money?" co-authored with Enrique Fatas of the University of East Anglia, seeks to determine whether response times from stimuli are a useful statistic to measure particularly defined cognitive activity in economics experiments. Very rarely used in economics, Dave and Fatas are using time responses to explore deliberation processes, "but with homogeneous environments and experimental economics methodologies," Dave explained. They are exploring how deliberation processes are altered by game features such as complexity and whether games are of the "social" versus market interactions variety. "I must admit I am having a lot of fun with the econometrics of the data," said Dave.

NYUAD Assistant Professor of Economics Chetan Dave.

These are but three of the various projects Dave currently has under way. In addition, within the area of macroeconomics, he continues to work on three additional projects. The first involves theories of large deviations in economic aggregates with NYU New York Professor of Economics Jess Benhabib. The second project, with NYUNY Professor of Economics John Leahy, is focused on evaluating the informational content of professional forecasts of macroeconomic variables when they are included in macroeconometric frameworks. Finally, in collaboration with a colleague at the Paris School of Economics, Dave is developing encompassing methods of distinguishing between endogenous versus exogenous sources of cyclic variations in real GDP.

Outside of the publishing arena, Dave is the faculty advisor for the NYUAD Economics and Finance Club, and conducts experiments at the University's Social Science Experimental Laboratory, an interdisciplinary center where experimental work in the social sciences combines economic theory, political science, and sociology. There, he runs incentivized decision-making experiments with human subjects in order to test theoretical predictions and the properties of proposed or existing models of economic, political, or social institutions. "This allows an economist to cleanly identify the effect of incentives on observed behavior," he explained.

With the goal of contributing to the development of better modeling of policy choices in the macroeconomic realm, Dave hopes to contribute to economics — albeit on the more microeconomic side — research in cognitive psychology to build better descriptive models of the reasons why individuals make the choices they do in economic settings. As Dave said, "Economics is to an extent the careful study of common sense in the process of resource allocation, and since common sense is often quite uncommon, the study and practice of economics tends to be critically central to the development of humankind."

CULTURAL EXCHANGE AND EDUCATION AT THE ARAB CROSSROADS

"In one sense, all of my work so far has been about forms of cross-cultural encounter," said Shamoon Zamir, NYU Abu Dhabi associate professor of Literature and Visual Studies. Indeed, for the past 30 or so years, this has been his primary academic focus. An Americanist working in the areas of literature, photography, and intellectual history, Zamir turned to cross-disciplinary and cross-cultural studies after studying with Professor Eric Mottram, a pioneer of American studies at the University of London and a key figure in the experimental poetry scene in the UK. Zamir arrived in England from Pakistan when he was ten and developed an interest in literature, in part under the influence of his father who was a journalist and fiction writer. "I had a passion for Milton and wanted to study the 17th century, but the encounter with Mottram fundamentally transformed everything that I was doing as an undergraduate and, therefore, as a graduate student," said Zamir.

Despite the fact that he professes to being "dangerously a dilettante," Zamir's interest in American studies has been a constant throughout his academic career. "It allowed me to deal with issues of cultural difference and identity without falling into what I saw as the traps of identity politics," he explained. "I was not interested in studying Urdu literature because I was Pakistani, in doing Asian studies because I was Asian, or in pursuing Islamic studies because I was born a Muslim. I very consciously made a decision that, for me, that would be a pitfall — a self-reflective study that would lead to a kind of identitarian politics that I wasn't interested in. Although I don't think I was fully aware of this when I was a student, I think that the complexity of American cultural history and the sheer vitality of the American achievement in the arts allowed me to negotiate both the experience of being an immigrant and to think of the meanings of the arts within an emergent international and global culture. American studies has been an indirect way of dealing with these issues, and, for me at least, a more creative way." This is not to say that American culture has been Zamir's only interest. He has also translated fiction from Urdu and, as a graduate student, co-founded *Talus*, a small press journal and book series that published contemporary writers and critics from around the world.

Zamir's first book was *Dark Voices: W.E.B. Du Bois and American Thought*, which, he explained, "attempts to read Du Bois' *The Souls of Black Folk* (1903), a landmark of African American literature, in the context of American pragmatism, European philosophy, and the development of social science in America." Recently, he completed his second book, a study of portraiture and photography focused on the work of Edward S. Curtis. Continuing the investigation of early-20th-century American culture

"I BELIEVE THERE IS A HUNGER, IN EUROPE, AMERICA, AND IN THE ARAB WORLD, TO FIND OUT ABOUT PHOTOGRAPHY FROM THE REGION. THE IDEA IS TO CONTRIBUTE TO BOTH WORLDS IN A USEFUL WAY."

begun with the work on Du Bois, the book reassesses Curtis' portraits of Native Americans and explores the relationship of ethics and aesthetics in photography.

Zamir is now in the initial stages of launching what he hopes will be a long-standing, collaborative, and international research project on Arab photography based in the region. Named Photography at the Arab Crossroads, the multi-part project will endeavor to develop a series of publications, exhibitions, and archival collections based on photography from the Arab world and the surrounding region. As Zamir explained, "The field of research in Arab photography is relatively poor, by comparison, say, with even African or Asian photography. The scholarship is fragmented and not easily available." And despite photography becoming a preferred medium of expression for many artists in the Arab world, the history and variety of Arab photography are not well known or sufficiently understood.

Working closely with the Arab Image Foundation in Beirut as well as, potentially, cultural authorities and institutions in Abu Dhabi, the project will bring together scholars, photographers, and curators with a wide range of expertise in order to develop a long-term, sustainable research and publication plan in this field. The project was kicked off in May 2012 with a two-day colloquium, conceived as the first of a series and convened by Zamir, which began the establishment of this network of scholars and institutional partnerships. "We had people from America, Europe, Lebanon, Egypt, Qatar, as well as the UAE," said Zamir. "We had people who were experts in Arab photography as well as scholars who worked in other areas of photography; we had scholars from a range of disciplines; and we had academics, practicing photographers, curators, and local cultural organizers talking with each other around the same table. It was a very encouraging beginning."

Photography at the Arab Crossroads will be an international venture, but remain of the region. "I believe there is a hunger, in Europe, America, and in the Arab world, to find out about photography from the region," Zamir explained. "The idea is to contribute to both worlds in a useful way."

Planned contributions will come not only in the form of publications, but also as exhibitions, the first of which opened at NYUAD's Downtown Campus during the fall 2011 semester with *The Undispossessed*, a large photographic exhibit of selected works by Egyptian documentary photographer Yasser Alwan. In the fall semester of 2012 the campus also hosted the work of Paris-based Algerian photographer Nadia Benchallal. Zamir is at present in conversation with Abu Dhabi cultural authorities about the possibilities of a much larger exhibition or photographic festival.

Additionally, the project plan includes the development of photographic archives. There are, according to Zamir, a number of private expat and

A photograph from Yasser Alwan's collection exhibited at the NYUAD campus is appreciated by a student.

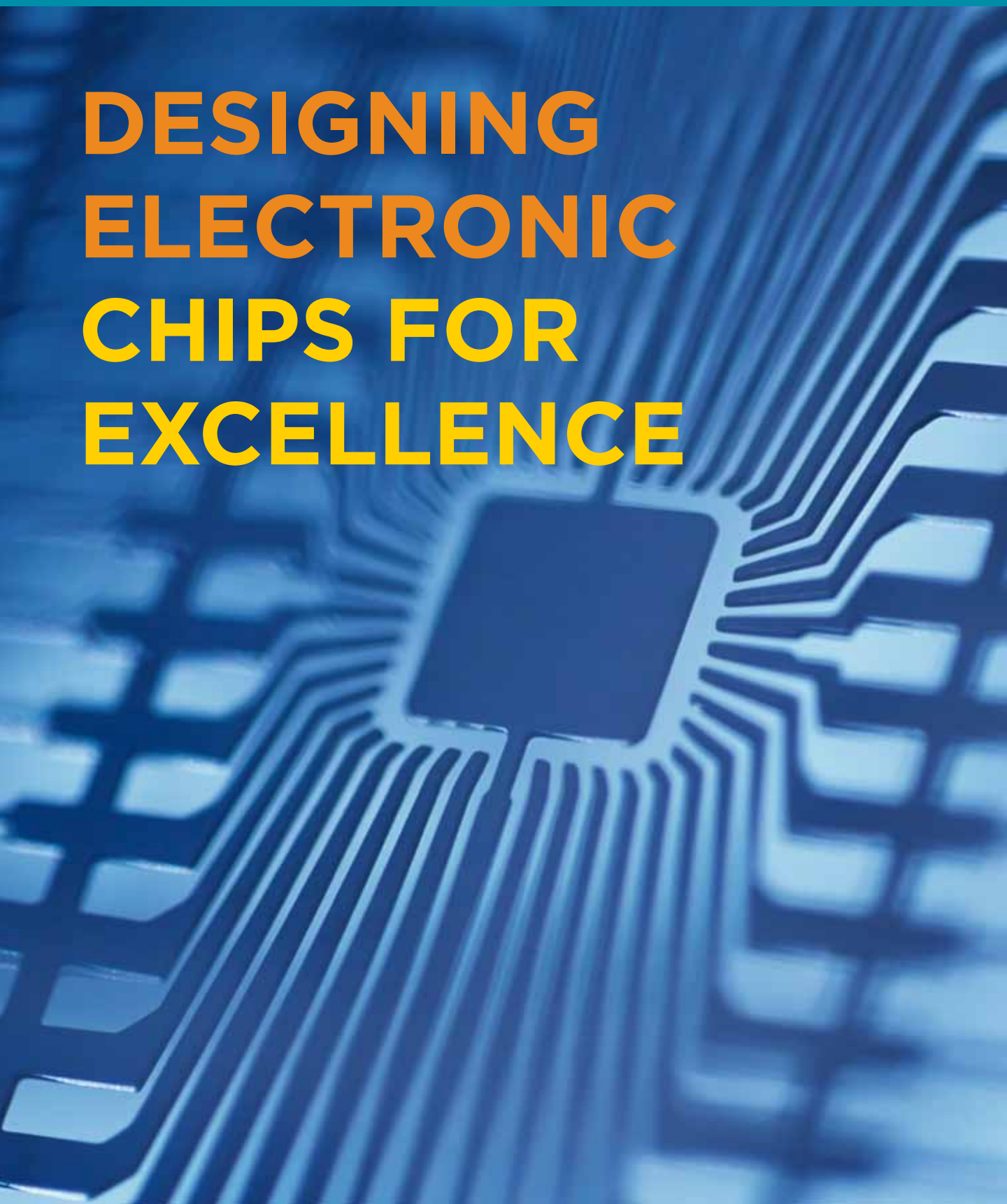
citizen collections in the UAE that are of cultural and historical importance. "My worry is that because they may not fit the model of national history or symbolism, they may leave the country before they are collected or documented," he explained. "Whatever the level of interest in them today, I am pretty sure in 20 or 30 years they'll be absolutely crucial to the writing of the history of the country and the region. Everything will depend, of course, on whether we can organize the resources to successfully undertake such a venture."

Zamir sees the Arab photography project as part of a larger commitment on the part of NYUAD to developing an understanding of and dialogue with the region. The University has established a new undergraduate major focused on the historical, social, and cultural aspects of the region, titled Arab Crossroads Studies. And the NYUAD Institute's Library of Arabic Literature project, which will constitute the first comprehensive library of translations of the major works of Arabic literature into English, will without doubt prove to be one of the institution's signature contributions. It is Zamir's hope that Photography at the Arab Crossroads will also be able to contribute meaningfully to NYUAD's aims to be in and of the city of Abu Dhabi, and that it will be able to do so by representing the experiment in international cultural exchange and education that is driving the development of the University.

COLLOQUIUM HIGHLIGHT

Convened by Shamoon Zamir, NYUAD associate professor of Literature and Visual Studies and director of Photography at the Arab Crossroads, the eponymous colloquium, which took place in May 2012, brought together individuals including photographers, photographic historians, curators, and scholars — with knowledge of Arab photography and without — to discuss the development of a long-term, sustainable research and publication plan in the field of Arab photography. Despite photography becoming a preferred medium of expression in the Arab world, the history and variety of Arab photography are not well known or sufficiently understood. The two-day colloquium, which kicked off the Photography at the Arab Crossroads project, was the first in what Zamir hopes will be a series that aims to establish a network of scholars and institutional partnerships as a means to developing a collection of publications, archival collections, and exhibitions based on photography from the Arab world and surrounding region.

The colloquium was convened by Shamoon Zamir, NYUAD associate professor of Literature and Visual Studies, and director of Photography at the Arab Crossroads project.


DESIGNING
ELECTRONIC
CHIPS FOR
EXCELLENCE

Electronic chips responsible for data processing in digital devices like computers and phones weren't always high on the list in the war against counterfeiting. However, as chips have become more complex, and components of the design and manufacturing process are divided among different parties, control over the end product no longer lies in the designer's hands, which increases vulnerability in terms of safety and reliability.

As counterfeiters and hackers target electronic hardware, NYU Abu Dhabi Assistant Professor of Computer Engineering Ozgur Sinanoglu believes the best way to safeguard chips is to build protective mechanisms into the hardware itself — effectively designing a chip that outsmarts attackers by making itself inaccessible to unauthorized users.

Sinanoglu, who directs the Design for Excellence (DfX) lab at NYUAD, leads a research team of four students — three NYU-Poly PhD students, Samah Saeed, Sachhidh Kannan, and Chandra K.H. Suresh; and Abishek Ramdas, an NYU-Poly master's student — as well as postdoctoral researcher Subidh Ali.

Sinanoglu's 13 years of experience in integrated circuit testing for manufacturing defects have given him a unique perspective as he approaches issues related to the security and reliability of chip design and production. Throughout his academic and professional career, including two years at telecommunications company Qualcomm, he has specialized in devising strategies to improve testing efficiency, a process that Sinanoglu said currently accounts for approximately 30 percent of total overall production costs.

During this time, he found that by considering testing accessibility in the design stage, manufacturers could make a chip with embedded hardware mechanisms allowing for deeper and more comprehensive access into different regions of the chip at the same time — facilitating more expedient testing. While the DfX lab continues research in the field of testing efficiency, it is using similar principles and techniques to tackle a range of emerging security threats that have propagated with increasingly globalized manufacturing processes.

"We are the first ones to take a testing approach to security," Sinanoglu said. "They bear a lot of similarities, namely defects and security attacks. Dealing with chip defects is a mature field that is 60 to 70 years old, and there are software tools and techniques that are already available that we can apply to security challenges. There are key differences between the two that must be considered as well, however. Defects are random in nature and are typically testable, while attacks have been deliberately camouflaged. We collaborate closely with Professor Ramesh Karri's group at NYU-Poly, who are security experts, in devising solutions against security threats."

Security threats include counterfeiting, in which defective fabricated chips that were rejected during testing, but not properly destroyed, are fed back into the supply chain. Intellectual circuit piracy may also occur when the designed chip is fabricated in an overseas production facility, which produces more than the original order, selling the surplus on the black market. Yet another form of attack is the injection of hardware Trojans directly into the chips during the process of fabrication — this additional hardware may later serve the malicious purpose of hacking or accessing information off the chip.

According to SEMI, a global industry association serving the manufacturing supply chain for micro- and nano-electronics industries, these kinds of

WHILE THE DFX LAB CONTINUES RESEARCH IN THE FIELD OF TESTING EFFICIENCY, IT IS USING SIMILAR PRINCIPLES AND TECHNIQUES TO TACKLE A RANGE OF EMERGING SECURITY THREATS THAT HAVE PROPAGATED WITH INCREASINGLY GLOBALIZED MANUFACTURING PROCESSES.

security threats are estimated to result in a loss of USD 4 billion annually within the industry. Methods such as design encryption, through the addition of protective hardware on the chip, can help protect its integrity as it goes through various phases of the design and fabrication process.

"A chip design has inputs and outputs through which information enters and exits. If I, for example, add additional hardware into the design that is specifically controlled by additional inputs, I can make sure the design works only when correct inputs are fed in," Sinanoglu said. "This creates a locking mechanism controlled by the designer, so the chip can't be worked by someone who doesn't know the key for the right inputs. This logic encryption can be made more comprehensive by designing in a unique key for every fabricated chip—the key is held only by the designer, who must provide the key combination for production, providing the designer with a metering mechanism."

Protecting against human interference is not the only issue to address in ensuring the reliability of electronic chips, however. Sometimes integrated circuits are defect-free and have not been subject to malicious hardware, yet may still fail due to environmental interference. Transient errors, or glitches, may result from factors like radiation-induced alpha particles from the chip's material decay releasing and striking the chip. While this does not damage the chip, the particle, which carries a positive charge, can flip a value on the chip. These soft errors are typically seen as isolated events; however, these glitches, if large enough, may result in erroneous computations. As electronic chips become smaller and faster, they are more susceptible to this kind of error, which is particularly difficult to detect. The DfX research team is currently investigating hardware and software support to more effectively detect and correct these errors when they occur, improving the performance and power-efficiency of existing detection techniques.

Sinanoglu is also continuing his research in the field of chip testing, looking specifically at adaptive testing, which takes into account process variation that occurs during the manufacturing of chips. While chips of the same design are mass-produced on large-size wafers and then sliced into individual units, they may have very slight variations in certain elements such as wire thickness due to the minute size of each unit. Traditionally, testing has been conducted on chips uniformly, with the assumption that they are identical. However, adaptive testing first identifies characteristics of the chip and customizes the test to the individual chip, resulting in more accurate defect detection.

"Before you even fabricate the chips, you have a set of expectations on the possible variations of the chip that you might receive, so you can plan appropriate versions of the test," Sinanoglu explained.

"The challenge that remains is how to categorize them in a way that when you pick a chip randomly, you know which test to apply. Ideally, slow and fast chips must be tested differently."

There are design techniques that may help, he said. For example, quick time-related measurements from monitoring circuitries added into a chip can help identify which group the chip belongs to, as these measurements correlate closely with the length of the critical path — the path that takes the longest computation time — on the chip. As the goal is to apply timing-based tests on the critical path of a chip, the result of these quick measurements can be used to efficiently select the most appropriate test for that particular chip.

As the DfX lab focuses on data chip security and reliability through developing built-in hardware design solutions and accompanying Computer-aided Design (CAD) software tools, it is also investigating cutting-edge technology in the area of memory storage and chip design.

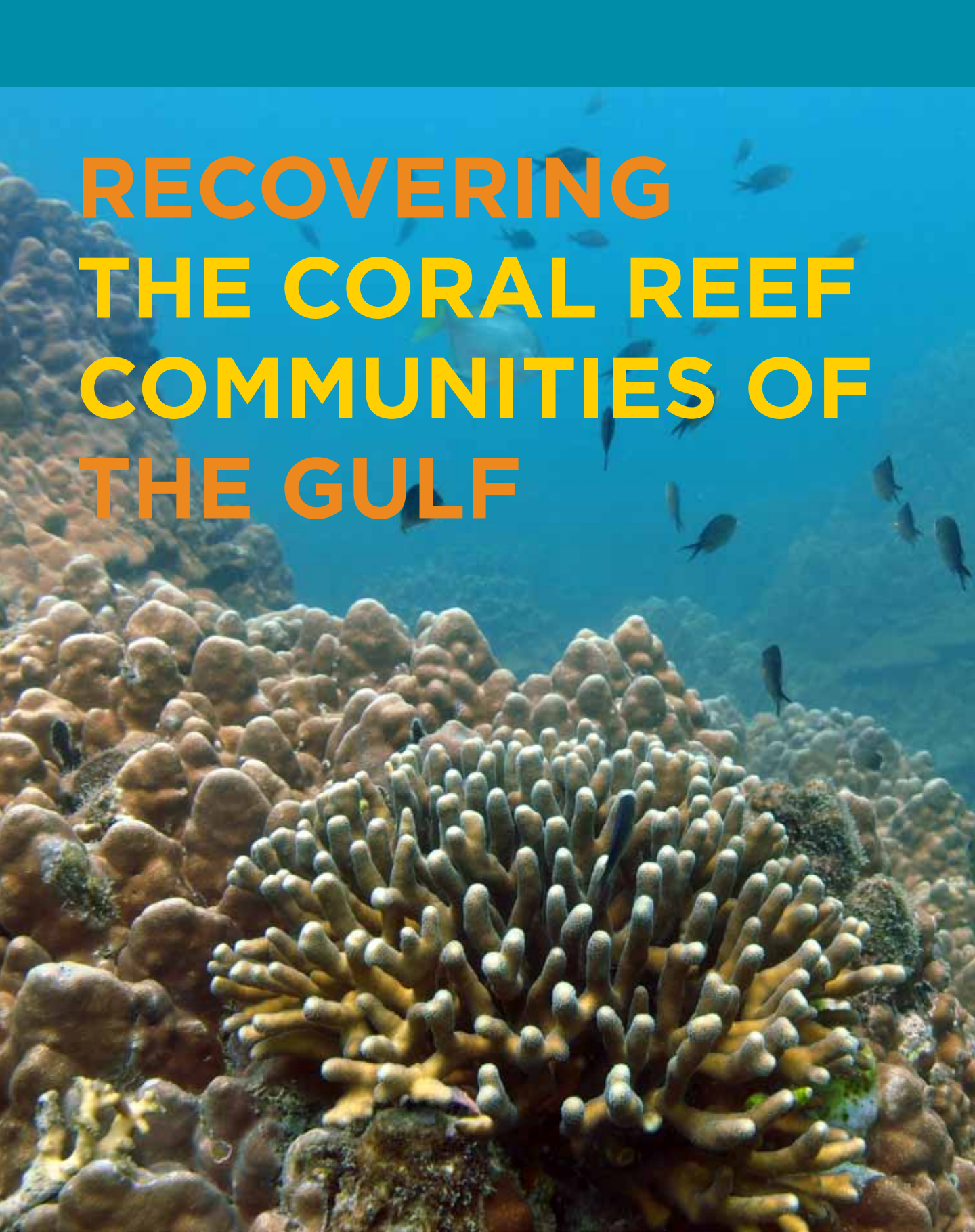
The most prominent technology currently used for memory storage in computing and electronic devices, known as static random-access memory (SRAM), is beginning to reach its limits in terms of power efficiency, speed, and size. The most promising alternate logic and memory design technology with potential to make significant advances in these areas, resistive random-access memory (RRAM), is currently in the stage of investigation and development. The technology, which is nearing accessibility for commercial use, will have a significant impact on the electronic devices that pervade modern-day life. PhD student Kannan was the first Middle East-based recipient of the IBM Great Minds Internship in 2012, through which he is actively continuing his work in this area.

Sinanoglu, who joined NYUAD in the fall of 2010 and moved to Abu Dhabi the following year, has published more than 90 conference and journal papers, and has received three patents, while having several filed patents in process. He was also the recipient of the best paper award of VLSI Test Symposium 2011 for his published work, co-authored by PhD student Saeed, on controlling power dissipation in an electronic chip during the testing phase.

DfX Lab Wins Research Grant from ATIC

NYUAD Assistant Professor of Computer Engineering Ozgur Sinanoglu has been awarded a USD 200,000 grant by the Advanced Technology Investment Company (ATIC) to conduct a two-year research project in electronic chip testing in Abu Dhabi. The grant is supported by the Semiconductor Research Corporation (SRC), an international technology research consortium that provided technical support and expertise in the grant selection process. NYUAD's Design for Excellence Lab, headed by Sinanoglu, focuses on the area of electronic chip reliability and security. With the ATIC grant, Sinanoglu — supported by NYU-Poly PhD student Chandra K.H. Suresh — will investigate the areas of adaptive testing and dynamic voltage scaling in computing, which involves chips that are designed to adapt their power intake depending on the performance requirements of a given application. In addition to receiving funding for this research, Sinanoglu said that having the opportunity to discuss findings and receive feedback from industry leaders that are member organizations of SRC — such as GlobalFoundries, IBM, and Intel — during annual research meetings will be a particularly beneficial aspect of the grant.

Ozgur Sinanoglu, NYUAD assistant professor of Computer Engineering.



RECOVERING THE CORAL REEF COMMUNITIES OF THE GULF

It wouldn't be a stretch to surmise that a childhood of summers spent on the water had something to do with NYU Abu Dhabi Assistant Professor of Biology John Burt's chosen profession. The marine biologist, who grew up in Nova Scotia, Canada, stayed on the family boat for two months each year. "It gave me an appreciation for living along coastlines and the marine environment," he said. Initially focused on fresh water ecology — using river- and lake-dwelling larval insects as indicators of pollution for his master's degree — Burt switched to marine biology while working toward his PhD. "I was still interested in the environmental genre," he explained, "but just changed direction." And, he laughed, "I must say that it's much more attractive to work in tropical coral reef environments than hanging off the side of a boat in the middle of the Great Lakes in November."

Joking aside, what Burt has already accomplished in his three years at NYUAD is no small feat. Working with the Environment Agency — Abu Dhabi (EAD) on a two-year project to develop a monitoring program to determine the current state of Abu Dhabi's coral reefs following degradation in the late 1990s, the processes driving differences in recovery among reefs, and what might be done to improve the situation, Burt's research has helped lead to the development of a marine-protected area around a formerly unprotected reef. As he said, "Developments like this make a huge difference in terms of knowing that the contribution you are making is having an impact on the local community."

Using the Arabian Gulf as a natural laboratory, Burt studies the process of recurrent mortality and recovery in its corals and is examining the resilience of coral reef communities in the region. "Throughout the Gulf there has been widespread degradation of coral reefs in the last 20 years," he explained. "Some of it is the result of coastal development, pollution, and other anthropogenic factors, but a lot of it has to do with the naturally elevated sea-surface temperatures that occurred in 1996 and 1998." According to Burt, the Gulf lost more than 90 percent of its reefs during the summer of 1998, when water temperatures in Abu Dhabi reached 37.7 degrees Celsius. "Using the Great Barrier Reef as an example, if you put the corals there in water at 31 or 32 degrees Celsius, the entire reef — the largest reef on earth — would be dead," Burt said. "Here we're going well in excess of that naturally every summer."

As well as discovering that reef communities had become increasingly degraded traveling west from Dubai to the border of Qatar — this due to western waters being somewhat shallower and having lower circulation, thus exposing the coral to a more extreme environment of higher water temperatures and salinity — Burt also noticed that a branching coral called Acropora, almost entirely lost in 1998, was showing limited recovery in Dubai and the eastern reefs of Abu Dhabi, but not in the west. Questions of

THIS EXTRAORDINARY ECOSYSTEM MAY ALSO PROVIDE INSIGHTS INTO THE POSSIBLE IMPACTS OF FUTURE CLIMATE CHANGE ON REEFS WORLDWIDE AND WHAT PHYSIOLOGICAL PROCESSES THE INDIVIDUAL CORALS, FISH, AND OTHER FAUNA ARE USING TO ADAPT TO EXTREME CONDITIONS.

degradation turned to those of recovery. Specifically, why the Acropora, a once-dominant and important reef-building coral that provides important three-dimensional structure for fish and other reef fauna, was recovering in some areas but not others.

Despite the presence of source populations of Acropora that were not destroyed in 1998, and the fact that they are indeed sending out larvae in order to reproduce, the reefs, especially those in the west, show few signs of improvement. Additionally, Burt found that some of the most degraded reefs in Abu Dhabi actually have the highest number of juvenile corals landing on them, suggesting that local environmental conditions are hampering the reef's chances of recovery. "There's not much you can do about local conditions," Burt said, "so our plan is to draft a proposal for the next two-year phase of the project, which will look at using management intervention in the form of propagating the corals." A task he will complete with colleagues at the EAD, as well as a physical oceanographer who will develop models for water circulation in the southern Gulf using satellite imagery and meters placed around the Gulf.

As Burt explained, reefs can reproduce in two ways: vegetative propagation, during which pieces of the coral's branches break off in a storm and attach to substrate elsewhere to start a new colony, or broadcast spawning and sexual propagation, during which the corals release eggs and sperm at the same time to form planktonic larvae. Usually occurring in April or May, a couple of days after a full moon, broadcast spawning creates spawn slicks (large red slicks of fertilized eggs that float above the reefs), which spread out for a period of about a week, allowing the larvae to develop swimming behavior before they start searching for a place to settle down and start their life. "There are literally billions and billions of eggs floating there," said Burt, "however, more than 99 percent die. They get eaten by fish and other organisms, or they get advected offshore and eventually die of 'old age,' but some of them do successfully find a bottom." That "bottom" could be concrete, a rock, or dead coral skeleton, as corals will not start their life on a mobile substrate such as sand.

In order to propagate the corals for reef recovery, Burt could use fragmented pieces of coral or actually artificially seed the reef by collecting larvae, raising them in situ or in aquaria, and putting them onto artificial substrates that would then be placed on the reef. "If there's some way that researchers can facilitate the number of successful larvae that are

NYUAD Assistant Professor of Biology John Burt is a leading expert in the marine biology of the Arabian Gulf.

landing on reefs, that's going to enhance recovery patterns," said Burt. "The question is whether or not it is economically and logistically feasible."

In 2013, Burt will head a team of four researchers in the NYUAD Marine Biology Lab, one of whom will examine the molecular responses of coral, specifically looking at what physiological mechanisms corals are using to protect themselves from dangers including extreme summer temperatures. "Be it swapping out the algae they have inside their tissue or the production of stress proteins or green fluorescent protein — a protein corals produce which acts as a sunscreen — together, we'll be conducting a multi-faceted approach in trying to develop an understanding of the physiology that allows corals to survive in this really unique and interesting ecosystem we have right off of our shore."

This extraordinary ecosystem may also provide insights into the possible impacts of future climate change on reefs worldwide and what physiological processes the individual corals, fish, and other fauna are using to adapt to extreme conditions. "It provides a proxy, a predictor of what's going to happen elsewhere," said Burt. "It is already experiencing temperatures that will be felt by the rest of the world, the tropics at least, probably in the next 100 years."

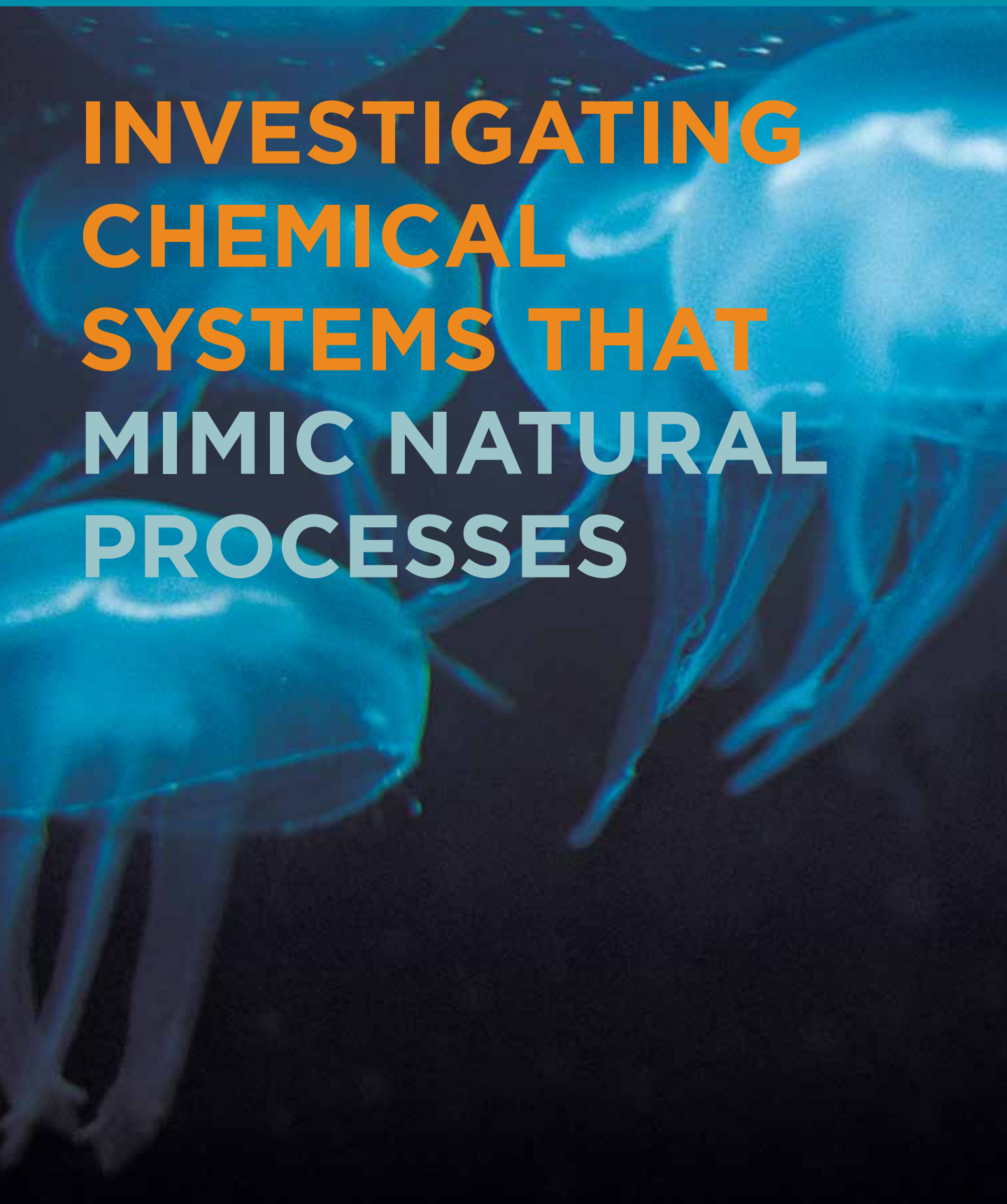
CONFERENCE HIGHLIGHT

The Coral Reefs of the Gulf conference, hosted in January 2012 by the NYUAD Institute "as a means to open opportunities for collaboration and dialogue among scientists working on reefs in the Gulf, and to promote the regionally focused research that is going on here at NYUAD in my lab and with my collaborators at various government institutions in the region," said NYUAD Assistant Professor of Biology John Burt, was the first of its kind in the region.

The three-day event, which was organized by Burt, brought together leading regional and international scientists from 19 different countries, each studying marine systems in the Gulf and surrounding seas. Together, they addressed the region's coral reef issues in a science-oriented manner (rather than in a management-, conservation-, or policy-oriented way), providing a more technical forum for researchers to "share knowledge on our current understanding of these unique systems, to open dialogue on the gaps in our regional research, and to develop collaborative relationships to work together to fill those gaps," Burt said.

In order to facilitate a more open dialogue among participants, conference attendance was limited to 120 attendees, who, over the course of the conference, took part in a series of themed symposium sessions. Topics ranged from the natural history of Gulf reefs, environmental extremes and climate change, future threats and opportunities, and science-based management and conservation, with each session beginning with a keynote address from a renowned expert in the field.

"The breadth of interests and depth of knowledge was incredibly uplifting," Burt said. A variety of papers presented at this conference are being published in a special issue of *Marine Pollution Bulletin*, which will focus on Gulf reefs; Burt is guest editor of this issue.



INVESTIGATING CHEMICAL SYSTEMS THAT MIMIC NATURAL PROCESSES

Fireflies and other luminous organisms may be a rather unassuming subject for solid-state chemists, but the nifty in-built enzymatic process these insects use to emit a luminescent glow for elementary communication functions is of great interest to the fields of science and medicine. This natural process of energy conversion, from chemical energy to light, has use in biological imaging of live tissues, particularly in the role of detecting pathogens. However, as practical applications were being developed to leverage this chemical reaction in the field of medicine, the underlying processes and mechanisms of bioluminescence itself were not well understood.

To improve scientific knowledge on this process, NYU Abu Dhabi Chemistry Professor Pančе Naumov (who was at Osaka University at the time) decided to look beyond bioluminescence as an observed phenomenon to the reaction at the molecular level.

Bioluminescence occurs when an enzyme, lucerifase, binds together with a molecule called luciferin, resulting in several steps of chemical reactions that convert luciferin into oxyluciferin, an extremely unstable molecule responsible for emitting light. In 2009, Naumov, along with fellow researchers, used the method of X-ray diffraction to determine the crystal and molecular structure of oxyluciferin, providing essential knowledge for the reconstruction of the mechanism of bioluminescence for practical application.

In his solid-state and structural chemistry lab at NYUAD, Naumov is now expanding upon this research to investigate other chemical systems that mimic natural processes. The lab, which houses a team of four postdoctoral researchers, is principally concerned with investigating the conversion of energy from its different forms, particularly among chemical, mechanical, light, and thermal energy. "When converting from one type of energy to another, there is a physical process involved," Naumov explained. "We want to investigate the mechanism of these physical processes at the molecular level, and understand how we can recreate these by using certain materials, and how we can make these processes more efficient. Our unique approach is to combine solid-state supramolecular chemistry with photochemistry and photophysics to reach a new interest in science."

Prior to joining NYUAD, Naumov had already made noteworthy progress in inducing polychromatic light emission using synthetic molecules and light stimuli, but this time around he is developing an entirely different approach by using natural systems and processes. In this new research, the light emission appears as a consequence of a chemical reaction, so research involves altering the chemical reaction or reactants themselves to produce a different color of emission. This is just one project in the team's study of energy conversion, but like this study, the lab's other research areas are also inspired by processes observed in nature.

"We can learn a lot from nature," Naumov explained. "We can try to mimic natural systems, like photosynthesis, through which nature can

"OUR UNIQUE APPROACH IS TO COMBINE SOLID-STATE SUPRAMOLECULAR CHEMISTRY WITH PHOTOCHEMISTRY AND PHOTOPHYSICS TO REACH A NEW INTEREST IN SCIENCE."

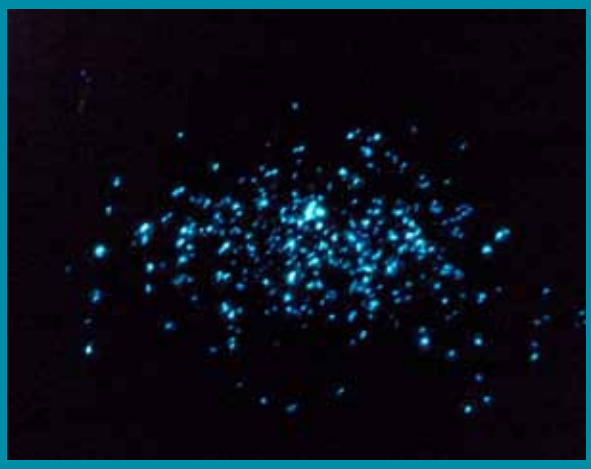
create carbohydrates using sunlight, carbon dioxide, water, and minerals. By learning about this and utilizing similar processes in a laboratory setting, we can employ them for a controlled conversion of energy—like an artificial photosynthesis." The seeds for new research ideas may range from long-standing scientific observations that remain previously uninvestigated, or by starting first with practical goals and looking to natural processes to identify the materials best suited for the purpose.

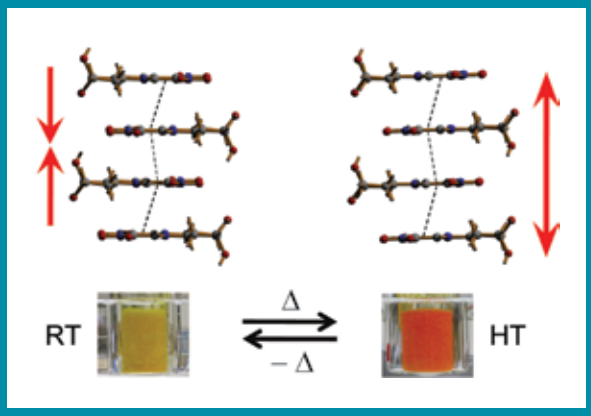
One of these priority research areas is the synthesis of pharmaceutical drugs through inducing a natural light to chemical energy conversion. "Solar light can be used directly to shorten the reaction sequence for producing pharmaceuticals, reducing high energy costs and achieving the same goal in fewer steps, with higher efficiency and without using solvents," Naumov said. "Solvents not only create a waste byproduct, but they require energy to be removed once the desired medicine has been produced." The research team will determine information about molecule structures and the way they react, then pre-orient molecules within the solid state. These reactant chemical structures will then be exposed to direct sunlight with the aim to stimulate a photoreaction that will fuse molecules into a new chemical structure, for example, one similar to commonly used pharmaceuticals. Advancements in this kind of technology would be significant for places like the UAE, which have abundant amounts of natural sunlight.

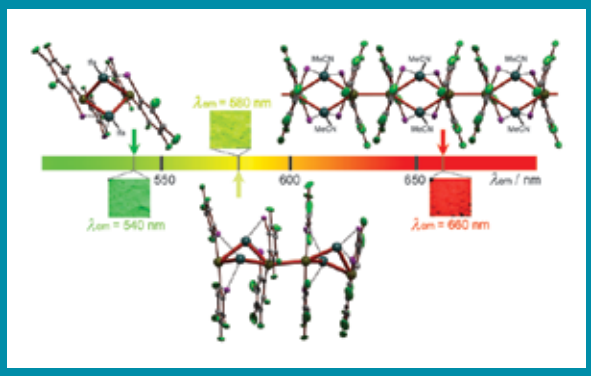
Another example of this natural energy conversion is the use of specific materials as actuators that can cause movement on a very small scale. Components of microfluidic devices, which are used as "lab-on-a-chip" for biochemical assays, for instance, can be controlled through tiny actuating elements. This technology of actuating materials may also assist in the construction of artificial muscles that would move and be controlled by thermal or electrical stimuli. Research in energy conversion may also lead to the development of smart material structures, which change their properties according to energy impact, such as glass that adapts its levels of transparency based on the direction and incidence of incoming light.

Naumov, who hails from Macedonia, was drawn to this field of research because of the undiscovered potential for practical application of a number of unconventional natural phenomena, as opposed to other areas of research in energy conversion, like solar energy, that are reaching their efficacy limits. His experience in solid-state and structural chemistry and molecular structure has been essential in understanding these processes and reactions.

"Basically, the understanding of the structure of the molecules and how they change translates into understanding of the properties of materials and how the properties change. From there we can understand how the processes occur and with what efficiency. This means that in order to improve any dynamic process we need to first understand the underlying chemical structure."

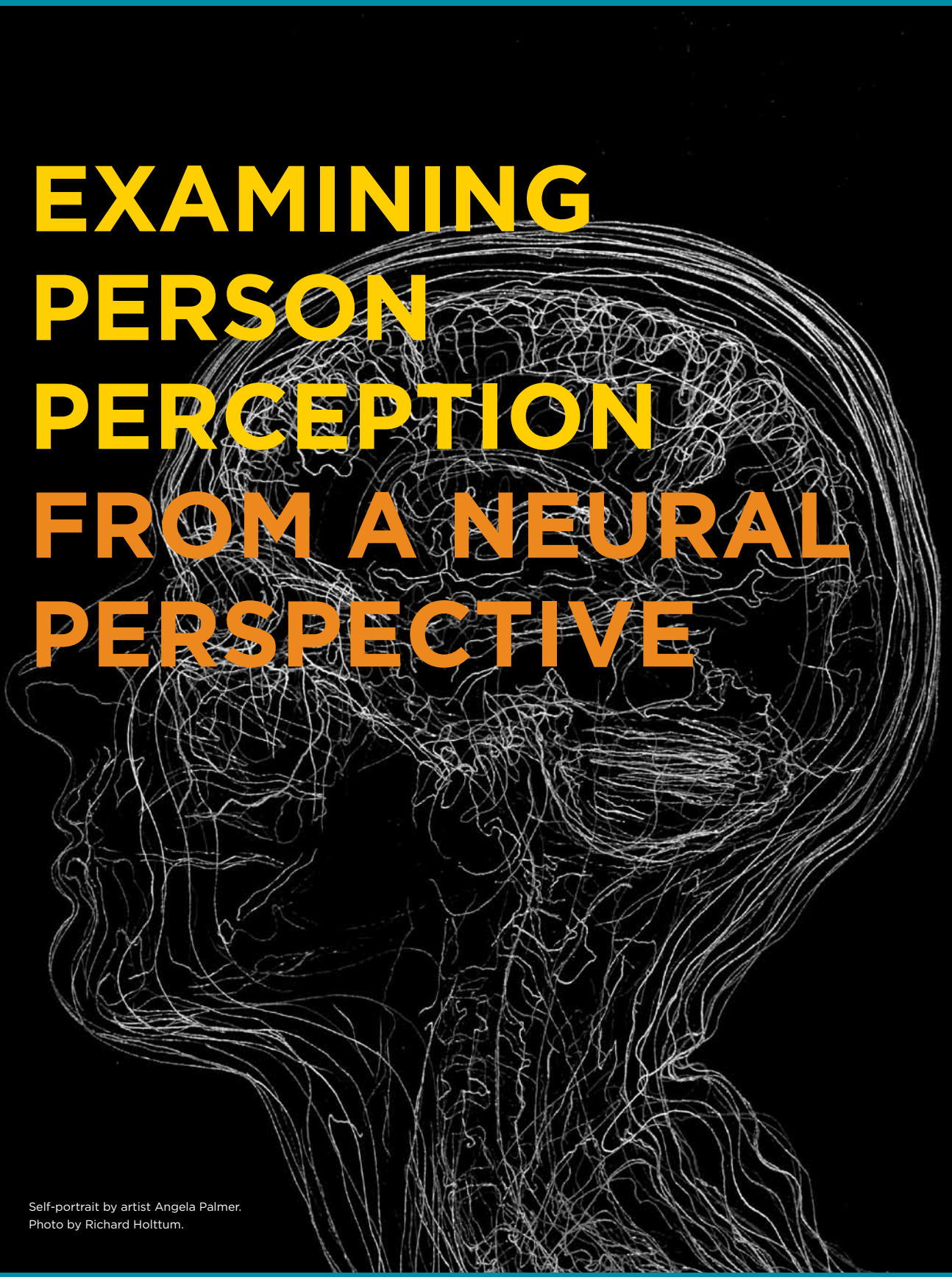






LEFT: NYUAD Associate Professor of Chemistry Panče Naumov. **TOP:** The small ostracod *Vargula hilgendorfii*, also known as the "sea firefly," emits light by ejecting two compounds, a protein and a substrate, in the sea water to escape. **CENTER:** Solid-state thermochromism in an "X-type" intramolecular charge-transfer compound: Repetitive heating and cooling cycles are visually observed as reversible color changes between yellow and orange-red due to the change of distances between the stacked molecules in its structure. This rare property may be important to organic-based optoelectronics. **ABOVE:** Modulation of the emission color by aurophilic interactions: The aurophilic interaction, which occurs between gold and other closed-shell metals, represents a special case of general metallophilic interactions. The related heterometallic complexes are of practical interest because of their strong photoluminescence and the unconventional property that allows them to change color as a result of elevated pressure levels or exposure to vapors.

EXAMINING PERSON PERCEPTION FROM A NEURAL PERSPECTIVE



Self-portrait by artist Angela Palmer.
Photo by Richard Holttum.

As humans, we try to make sense of other people every day. Based on our own judgments and stereotypes deduced from social information, interactions, and expectations, we categorize them, classifying, say, the woman next door as a gossip, the man at work as easygoing, or the new friend as kind. While this processing may come as second nature, most likely don't think about why we respond the way we do or what factors influence that response. For NYU Abu Dhabi Assistant Professor of Psychology Susanne Quadflieg, understanding how we navigate our social world from a neural perspective is the focus of her current research. "I want to understand how the brain enables us to be a social species," she explained. "Everything you are stems from your brain. I find it the most fascinating thing!"

Quadflieg began working in the "relatively new field" of social neuroscience as an undergraduate at the University of Jena in Germany. Since then, she has conducted research in Europe, America, and, now, the Middle East. Often fueled by personal curiosity, Quadflieg has always been fascinated by the fact that humans are an ultra-social species. "We need other people, it's as simple as that," she explained. "At the same time, they can be our biggest danger. They may deceive or reject us, suffocate us with their expectations, or even harm us physically."

In order to understand our perception of social interactions, Quadflieg is studying humans engaged in typical social activities, such as shaking hands, taking a walk, or engaging in conversation. Specifically, she seeks to determine the stage during the person perception process at which sensitivity to such interactions (and their inherent social meaning) arises.

Previous research has found that the brain has modules particularly dedicated toward perceiving human faces and bodies; however, this research typically considered these faces and bodies out of context. By looking at actual person interactions, Quadflieg has put human faces and bodies in context to study how our brain processes the same stimuli when they are presented within a social narrative. While undergoing functional magnetic resonance imaging (fMRI), a method that allows neuroscientists to measure neural activity, participants view images of two people presented on a uniform background. While some of these dyads show well-known social interactions, others consist of two people whose involvement with each other remains unclear to the perceiver. Through this control condition, Quadflieg can determine whether our brain perceives other humans differently depending on whether we can make sense of them.

As Quadflieg explained, "Compared to these control images, meaningful or easily understood social interactions elicit reduced activity in the brain's person perception modules. These results support the

view that our social expectations shape the way our brains make sense of the visual input, not only at an inferential level but also at a perceptual processing stage. In other words, seeing people involved with each other in a way that you understand makes seeing them easier." Quadflieg has submitted her findings for publication and has planned follow-up projects on the topic. One such study will involve further probing to determine when in the processing stream the brain begins to distinguish between meaningful and non-meaningful dyads, as opposed to discovering where in the brain activity is taking place.

Her second project, which also uses the fMRI, investigates the nature of knowledge representation and knowledge use in the human brain. "Many people would find it rather simple to form an impression of a neighbor described as narrow-minded," Quadflieg said. "However, the question of how the human mind represents and integrates such social information is far from trivial." Besides providing the basis for retrieving the meaning of thousands of words, a person's repository of social knowledge holds the elementary units for many higher-order social-cognitive operations, including anthropomorphizing, mentalizing, and stereotyping. "Given these observations, it is unsurprising that neuroscientists have expended considerable effort in attempts to understand how the mind represents and organizes social knowledge," she said.

According to Quadflieg, researchers have begun to argue that the representation of social knowledge depends on a unique network of brain regions, with three specific regions—the medial prefrontal cortex, the temporoparietal junction, and the anterior temporal lobe—playing a particularly important role. Though all three regions have been found to be involved in a variety of social reasoning tasks, their exact functional contributions remain a matter of debate. Quadflieg expects that the three regions of the social brain are recruited differently depending on the type of social knowledge probed and the intended use of the knowledge. More specifically, "We predict that neural activity differs depending on whether social knowledge refers to the traits, states, or outer appearances of others," she said. "In addition, we expect that attributing social concepts toward a specific person—for example, is Tom kind?—causes the recruitment of additional neural resources compared to those used for mere semantic processing—such as, is the word kind related to the word nice?"

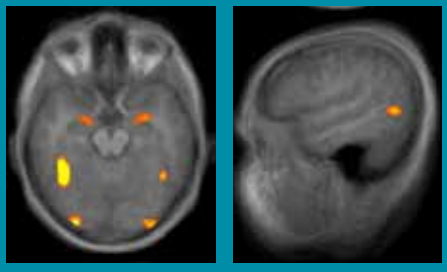
Quadflieg also plans to conduct research focusing on faces to answer questions such as why we judge some faces trustworthy and others not, and who we think is smiling out of genuine enjoyment and who is faking a smile. She will present photographs of human faces to her participants, who, among other methods of investigation, will be asked to numerically rate each face on a variety of dimensions. Quadflieg is currently building up the "face database" and will determine future studies based on its contents.

This research will be reflected in *Snap Judgments*, a course taught by Quadflieg that examines the mechanisms that explain this phenomenon. As she said, "I want to unravel a fundamental social mystery with my students: Why we often think we know things about others without ever having exchanged a single word with them?"

Based on discovering the neural foundations of perceptions or judgments formed by the collection of social information, interaction, and expectation, Quadflieg's research will address how the human brain makes sense of others. "I hope that this can help us in the long run to better understand why these skills are sometimes poorly developed—either because we have a momentary lapse (most of us have occasionally misinterpreted social situations), or because certain mental disorders such as autism or intense social anxiety make it particularly hard for some people to make sense of their social surroundings."

Quadflieg has also set up a research laboratory, the Person Perception and Person Knowledge Lab, that targets questions of person perception and person knowledge with the help of various neuroscientific methods, including fMRI. As she said, "I'd like to make use of what makes this region so unique: so many different ethnicities and nationalities coming together, all bringing their own social rules and expectations. I want to understand these different realities."

BY LOOKING AT ACTUAL PERSON INTERACTIONS, QUADFLIEG HAS PUT HUMAN FACES AND BODIES IN CONTEXT TO STUDY HOW OUR BRAIN PROCESSES THE SAME STIMULI WHEN THEY ARE PRESENTED WITHIN A SOCIAL NARRATIVE.



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NYUAD Assistant Professor of Psychology Susanne Quadflieg.

ENABLING NETWORK CONNECTIVITY IN DEVELOPING NATIONS

The Internet is so seamlessly integrated into modern life that it can be easily taken for granted. But when Jay Chen — now an assistant professor of Computer Science at NYU Abu Dhabi — stepped outside of the "bubble" of his US upbringing and got on a plane to Kerala, India, to participate in a Microsoft research internship while working toward his PhD, he experienced "a series of culture shocks" about network connectivity in the country that made a lasting impression.

"I went to this university and nothing worked," Chen, who is a researcher at NYUAD's Center for Technology and Economic Development (CTED), said. "The network was down for four hours in the afternoon — why? No idea. I went to a school and they had no Internet for a week — why? Because somebody was digging somewhere, building a road. I went to another school and they had Internet access in the form of one of those USB modems that the teacher was paying out of pocket for to get one day of access a week — why? Because they couldn't afford it and there was no infrastructure, so that was his only option."

Improved access to technology and information will go a long way in accelerating economic productivity in rural and developing areas and will play an important role in educating the workforce so that it can compete on the international stage. But bridging the technology gap is no simple feat. While computer hardware donations distributed in rural areas are well intentioned, a critical gap remains: "The technology that exists is typically built for the developed world where everything works," Chen explains. "You have reliable power, you have reliable Internet access, maintenance is easy, and everyone knows how to use technology — there are numerous problems with those assumptions when you're taking your laptop to a place that has nothing."

This is why Chen is using his computer science expertise to research real issues on the ground in developing countries, with the aim of developing unified system architecture solutions that have the potential to be reapplied across different geographic locations that face similar challenges.

One of his first projects at CTED involved providing valuable electronic information services to educational organizations within the constraints of an extremely limited and slow network connection. In certain rural areas at the frontier of Internet service provider (ISP) locations, where connectivity may be limited to one USB modem shared across a classroom, offline Internet access has proven to be an effective solution. By using a teacher's course syllabus as a guide, Chen and his research team developed a focused web crawler to search relevant topics and automatically download pertinent web pages relating to those subjects. After being stored on an external hard drive, the information within the system architecture is then integrated as a cache for the web browser and can be accessed and produced through search, removing the need to go through a congested local area network link. The offline webpage solution has been well received at schools in India and Kenya, and is being more widely deployed.

Another solution that Chen has explored in the effort to support organizations with exceptionally stretched network capacity is the concept of asynchronous web browsing. This model was developed for a university in Kerala that did in fact

have a decent 2-megabit connection through fiber optic cable, but when shared by more than 400 users, speed was reduced to less than one-tenth the speed of a dial-up connection. As the connection degrades, users may find that pages sometimes do not load; but with an asynchronous web browsing model, if the system detects that this situation is occurring, user requests can simply be cued up to download at a later point, without causing time-outs that might otherwise occur, thus providing a more seamless user experience.

"We put a local proxy on the user side that sits on the local area network so that it's well connected to the client's machine. That local proxy is then paired with a remote proxy across the network link, which is well connected to the Internet in a different location. The user communicates directly with the local proxy as if that were the Internet, and the local proxy serves the clients as well as it can, often using cached pages," Chen explained. "When the connection is up, but maybe slow, the local proxy will communicate with the remote proxy to get the pages that it needs and the remote proxy will communicate with servers, get the pages, filter, and compress them — so everything is pushed away from that bottleneck network link. Instead, you have these two agents on either side that negotiate with the clients and Internet servers respectively."

This innovative solution solved the research problem of reestablishing connectivity in some form, but it was not perfect during implementation, Chen admitted. Other infrastructural limitations created a new set of drawbacks, and as he explained, "Once you chop that end-to-end connection from the user to the actual servers, you need to do a lot to make it seamless again."

While Chen continues to specialize in areas of computer science and networking, he has also been involved in a range of other CTED projects, including using mobile phone text messaging as an efficient tool for gathering and collecting information for practical purposes. In many rural areas, data collection is still paper-based, using significant time and financial resources. Given that most of the world has at least a 2G connection, SMS is one of the "least common denominators" of mobile communication. Chen has been involved in developing tools, such

as easy-to-use, form-based applications, as well as automated response to text-based search, in order to leverage mobile phone technology for tasks traditionally associated with computing. He has also contributed to the development of an anti-counterfeiting system that utilizes unique barcodes to track and verify the authenticity of goods as they travel through the supply chain, making it prohibitively more difficult and expensive for counterfeiters to circumvent official channels.

As Chen continues his work of creating practical technology solutions that enable greater access to information for those in the developing world, he remains mindful of the fact that as the Internet becomes faster and webpages become more complex, the technology gap is growing at an accelerating pace.

"It's always a matter of frontiers," he said. "We're always going to be getting better speeds and the frontier for connection is going to keep pushing further and further out geographically. The question is: Can we push past that frontier so that those who are way out there with no connection can get access to information?"

TOP: Hohoe Evangelical Presbyterian Senior High School in Ghana, where Chen has deployed a network connectivity project. **ABOVE:** CTED student interns discuss research in the school's computer lab.

Jay Chen (right) with local field contact in Ghana, Johnson Achemdey, and his daughter Germaine Achemdey who assists with translation for CTED projects.

“THE TECHNOLOGY THAT EXISTS IS TYPICALLY BUILT FOR THE DEVELOPED WORLD WHERE EVERYTHING WORKS. THERE ARE NUMEROUS PROBLEMS WITH THOSE ASSUMPTIONS WHEN YOU’RE TAKING YOUR LAPTOP TO A PLACE THAT HAS NOTHING.”

DEVELOPING NEW TECHNIQUES FOR CINEMATOGRAPHIC EXPRESSION

What began as a pastime with childhood friends became a full-time passion for Dutch-Indonesian cinematographer, film director, and NYU Abu Dhabi Associate Professor of Film and New Media Leonard Retel Helmrich. Armed with an 8mm camera at the age of 13, he explored Amsterdam, creating movies. "I've always loved film," he said.

Now, 40 years later, Helmrich is known not only for his successful documentaries, but also for his Single-shot Cinema technique, an unobtrusive cinéma vérité approach to filmmaking in which each scene is filmed using one camera that swoops in and spins around the actors, flies in and out for extreme close-ups and wide angles, and shoots from many perspectives at different speeds, all in one shot. In addition to the movement of the camera becoming the vehicle for cinematographic expression, "the scene is continuous," Helmrich said, "and because of the movement, everything is connected."

Helmrich likens this interconnectedness to the inner workings of a clock. As such, the smaller gears are of equal importance to the larger gears, and if one was to remove a single component, the clock wouldn't run. It is this connection, which binds interrelated elements into a whole, that allows the viewer to travel within a scene, inside an event, to a particular spot at a specific moment.

It's also about the perception of reality. "I noticed that film is typically taught as a segregated reality, and then in editing you have to make believe that it is a whole," Helmrich said. "I think this is a mistake. You should shoot it as a whole and then the way you segregate it is up to you. You should film the way you perceive something—as a whole with interrelated elements. As a result you can feel that everything is interrelated and express your personal feelings and perceptions of that moment." In short, Single-shot Cinema is about how filmmakers perceive the reality while filming, not in how they present the film.

For Helmrich, the technique goes further than film. "It's actually more a philosophy," he said. "It's a way of looking at and perceiving the world around you, recognizing that everything is connected. It may

be very far off," he laughed, "but it's a feeling. And I want to bring across this feeling in my films."

This feeling is often conveyed with the help of Steadywings, a camera mount invented by Helmrich that places the weight of the camera between one's hands to allow for stability and maneuverability while filming. Using the wide-set, multifunctional handles, the camera can be easily and safely moved from one cameraman to another, and folds up to accommodate filming in or through small spaces. The flexibility of the mount also enables Helmrich to execute complicated maneuvers, including orbital camera movements (instead of panning), which circle around a point of interest and move from one interest point to another in one smooth flow. Often found in video games, but not yet introduced into mainstream film language, these movements eliminate many physical limitations in camera work, allowing a film to be shot not based on specific scenes, but on camera movements that feel intuitive and natural, thus creating an intimacy unmatched in other filmmaking styles, Helmrich said.

Helmrich has directed one feature-length movie and four documentaries, the latest of which, *Position Among the Stars*, garnered him a Best Documentary Award at both the 2011 European Film Awards and the Abu Dhabi Film Festival, and a World Documentary Award at the 2011 Sundance Film Festival. The final chapter of a trilogy 12 years in the making, *Position Among the Stars* follows an Indonesian family living in inner-city Jakarta and tells a moving story about the religion, politics, and economics of the country through the intimate portrayal of each character.

Currently, Helmrich is filming a 30-minute 3D documentary in the UAE, for which he has developed new techniques in order to incorporate his single-shot theory. "The camera movements that I have developed for Single-shot Cinema are really good for 3D filming because it requires continuous scenes," he explained, "but with 3D you always have to calibrate the camera, you are shooting with two cameras simultaneously, and the cameras should be at a fixed distance from one another for every shot." Thus, problems arise when moving the cameras, a fundamental feature of Single-shot Cinema. "You can only make tracking shots; moving in and out and toward small objects is more difficult," he said.

However, inspired by Steadywings, Helmrich is testing a new mount based on the Steadywings mechanical system that will bring the cameras closer and further away from each other without losing the calibration. It is still a work in progress, but he has had positive results so far. "It's very important, as camera movements are required to tell the story," he said.

Based on the abstract works of Emirati artist Wasel Safwan, whose large-format paintings are influenced by architecture and composed of contrasting geometric shapes, volumes, and colors, Helmrich's 3D film will follow Safwan's creative process and observe "how he absorbs his inspiration from the world around him," Helmrich said. According to Helmrich, Safwan's art is much like his own filming style. "Even though it's a different art form, it's the same kind of philosophy," Helmrich explained. "He paints as if in one movement and tries to interrelate elements in each painting." Based on the success of the short film, Helmrich will consider transforming it into a feature in the future.

Helmrich is working with NYUAD student Weichen Zhu (Class of 2015), whose short film, *The Blessing*—created with fellow classmate Umair Saad—was selected for the 2012 Zayed University Middle East Student Film Festival. Together, in the Netherlands, they are conducting research on 3D film technologies and collaborating on another of Helmrich's projects: a film about the last herring fishermen in the Netherlands.

Interested in the ways that older methods of storytelling can incorporate new technologies, Helmrich will continue to surprise his audiences by developing new techniques and pushing the boundaries of film. "Film is always new, never dull," he said. "It's never following standard rules. It's always trying to adapt from your own perspective. During film school, I realized that films are typically made in a very strict way. But I found out that the more you understand the rules, the more you can gain in expressiveness because you know when not to follow them."

Helmrich filming *Position Among the Stars*, the award-winning documentary about a family living in inner-city Jakarta.

"YOU SHOULD FILM THE WAY YOU PERCEIVE SOMETHING—AS A WHOLE WITH INTERRELATED ELEMENTS. AS A RESULT YOU CAN FEEL THAT EVERYTHING IS INTERRELATED AND EXPRESS YOUR PERSONAL FEELINGS AND PERCEPTIONS OF THAT MOMENT."


ENGINEERING
THE BIOFUEL OF
THE FUTURE

In the search for viable alternative energy sources, biofuels have been in the spotlight in recent years as strong candidates to lead the way for the future of clean energy. However, just as biofuels have been recognized for their potential, they have also been criticized for their limitations, including issues of scalability and for the significant land and agricultural resources they require that would otherwise be utilized in food production.

As research entities and ambitious start-up companies around the world join the race to discover practical techniques to harness usable energy from these sources — ranging from sugar- and starch-based crops like sugarcane and corn, to cellulose-based materials like wood and grasses — NYU Abu Dhabi Associate Professor of Biology Kourosh Salehi-Ashtiani is placing his bets on common algae. He is not alone. Algae have been noted for their oil production capacity, and according to the US Department of Energy, "can potentially produce 100 times more oil per acre than soybeans — or any other terrestrial oil-producing crop."

"Algae is an ideal system to probe fundamental aspects of biology, such as evolution, and genetic interaction, while working toward developing resources with very important practical use, such as biofuels, biopolymers, and nutraceuticals," Salehi-Ashtiani said.

Algal mass partially consists of lipids or triglycerides — the primary constituent in vegetable oils — which can be processed into transportation fuel that is suitable for use in existing machinery and systems. Once these oils have been harnessed, the remaining biomass can also potentially be used to generate fuels by other means, for instance through fermentation or pyrolysis. Algae can generally be found abundantly in various natural environments, do not consume human or animal food resources, and can thrive in salt and waste water, or on non-arable land. In addition, algae, like plants, are photosynthetic, taking in carbon dioxide and emitting oxygen as a byproduct. This means that algae not only produce clean energy with limited carbon emission and minimal impact on human agricultural resources, they can be used to clean up existing greenhouse gases in the environment. As this nascent industry matures, however, there are certain challenges that remain in the use of algae as a biofuel; namely cost efficiency and scalability of production.

This is why Salehi-Ashtiani's work in his Algal Systems Biology Lab at NYUAD on the genetic structure and engineering of *Chlamydomonas reinhardtii*, a model algal species, is particularly relevant. In the fall of 2011, he played an instrumental role in developing the first computational genome-scale metabolic model of an algal species, with predictive capacity on how gene manipulation can affect factors like growth and lipid production. The model also incorporates the impact of photosynthetic elements, including characteristics of varied light consumption and its impact on the metabolic process. The computational model can simplify the task of conducting an unfeasible number of bench lab experiments by providing predictions of the impact of altering a certain gene or set of genes. The genetic modeling of *C. reinhardtii* was a four-year collaborative project led by Salehi-Ashtiani and Jason Papin from the University of Virginia and was supported by 11 experts from a range of international institutions.

Salehi-Ashtiani, who has served as principal investigator on a number of projects funded by the US National Institutes of Health and the US Department of Energy prior to joining NYUAD, has since been continuing work with the model to run strain optimization experiments in Abu Dhabi. His research team is exploring the impact of altering certain factors in the genome to yield the desired results of higher lipid production and faster metabolic function.

"Our approach is to look at metabolism at the systems level, which frequently means looking first at the genome. In collaboration with Michael Purugganan and his group at NYU New York, along with the NYUAD Center for Genomics and Systems Biology, we have now sequenced the genomes of approximately 20 or so *C. reinhardtii* strains, defining gene variations among these isolates. These strains, directly or indirectly come from various geographical locations. Using an array of photo-bioreactors, we aim to define metabolic characteristics of these strains — for example, growth rates and lipid contents — and to the extent that is possible, link them to their genomic variations. These strains are in a way optimization experiments that nature has carried out over many thousands of years and are now available to us to study. The information gained from our studies will clearly guide us to better design our future experiments."

Because *C. reinhardtii* has historically been used as a scientific model for understanding processes like photosynthesis, reproduction, and metabolism in microorganisms, genetic findings about this species are easily relatable to similar algal species. The NYUAD lab has begun exploring UAE- and region-based variations of algae, fitting them to the model to understand how different environments impact the characteristics of the organism. An environmental sampling program conducted in the extremely hot summer months in Abu Dhabi allowed the team to study organisms adapted to extreme climates. "This is rather important because any species or strain that would be useful for commercialization would need to be able to tolerate high environmental temperatures," Salehi-Ashtiani said.

Researchers at the lab are also using the model as a tool for continued discovery about the species and about the functioning of algal metabolism through testing specific hypotheses. For example, the species has both animal- and plant-specific genes. Through controlled wet bench and computational experiments, the research team is investigating how the genes within the metabolic network work together, hoping to answer a very basic question: Do genes tend to work with those that they have a similar evolutionary affinity with, or not?

"We have now carried out in-depth and integrated evolutionary and topological analyses on the metabolic network that we published in 2011. On the evolutionary side, we have interrogated more than 150 sequenced genomes to map evolutionary relationships of the 1,000 or so *Chlamydomonas* metabolic genes to (evolutionarily) near and far away lineages. On the topological side, we have defined pairwise relations, hubs, gene communities, and how the network behaves in response to light and dark," Salehi-Ashtiani said. "What's exciting is that we can see legacy of relationships in the network that may date back to hundreds of millions of years ago. With this information in hand, we are now at a much better position to understand metabolism of the algae and identify the key nodes within the network, and importantly, recognize key connections within the network."

As Abu Dhabi strives to diversify its economy and develop clean energy sources, Salehi-Ashtiani sees the emirate as an ideal location for this research. "I see Abu Dhabi as an environment that is very motivated in exploring new frontiers," he said. "I hope that we can start collaborative efforts with organizations here in the UAE to further this research. The potential and level of interest that I see here in developing renewable resources is going to be very important moving forward."

NYUAD Associate Professor of Biology Kourosh Salehi-Ashtiani in his lab at the University's Center for Science and Engineering.

ALGAE NOT ONLY PRODUCE CLEAN ENERGY WITH LIMITED CARBON EMISSION AND MINIMAL IMPACT ON HUMAN AGRICULTURAL RESOURCES, THEY CAN BE USED TO CLEAN UP EXISTING GREENHOUSE GASES IN THE ENVIRONMENT. AS THIS NASCENT INDUSTRY MATURES, HOWEVER, THERE ARE CERTAIN CHALLENGES THAT REMAIN IN THE USE OF ALGAE AS A BIOFUEL.

EMBRACING GLOBAL PERFORMANCE TRADITIONS FOR A WHOLE THEATER EXPERIENCE

NYU Abu Dhabi Associate Professor of Theater Rubén Polendo was on the path to a career in science when he was asked to advise on a theater piece. This simple introduction to the stage quite literally changed his life. "What I witnessed in that room changed everything," he said. "My life up to then had been surrounded by protocol, hypothesis, and theory — and before my eyes there was creation, pure and simple creation."

Since that pivotal moment, Polendo has traveled the globe, making explorations into a variety of world theater traditions in an effort to create a "Whole Theater experience," a theatrical journey that is at once "rigorously visual, aural, emotional, intellectual, and spiritual," he explained. In fact, this exploratory methodology forms the core of Theater Mitu, Polendo's New York- and Abu Dhabi-based theater company — in essence, his lab — which, since its founding in 1997, has merged global performance traditions into innovative productions worldwide.

Polendo's first research trip to India resulted from his involvement with a South Indian Kathakali company that was in residence at Lancaster University in the UK, where he switched from a master's in biochemistry to non-Western theater. Since then, Polendo has studied performance traditions and the philosophies behind them in countries including Japan, Thailand, India, Ethiopia, and Iran. Through the investigation of theatrical forms from Kabuki and Muay Thai to Kalaripayattu and Ta'zieh, he seeks to answer the question that was the genesis of his research: How does one train for the Whole Theater experience?

For Polendo, the answer to this question is in the examination of how performers train their focus, emotions, spirit, and physicality. By studying and learning these elements, he — and the members of Theater Mitu — explore in depth a wide range of theatrical forms and codify them into a training methodology that shapes each work the company produces.

Recently, this methodology informed Polendo's adaptation of *The Ramayana*, an ancient Sanskrit epic and one of Eastern literature's central myths, during which he directed NYUAD students in the University's first student-run theater production. "The type of theater I'm interested in is large, physical, visual, and hyper-theatrical," Polendo said. "The language and emotionality are scaled to the visual landscape and supported by the Whole Theater training. In turn, the best structure on which to build this is the epic."

For the production (Polendo's third play at the University), approximately 50 members of the Classes of 2014 and 2015 participated in *The Ramayana* as actors, assistant designers, producers, managers, crew, documentarians, and dramaturges. Collaborating with designers and musicians from Theater Mitu, the students staged eight performances, incorporating Turkish-inspired shadow puppetry; Balinese masks, ritualized movement, and percussion; and Afro-Indian drumming. As Polendo said, "Producing the work themselves makes the art a very personal experience for the students."

It is with this in mind that Polendo emphasizes the foundations of Whole Theater in his courses. Giving his students the opportunity to get out of the classroom and experience firsthand some of the global performance traditions covered in class, he leads local and regional trips, during which the students perform immersive and physically rigorous explorations into understanding different theatrical forms. It is Polendo's hope that this intensive field

research will give his students "the ability to go from instinct to creation in any field, and to master the discipline to follow through and to further articulate their process."

As such, on regional field research trips to India, students investigated Nepali, Newari, and Malayalam performance traditions with a focus on South Indian traditional dance and martial arts including Kalaripayattu, Kathakali, Theyyam, Mohiniattam, and Kalari-Yoga, and Nawari performance rituals such as Charya Nritya and Kumari. Closer to home, during trips within the UAE, they learned the tradition of Arabic clowning; the predominantly Yemeni, Omani, and Pakistani Pehlwani fighting form; and the Emirati tribal dance-ritual form of Ayyalah.

Polendo's current research focuses on these and many other world theater traditions. Through ongoing artistic field research, he examines their foundation work, preparation, theories, and philosophical values to further articulate his Whole Theater methodology, which is constantly re-envisioned and re-invented. "In many cases, these are further explorations into landscapes that have been incredibly fruitful," Polendo said.

Projects include the practical study of South Indian performance traditions — including Kalaripayattu, Kalaric-Ayurvedic healing traditions, Mohiniattam, and Kathakali — many of which are "lynchpins" in Whole Theater training and which Polendo has studied for more than a decade; the Japanese forms of Noh and Kabuki theaters, Bunraku puppet theater, and Butoh, whose theories, trainings, and ideas Polendo began studying 15 years ago and which are also key to the Whole Theater experience; Nepali and Newari performance rituals such as Charya Nritya, Lakhe, Kirtich Nach, and Harasiddhi; and Yemeni forms including Jambiya, Manakhah, and Harazi. Comprised of performative martial arts, dance rituals, street clowning theater, and narrative mask dances, among other forms, Polendo's research seeks to extrapolate the values of these global, and oftentimes ancient, performance traditions and fuel the exploration of their application into both original and existing theater works, thus challenging modern conceptions of what theater is and what it can be.

Polendo also continues to focus on the traditional performance and ritual forms of the UAE. In what is an ongoing research project, he is studying the Emirati cane dance of Ayyalah, the Emirati performance of Ma'alayah, ritualized bull fighting outside the Emirate of Fujairah, and the Arab/Pakistani ritualized fighting art form of Pehlwani, while continuing to investigate the theatrical ecosystem of Abu Dhabi in order to produce highly original contemporary local theater productions.

Additional project-specific research will take place outside the UAE, in Juarez, Mexico, for Polendo's original piece entitled *Juarez: A Documentary Mythology*. Initial research focused on the documenting and amassing of interviews in Juarez (where Polendo was raised) and the surrounding areas to explore the emotional and personal effects created from living in the northern Mexican city known as the "murder capital of the world." A meditation on violence and identity, the piece navigates between present-day political strife and the mythological retelling of family memories, "ultimately interfacing potent interviews and firsthand experiences of life in Juarez with 1940s Mexican cinema — one filled with horror and death, the other with love, romance, and tradition — to uncover the strength of family, national pride, identity, and memory," Polendo explained.

With the goals of building a vibrant, global theater program for NYUAD, and sharing the arts with communities whose exposures to theater border on non-existent, Polendo hopes to create a dynamic production life for both the University and Theater Mitu in Abu Dhabi. As he said, "My field is the study of the human experience as it spans from the personal and emotional to the cultural and communal. It interfaces politically and socially. It is both classical and contemporary and expands through time. It is a collaborative art form and depends on the union of heart, head, soul, and senses to vibrate at its highest intensity. It lives between lines and explores between lines. Theater has historically been a key tool in the defining and articulation of a city, and as a liberal arts university, NYUAD has a commitment to engaging the community of Abu Dhabi. I think theater is key to this conversation."

"MY FIELD IS THE STUDY OF THE HUMAN EXPERIENCE AS IT SPANS FROM THE PERSONAL AND EMOTIONAL TO THE CULTURAL AND COMMUNAL.

TOP LEFT: Polendo studies local UAE performance rituals, including the Emirati cane dance of Ayyalah. **TOP RIGHT AND CENTER:** Polendo directing students in NYUAD's first student theater production of *The Ramayana*. **ABOVE LEFT:** Polendo's Theater Mitu fuses global performance traditions to create a "Whole Theater" experience. **ABOVE RIGHT:** Students study local dance and performance forms in Kerala on a *Making Theater* class trip led by Polendo.


CREATING
A NEW
CLASS OF
MATERIALS

In the early 2000s, Ramesh Jagannathan, now associate dean of Engineering and professor of Chemical Engineering at NYU Abu Dhabi, was in Kodak's research labs in Rochester, New York, investigating a common efficiency problem in inkjet printing: the speed of printing was being significantly hindered by the amount of time required for liquid solvents, such as water, to evaporate from a printed surface. Jagannathan found himself in search of a solvent that had a density similar to that of water, allowing enough ink material to be dissolved in it, but that would evaporate by the time the ink was deposited so that no drying would be necessary. As he explored the use of supercritical CO_2—a unique phase of CO_2 that at a certain pressure and temperature exhibits both gaseous and liquid properties—he not only found a solution that would advance printing technology, but also realized the unique properties of this solvent that would result in the generation of a new class of materials that could not readily be explained by the current theories.

Jagannathan began exploring the area of cluster science, which is concerned with clusters of molecules bound by a range of forces, both weak and strong. While covalent bonding, or the sharing of electrons between atoms, is considered to form a stable molecule, other physical forces can also cause weak attractions between molecules. Molecules with a neutral charge, for example, can form weak affinities with others through what is known as Van der Waals forces, established by the movement of electrons within a molecule that create very slight positive or negative charges depending on which side of the molecule the electron is located at a particular moment.

While Jagannathan realized that he was able to create molecular structures that wouldn't ordinarily stick together, the attraction between the molecules was very weak and thermal energy was often enough to bring them apart. "It was a daunting process," he said, "but if I could permanently capture these molecular clusters that demonstrate these unique properties, then I could build unique materials."

The idea persisted with Jagannathan and he considered the use of supercritical CO_2, which maintains density similar to that of a liquid—allowing it to dissolve molecules—yet expands to fill up a container much like a gas. He was promptly dissuaded by his peers who pointed out the obvious challenge: Even if he could initially create these molecules, Van der Waals forces were too weak to allow them to hold together. Added to that, while at

JAGANNATHAN CONTINUES TO WORK ON BUILDING UP DATA AND INFORMATION IN THIS RELATIVELY NEW AREA IN SCIENCE TO HELP EXPLAIN AND FURTHER INVESTIGATE THE UNIVERSALITY OF THESE UNIQUE PROPERTIES.

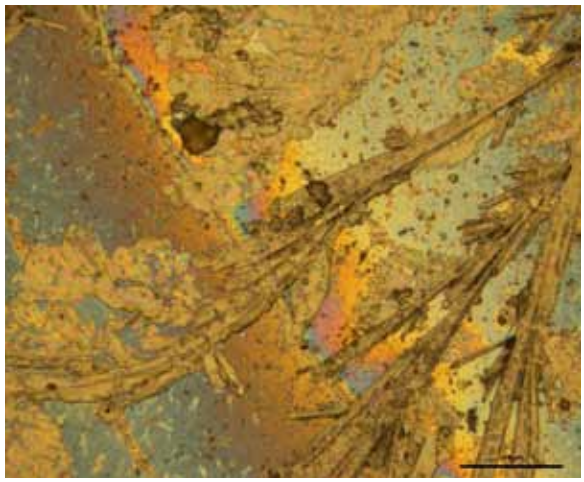
an industry conference, Jagannathan was posed with an equally perplexing question: Let's assume you can somehow stabilize these molecules, which you can't, how are you going to collect them when they are gas-like?

Using a process known as rapid expansion of supercritical solution (RESS), Jagannathan built a custom system that was able to generate highly mono-dispersed aerosols of solute materials from a supercritical CO_2 reactor at a constant pressure and temperature. "When you expand supercritical CO_2 through a fine nozzle, it becomes a gas when it expands and goes from a dense state to a non-dense state. When this happens, the velocity of expansion becomes supersonic, resulting in an extremely turbulent environment characterized by large shear forces. Moreover, such expansions are accompanied by a significant amount of local cooling due to a well-known phenomenon called the Joule-Thomson effect." Jagannathan hypothesized that "through the combination of extremely high shear forces and extreme cold temperatures in a supersonic environment, these soft, organic molecular clusters are likely to get locked into configurations that would normally be thermodynamically forbidden." Once formed in an abnormal environment the structures are quickly released to a normal environment, before they have the chance to disentangle themselves. If this happened, Jagannathan explained, they would forever be locked in these unusual structures because, by reverse logic, the energy barriers that made their formation difficult in the first place would provide the same high-energy barrier to prevent their disassembly.

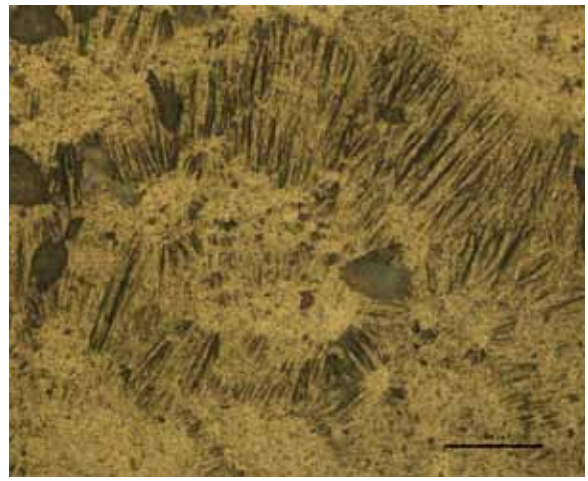
Jagannathan set out to collect and characterize these molecular clusters, and after several trials he successfully used a fine capillary to bubble the aerosols into a liquid vial. As the CO_2 gas escaped, it carried with it most of the molecular clusters, but left behind a small amount of clusters as a dispersion. These dispersions, against all odds, were found to be stable even two years after their formation.

These newly formed organic nanoparticles have several unique properties that don't quite adhere to conventional rules of chemistry and thermodynamics. For one, the clusters have unusual phase behavior. For example, the normal melting point for Alq_3 — the chemical compound Tris(8-hydroxyquinolinato) aluminium — is greater than 300 degrees Celsius. But, when affected by the supercritical CO_2, it is a liquid at room temperature. The "liquid-like" nature of molecular cluster assemblies has been observed in several chemical compounds and suggests that, at these small sizes, the traditional definitions of solids and liquids are no longer valid.

Another original attribute, characterized by X-ray powder diffraction measurements, is that these molecular clusters rapidly self-assemble into highly



AF1600 Teflon thin films and dendrites are materials used in Jagannathan's experiments.



AF1600 Teflon nano-structured, superhydrophobic thin film on an air-water interface.

aligned superlattice structures (an organized 3D layered structure) at room temperature, much like a crystal, while showing complete disorder at the molecular-length scale. Perhaps even more remarkably, testing these same samples after two years has shown that they have maintained this organized structure, a finding that creates possibilities of designing stable mixtures of new materials, which would not have been possible before, Jagannathan said.

The optical properties of materials such as Alq_3, an organic light-emitting diode (OLED) material, were also found to be tunable by the supercritical CO_2 process. For example, the peak fluorescence emission of Alq_3 created by the supercritical CO_2 process was "blue-shifted" by 40 nanometers. In some cases, peak emission was tunable as a function of the supercritical process parameters and shifts up to 100 nanometers were observed. Functional OLED devices were built with doped Alq_3 and their electroluminescence colors were tuned from green to yellow by changing the supercritical CO_2 process parameters.

"By changing the process conditions by which I create these clusters, I can change the peak emission to different positions. Our classical understanding says that molecules have very fixed emission characteristics to the position of a tenth of a nanometer, so for me to say I can 'blue-shift' this by 50 to 100 nanometers is difficult to explain."

The molecular cluster assemblies also demonstrate super-hydrophobicity, that is, they repel water. This is important for OLED materials because of their tendency to crystallize in humid ambient conditions. The property of super-hydrophobicity would improve their environmental stability.

Jagannathan continues to work on building up data and information in this relatively new area in science to help explain and further investigate the universality of these unique properties. His lab at NYUAD is equipped with a custom-built reactor, and he is currently conducting experiments with Teflon, a soft and highly hydrophobic material. He has found through the RESS process that Teflon molecules will congregate into a highly structured interface forming a fine film that acts as a seal against water.

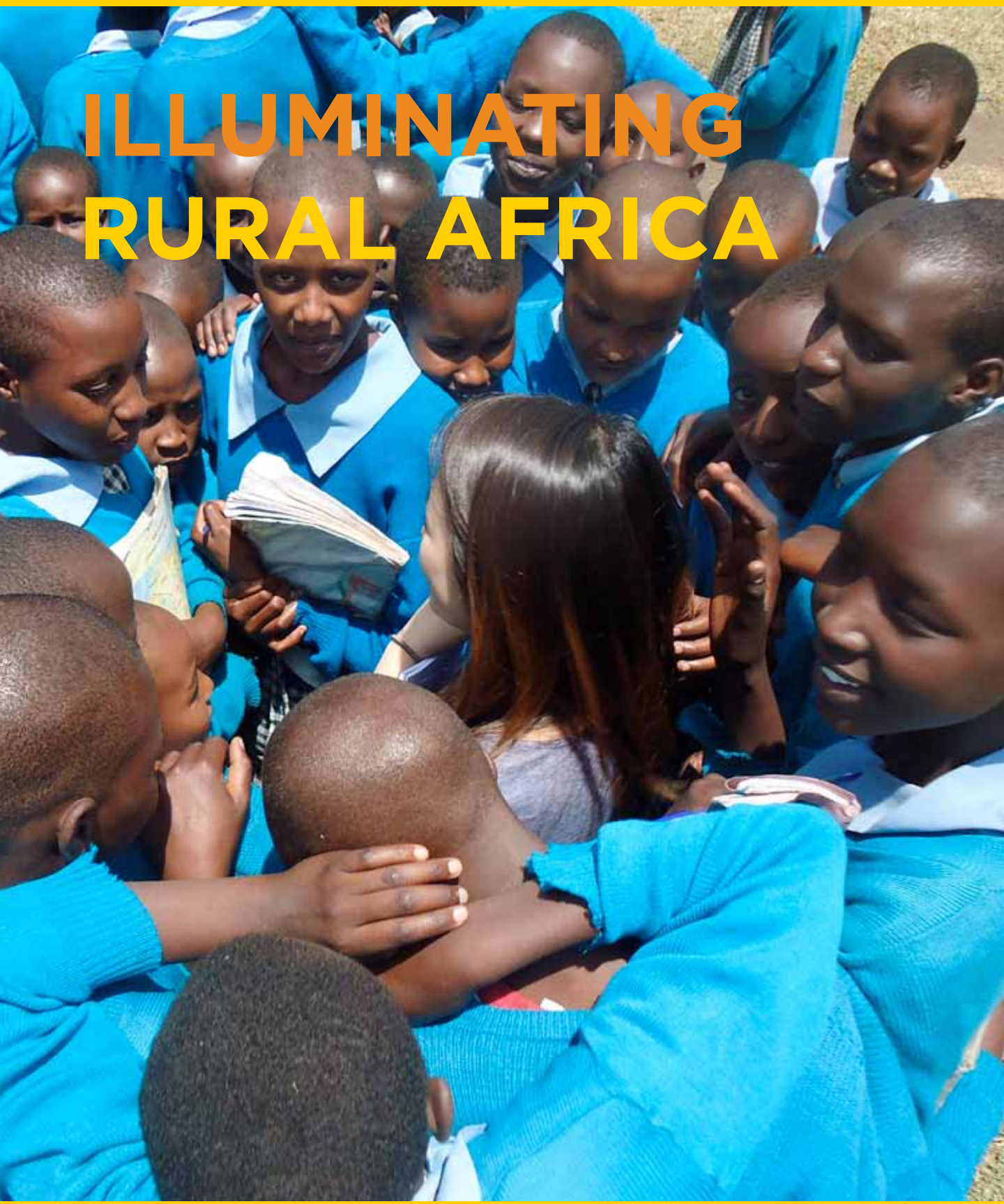
The practical application of these kinds of materials has vast potential, Jagannathan said, from creating self-cleaning glass, to nano-nets that prevent evaporation of water, or to altering the requirements of TVs that use three different chemicals to emit a full color spectrum.

"Using these molecular clusters, we can actually build new materials that you have never heard of. When you take materials like paper, iron, or steel, they have components that are well-defined, but when you design and build materials with these molecular clusters, their properties are so unique that you can't readily explain them."

STUDENT RESEARCH

NYU Abu Dhabi students are among the most talented in the world. They bring an astounding range of interests and skills to a richly diverse and exciting undergraduate experience. They are students who engage the examination and shaping of thought with passion and rigor. They are students who strive to make their own mark on a more knowledgeable, productive, responsible, just, and peaceful globe.

ILLUMINATING RURAL AFRICA



For the NYU Abu Dhabi team competing in the 2012 Hult Global Case Challenge, the proverb "two heads are better than one" could only have rung more truly if "two" was replaced by "five." Indeed, bringing together five individuals, with five very different perspectives, to come up with actionable solutions to the global poverty crisis led to the team's eventual success. The world's largest crowd-sourcing platform for social good, the Challenge was created to foster innovative ideas and solutions to global social issues. This year, thousands of students from 130 countries formed four- or five-person teams, each posed with tackling problems in one of three tracks: Energy, Education, or Housing.

The NYUAD team, an international group of juniors (then sophomores) — Madhav Vaidyanathan (India), Songyishu Yang (China), Muhammad Awais Islam (Pakistan), and Gary Chien (Taiwan) — along with NYU alumnus Neil Parmar (Canada), competed in the Energy track and came out on top in Dubai during one of five regional competitions held simultaneously around the globe. The team not only advanced to the international finals in New York City with 17 other teams, but also won their track. Along with the winners of the Housing and Education tracks, the NYUAD team will share the competition's USD 1 million grant among the three non-profit organizations paired with the teams to implement the students' winning ideas.

For the NYUAD team, which was paired with SolarAid — an organization that installs solar panels in rural areas across East and Southern Africa — the challenge was coming up with a plan to provide solar lighting to one million homes in Africa by 2013. As Yang explained, "Today, 120 million households in Africa are still off-grid, and the governments are not planning to set up electricity grids in more than 10 percent of these households in the near future. People use fire or kerosene to light up their homes, but they come with serious health problems and safety issues. Solar lanterns will not only provide a safe, clean light source, but also save a significant amount of money for the villagers over time and allow for longer working hours and more diversity in recreational life."

Motivated by solving a very real problem rather than winning a competition, the students began by determining the challenge's key issues and gathering data to construct their proposed solution. They also approached NYUAD faculty to help them along the way. Working with professors Ramesh Jagannathan (Engineering), Chetan Dave (Economics), and Yaw Nyarko (Economics), the students developed their case solutions by bouncing ideas off of their mentors. "It was great working with them," said Vaidyanathan. "They allowed us to think freely, but helped us filter our ideas. It gave us the freedom to learn something."

The team conducted two field research trips, one in Ethiopia, the other in Kenya, to gather information on the ground and test their model. While in Ethiopia, before the regional competition in Dubai, the students discovered something that would set their solution apart from all the others. "We realized that the general opinion is that solar parts are too expensive and

"NYUAD'S SOCIAL ENTERPRISE IS UNIQUE AND INNOVATIVE AND CAPITALIZES ON AN INCREMENTAL PAY BUSINESS MODEL. THROUGH MAKING ACCESS TO ELECTRICITY AFFORDABLE AND BITE SIZE, I AM CONFIDENT THEIR MODEL WILL BE WIDELY SCALED AND ADOPTED THROUGH COMMUNITIES ACROSS AFRICA AND BEYOND."

people don't have the disposable income to afford them," said Vaidyanathan, "but people are willing, if you provide them with after-sale service." With this realization, the group set out to establish a model in which African communities could be mobilized to be part of the process. By fostering and reinforcing trust as part of the solar package, buyers wouldn't worry about the product breaking, and the solution would create jobs for local people — "mostly women," said Vaidyanathan, "as they have the propensity to distribute income." By making the community part of their "office aid," the team's model proved one of the most successful solutions to addressing their case challenge.

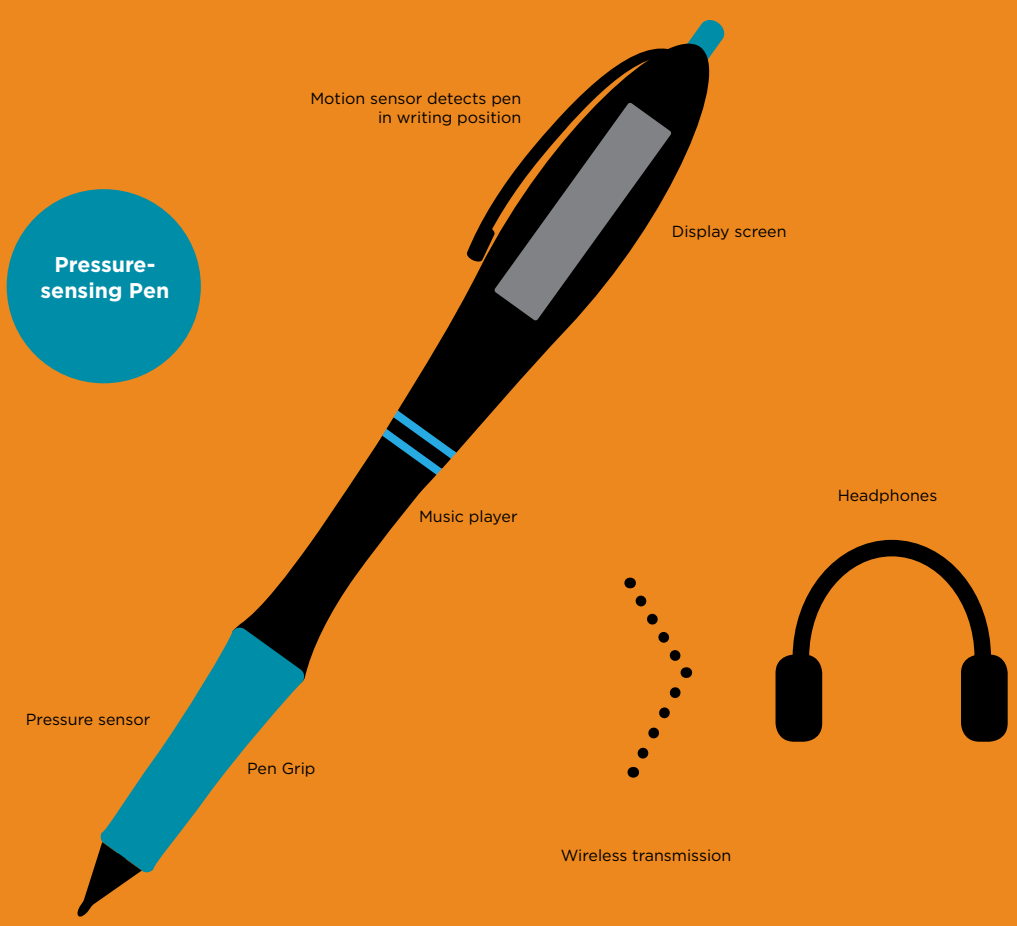
As Ahmad Ashkar, founder and CEO of the Hult Global Case Challenge, said, "NYUAD's social enterprise is unique and innovative and capitalizes on an incremental pay business model. Through making access to electricity affordable and bite size, I am confident their model will be widely scaled and adopted through communities across Africa and beyond." Indeed, when introducing the NYUAD team at the regional competition, SolarAid CEO Steve Andrews said, "This team has come up with a simple but powerful solution, which I wish I could use." Little did he know that the wish would become reality just two months later.

In addition to differentiating themselves with a unique solution to their challenge, the members of the NYUAD team — the sole finalist in its track that did not include graduate students — were recognized for their diversity. While announcing the prizewinners, former US President Bill Clinton (whose organization, the Clinton Global Initiative, is a partner of the Hult Global Case Challenge) highlighted the importance of global collaboration amongst the team members, an embodiment of NYUAD's commitment to fostering cross-cultural exchange. "It's not just that we are from five different countries," said Yang. "We have five different mindsets and are five very different individuals," a fact that enabled the team to approach their challenge from five different angles and, from those various points of view, "understand the complexity of the issue," said Chien.

The process taught Yang how interdisciplinary the solution to a real-world problem can be. And now, with an implementable plan in hand, the students will positively transform the rural communities they hoped to impact. As Yang said, "We will actually be making some impact in this world."

TOP: The members of the winning NYUAD team speak with former US President Bill Clinton, who presented the students with their award. **ABOVE:** Prior to the final competition in New York City, the team traveled to Africa to conduct field research.

COMMUNICATING EMOTION IN AN UNCONVENTIONAL WAY



"It started with a pen," said NYU Abu Dhabi student Abdelrazak Al-Sharif (Class of 2014), who, along with classmate Mohammed Omar, has filed for a patent for a product they created in *Design and Innovation*, an engineering foundations course taught by NYUAD Associate Dean of Engineering Ramesh Jagannathan.

Putting into practice the modern principles of technology design and concepts of innovation covered in class, Omar and Al-Sharif — both engineering majors — partnered up to tackle a challenge put forth by a group of visiting engineers from the MIT Media Lab in Europe during an intensive week-long SuperLab: to come up with a product, as well as accompanying business and marketing plans, that would communicate emotion in an unconventional way without the use of typical visual communication tools like Skype.

The result was Penspire, a high-tech pen that works when connected wirelessly to another. When used by two individuals, each pen illuminates to communicate when the other is being used. And internal sensors respond to the pressure exerted on the pen to convey the stress level of the user: green for low levels and red for high. "We came up with the idea during our freshman year, when everything around us was new and we didn't have our friends or family nearby," Al-Sharif said. "This pen enables you to see when your friend is working, no matter where they are in the world, and motivates you to work, too."

Mentored by Jagannathan — himself the owner of 42 patents — who worked with the students to "morph the idea into a more commercially realistic product application," the duo added an MP3 player to the pen, which, depending on the pressure exerted, plays music relating to the user's mood. "It uses axial pressure, which is correlated to the emotion or stress that you have," Omar explained. Playlists can be customized depending on user preference and songs are transmitted to wireless headphones via Bluetooth.

Omar and Al-Sharif have built a series of working prototypes; however, the next "more professional" model will be designed using SolidWorks CAD software and printed with a 3D printer. "The first two were made from other things, including parts from whiteboard markers," Al-Sharif said. "The new one will be made from a computer model so it can actually be produced."

This would also give them the opportunity to perform user testing. "Initially the idea was to link the pen to a website like Stereomood (an online radio station that features playlists based on mood or activity), but after seeing how diverse people's music tastes are, we thought we'd start with the MP3 player and expand after getting some test data." By enabling wireless interaction between Penspire and an online environment, Omar and Al-Sharif could also address what they hope will be a future feature of the product design: the ability for a user to engage in social networking. In addition to sharing songs — and therefore moods — via status updates on sites including Facebook and Twitter, users could log on to Penspire's online interface to find out in real time what others are listening to and how they are feeling.

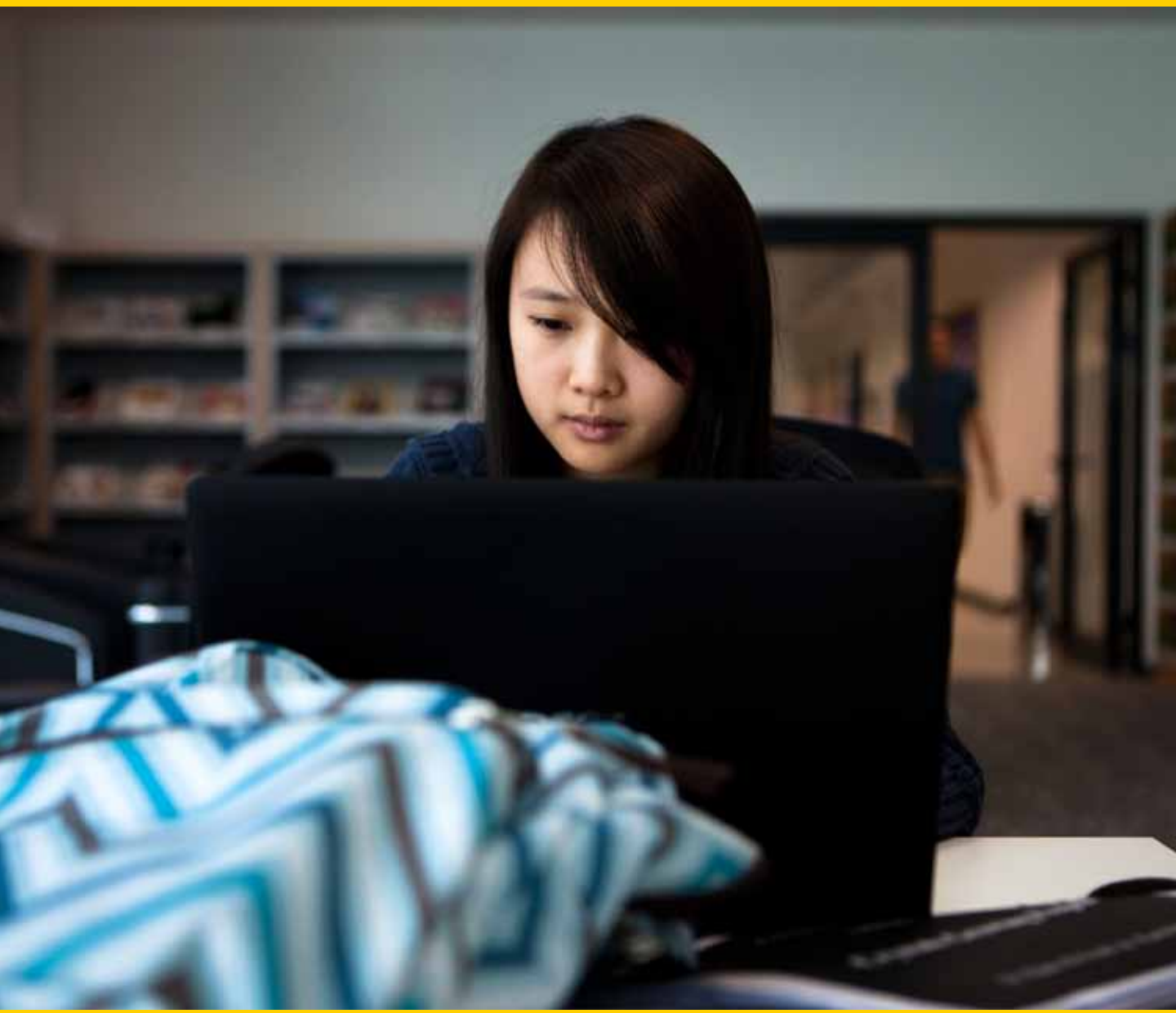
An online interface would also offer benefits in the classroom, where pens could be used to understand how the students are feeling, enabling instructors to design mood-appropriate lectures or assignments, or to monitor stress levels. As Omar said, "Really, it could be useful for anyone who wants to assess these sorts of emotions."

Before filing for the patent — which can take up to four years to be awarded — the students prepared the necessary documentation and performed market research to ensure that their product was unique.

For Jagannathan, whose support the students said, "was fundamental," the pen has good market potential. "The primary targeted customers are students who do significant amounts of writing everyday for their studies. And their study time is usually stressful and students listen to a lot of music. The combination of these makes the 'mood pen' a potentially successful product."

"The experience was very different from a usual engineering course where you study or do your labs and go home," Omar said. "Making a tangible product is hands-on and exciting. It gives us motivation."

EXAMINING CHINA'S ENERGY FUTURE



For most NYU Abu Dhabi students, winter break is a time to relax, but for Songyishu Yang (Class of 2014), the December 2011 holiday also included a trip to Tunisia. The first NYUAD student to have a peer-reviewed paper accepted for presentation, Yang traveled to Hammamet to take part in the third International Renewable Energy Congress (IREC).

During the three-day event, which provides a forum for researchers and practitioners around the world to discuss recent developments in the fields of renewable energy, 115 participants from 32 countries gathered to attend a variety of sessions with scopes ranging from sustainability and energy sources to environmental forecasting, policies, and regulation.

Yang's paper, co-authored by NYU-Poly's Industry Professor of Philosophy Harold P. Sjursen, discusses water management in Chinese cities and puts forth the argument that energy conservation, factors of climate change, and water management should not be considered mutually exclusive. As Sjursen explained, the paper "asserts that the interconnectedness of all of these concerns is best addressed from the perspective of a naturalistic ecology."

Having done preliminary research during her freshman year on water management problems in China — in preparation for the AECOM Student Design Competition on water in urban areas—Yang developed her proposal with Sjursen's help during her time in New York City in 2011, when she attended the Polytechnic Institute of New York University's summer program and worked on Sjursen's research project, China's Energy Future.

Quick to perceive a connection between water management and the issues of energy use and climate degradation, Yang focused on two urban areas in China "deeply affected by the problems of climate change, such as the flood-drought cycle, whose remediation would involve non-standard and ecologically sensitive engineering solutions," Sjursen explained. "The thesis for the paper emerged from the research which indicated potentially significant correlations between ecological urban water management strategies and energy choices."

As Songyishu noted in her paper, "The acute, costly, and devastating problem of floods in cycle with serious periods of drought that is plaguing China and other parts of the world is best addressed by natural, sustainable, or green approaches." One such approach is the creation of green roofs—the establishment of open space designed to minimize rainwater runoff with the addition of water-collecting ponds—thereby reducing the demand for air conditioning and lowering emissions.

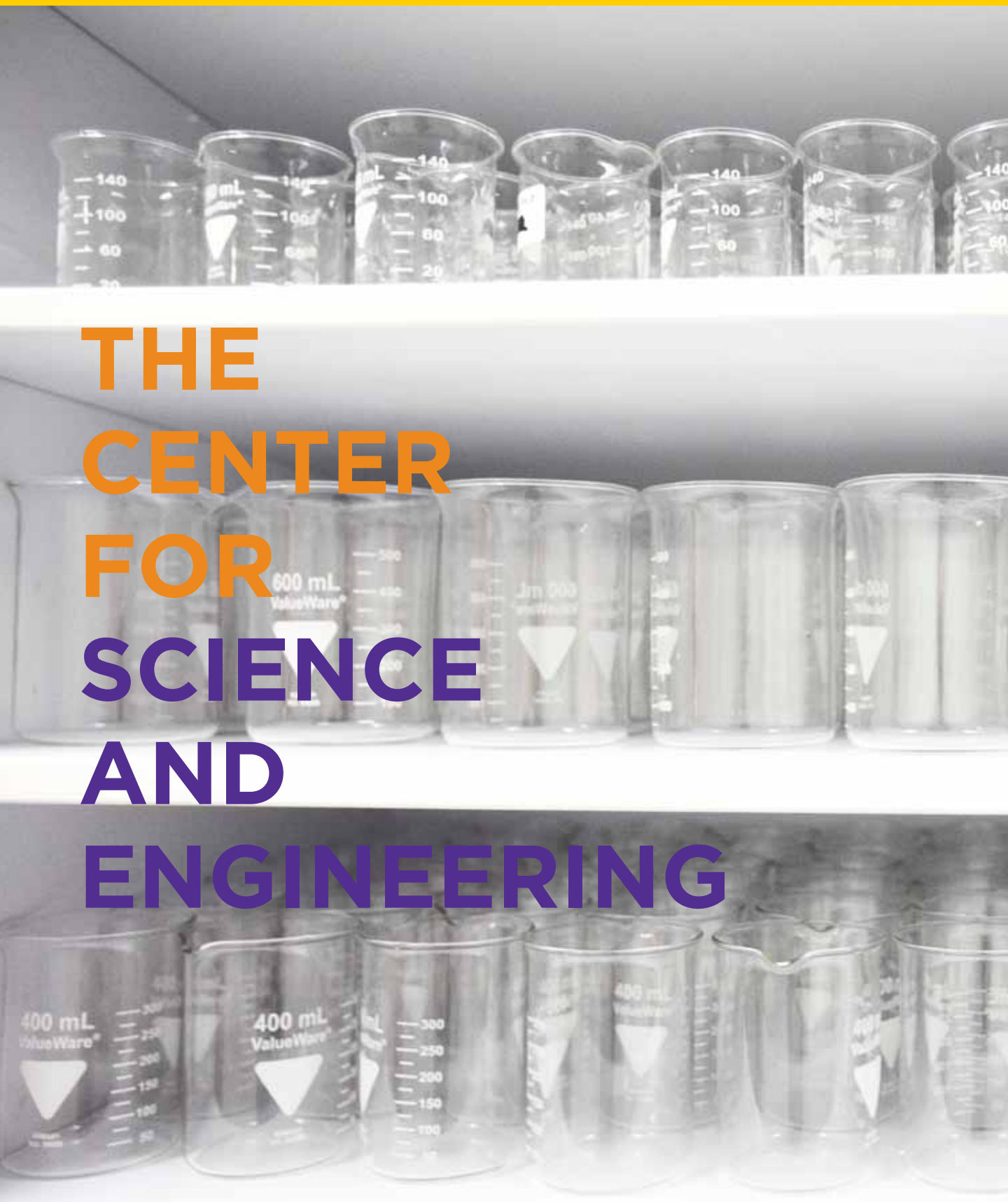
"This model conceives the city as an organism whose function includes the natural and sustainable exchange between the artificial built environment and the imitative natural built environment on the one hand, and on the other that which is perpetuated by the global natural environment," she wrote. "In this approach per capita energy consumption in the city will decrease, extreme (dangerous and destructive) conditions of excessive water and flooding will be moderated, and water will be conserved during periods of drought. The stress on existing drainage systems will be reduced and the problem of the backup of sewer systems in periods of heavy demand, leading to the intermingling of greywater and sewage, will be curtailed significantly."

Attracted to the interdisciplinary nature of Yang's proposal, Sjursen enjoyed working with the "brilliant, hard-working, and committed student."

As a Civil Engineering major with a concentration in Urbanization, Yang is poised to become an urban planner, and the IREC provided her with the opportunity to "discuss topics that I am fascinated by and receive critiques on my research," she said.

RESEARCH FACILITIES

As NYU Abu Dhabi continues to develop into a world-class center for cutting-edge research, creating access to top-of-the-line technical facilities is essential to this endeavor. In just a few years, NYUAD has developed a solid research infrastructure, investing in both the best talent in a range of disciplines and the highest-quality resources to support them in their scholarly investigations.



THE CENTER FOR SCIENCE AND ENGINEERING

About 12 miles southeast of NYU Abu Dhabi's Downtown Campus, in an area of Abu Dhabi called Mussafah, a modern glass building stands surrounded by offices, manufacturing plants, automobile shops, and desert. Housed inside is the University's Center for Science and Engineering (CSE), a laboratory with more than 60,000 square feet of instructional and research space. Occupying three floors, the Center supports both advanced research and the laboratory sections for the University's science and engineering courses.

In addition to instructional and research space, the Center also contains machine shops, materials labs, faculty offices, conference rooms, and storage facilities. As NYUAD Director of Laboratories Michael Davis said, "It's the basic infrastructure that will be used to facilitate building a Tier-1-quality research team."

As such, the instructional and research space contains a variety of experimental laboratories, including multipurpose wet and dry labs, organic chemistry and engineering labs, three digital manufacturing labs, a nanoparticle research lab, a smart environment lab, and a robotics lab. Each is supported by the CSE's core facilities, in addition to appropriate tissue culture, prep, and seminar rooms, as well as 110 lab benches and 100 cubicle workstations located throughout the facility.

Near the *Foundations of Science* classrooms and their adjoining labs is a digital manufacturing lab that uses the subtractive technique (in which a product is created through removal of material) and features two CNC (computer numerically controlled) machines. One of them — a five-axis milling machine with a dual-spindle turning center — weighs in at 5 tons and measures 2 meters across, which, according to Davis, is relatively small. However, it can handle hard-to-machine materials such as stainless steel and Inconel alloys. As Davis explained, "As far as machining, this high-precision tool can make just about anything, from sculptures to high-performance pump impellers for rocket engines, with a precision of plus or minus 5 microns. There aren't many like it in the country."

The materials lab is equally equipped. In addition to a laser cutter, it contains an X-ray fluorescence (XRF) spectrometer for the chemical analysis of materials, a scanning electron microscope (SEM) to determine information about a sample's properties using a beam of electrons, a research-grade CT scanner that can handle parts as heavy as 200 pounds, and universal testing machines that are used to test the tensile stress and compressive strength of materials. There is also a full range of student- and research-grade optical microscopes for student use.

"Traditionally, a materials course covers typical manufacturing processes such as casting and how these processes affect the behavior of the materials," Davis said. "However, despite being taught such concepts, NYUAD students will engage in digital manufacturing with high-precision metal and plastic 3D printers."

Down the hall, the nuclear magnetic resonance (NMR) spectroscopy facility characterizes materials by using the magnetic properties of atomic nuclei to determine chemical and physical properties of atoms or the molecules that contain them. NYUAD Assistant Professor of Chemistry Ali Trabolsi has used this NMR to map the shape of a new organic molecule that his team synthesized at the CSE.

Additional faculty research initiatives taking place on the ground floor include Assistant Professor of Biology John Burt's study of Gulf corals — the investigation of the process of their recurrent mortality and recovery, as well as the examination of

their resilience in regional communities. Also located on the ground floor is the Neuroscience of Language Laboratory, which uses a Magneto-encephalography (MEG) machine — a non-invasive brain scanner, the most sensitive device that currently exists to monitor the human brain — to integrate linguistic theory and psycholinguistic models with observed neurological activity of the brain. Alec Marantz, David Poeppel, and Liina Pylkkänen, all principal investigators of the Lab and NYU New York professors in the fields of linguistics and psychology, hope to better understand the way that the brain processes language.

Upstairs, much of the space is dedicated to organic chemistry, engineering, and biology, with departments sharing many of the floor's facilities, including central core labs for material characterization, microscopy, molecular biology, tissue culture, additive digital manufacturing, and digital manufacturing of electronics. Future plans include the installation of several mass spectrometers (to join the first, installed in July 2012), which ionize chemical compounds, generating charged molecules in order to determine the masses of particles, the elemental composition of a sample, and the chemical structures of molecules.

The first floor also contains connected teaching labs and seminar rooms to provide faculty with flexible instructional spaces. A lab for the *Design and Innovation* course includes a small workshop with drill presses, a four-axis bench-top milling tool, and a vacuum-forming machine, as well as an electronics workshop that enables students to create their own printed circuit boards, electronic-based devices, and working prototypes.

The University's Center for Genomics and Systems Biology (CGSB) has its home here. Its researchers, including NYUAD Associate Professor of Biology and CGSB Co-director Kourosh Salehi-Ashtiani, are currently working on three research programs with an emphasis on key areas of renewable resources and regional biodiversity, disease-related chemical genomics, and neuronal systems. With the aid of instruments including high-throughput sequencers, robotics, and the mass spectrometer — as well as specialized environmental rooms for algae, human cell lines, flies, and worms — the research team hopes to tackle regional issues in human health, energy, agriculture, and the environment by identifying the mechanisms that underlie the evolution of complete genome sequences and transform genetic information into cellular and organismal behaviors using a systems-level view.

One floor up, half of the space is dedicated to computational research and is used by faculty in engineering, math, physics, computer science, chemistry, and psychology. In addition to shared "core" spaces for chemistry and engineering, there is a synthesis area used by the chemists and an analysis room, an advanced materials characterization lab, an instrumentation room, a robotics lab, a smart environment living lab, a smart environment research lab, a super-critical $C0_2$ lab where nanoparticles can be created, and workstations and wet benches. There is also a dark room where photochemical experimental work can be done.

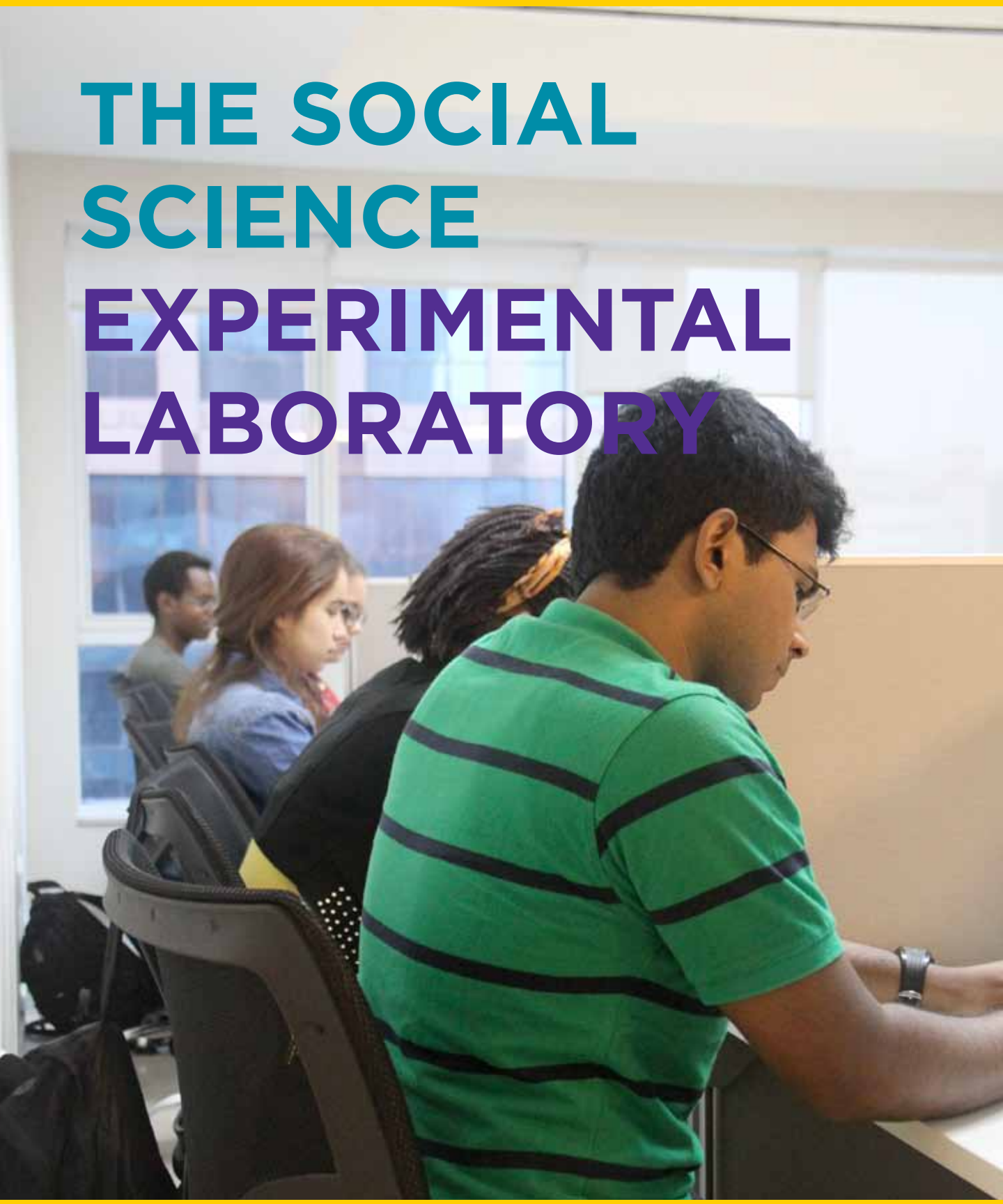
One of the active researchers in the computational sciences is NYUAD Chemistry Professor Pančе Naumov who, using his solid-state and structural chemistry lab at the CSE, is combining solid-state supramolecular chemistry with photochemistry and photophysics to investigate chemical systems that mimic natural processes such as bioluminescence to understand chemical energy conversion. Nearby, NYUAD Assistant Professor of Computer Engineering Ozgur Sinanoglu's Design for Excellence Lab is pursuing research in the field of computer chip testing and security, including designing electronic chips that outsmart counterfeiters and hackers with embedded protective mechanisms; investigating hardware and software support to more effectively detect and correct chips that fail due to environmental interference; and adaptive testing, which takes into account process variation that occurs during the manufacturing of the chip in order to more accurately detect chip defects.

As Davis said, "NYUAD is an incubator for producing the scientists and engineers of the 21st century. The UAE, and Abu Dhabi in particular, will benefit by influencing, both culturally and intellectually, these leaders of tomorrow."

“NYUAD IS AN INCUBATOR FOR PRODUCING THE SCIENTISTS AND ENGINEERS OF THE 21ST CENTURY.”

TOP: A student runs an organic chemistry experiment in one of the labs at the University’s Center for Science and Engineering (CSE). **ABOVE:** The CSE is a modern building that houses 60,000 square feet of instructional and research space.

THE SOCIAL SCIENCE EXPERIMENTAL LABORATORY



The Social Science Experimental Laboratory at NYU Abu Dhabi is an interdisciplinary center in which experimental work in the social sciences, including economics, political science, and sociology, is conducted. The Lab is equipped for interactive human decision-making experiments that are designed to test theoretical predictions and the properties of proposed or existing models of economic, political, or social institutions.

In these experiments, developed to investigate the relationship between human behavior and incentives, the subject pool receives detailed instructions describing how financial reward will depend on participants' decisions. Interaction then takes place over a computer network as subjects anonymously connect with other participants in game-like exchanges designed to test preferences, markets and related institutions, and how individual socio-economic decisions are made. Experiments may be conducted to study the impact of varied incentives on topics such as the degrees of cooperation among a group of individuals or society, levels of risk aversion and risk affinity among groups of people, participatory behavior in the contribution to public goods, or determinants of altruism, to name a few.

The Lab, housed in NYUAD's Sama Tower, comprises 14 laptops in shielded workstations that allow a private space for each subject, and a server that connects the network. The Lab's flexible laptop-based design allows for easy mobility, enabling researchers to conduct experiments off-site, both in the UAE and in countries throughout the region. This flexibility, paired with Abu Dhabi's location at a crossroads between countries in Asia, Africa, and Europe, presents a unique opportunity to conduct behavioral research among populations that have not been extensively studied.

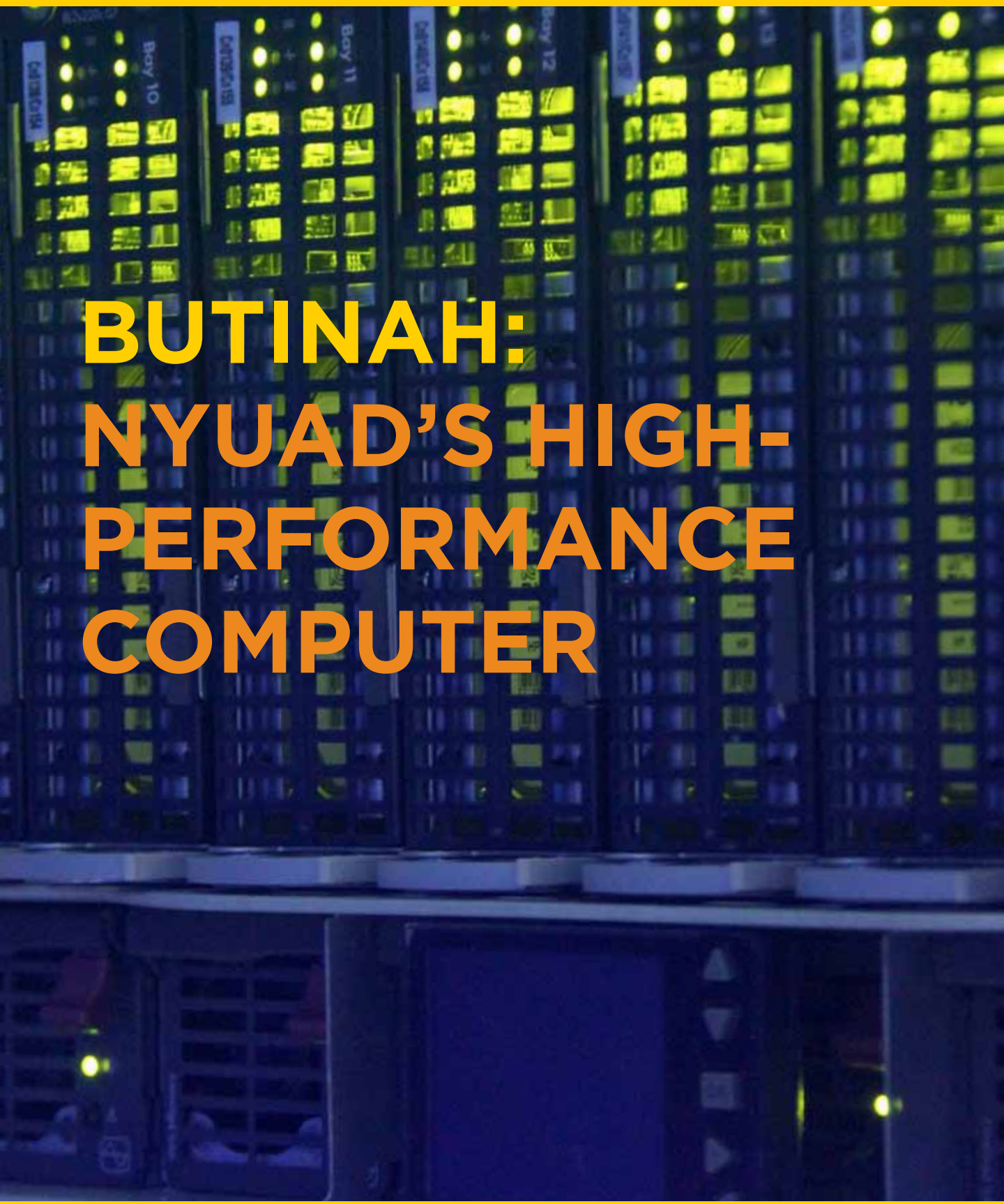
Comparing fundamental behavioral findings among different cultures may yield interesting insights on the universality of human behavior, according to NYUAD Assistant Professor of Economics and Director of the Lab Chetan Dave. This may also involve discovering unique solutions and mechanisms that are implemented by societies in the region that are not established elsewhere.

"For research, access matters," Dave said. "This Lab in Abu Dhabi has the location, potentially the resources, and certainly the mobility to be able to conduct more research throughout greater geographies in a way that is faster than otherwise possible."

The Lab, which became operational in May 2012, welcomes the participation of members of the UAE public who will be able to sign up as subjects on the Lab's website. The Lab functions as an important tool for social scientists to complete an important step in the scientific method — gathering data to measure against hypotheses and theories where naturally occurring data may not be available.

In addition to verifying academic models and theories, this research may take the form of testing practical applications for levels of efficiency. For example, incentives within a proposed policy reform may be evaluated in a controlled lab setting before allocating considerable funds and resources for implementation.

Social scientists, and the Middle East region at large, will benefit significantly from this resource that will soon provide a wealth of information characterizing human behavior in the Middle East and neighboring regions.



BUTINAH: NYUAD'S HIGH-PERFORMANCE COMPUTER

As NYU Abu Dhabi's researchers set about solving a range of scientific problems related to climate change, molecular structures, genome composition, and the like, there is one thing they have in common — the requirement to conduct highly complex numerical calculations.

NYUAD's high-performance computer (HPC) cluster offers the fastest and most advanced computational power both in the NYU network and in the UAE to support the needs of the NYUAD research community. This state-of-the-art resource was built by Hewlett-Packard and flown to the UAE, where it is currently hosted by Injazat, a leading information technology and business process services provider in the region, in a secure Tier IV data center that meets the industry's most stringent qualifications. Redundant links, which support reliable and fast data transfer, have been established between NYUAD's Downtown Campus, Sama Tower, and the Center for Science and Engineering (CSE) and the data center.

Named BuTinah after a marine-protected archipelago reserve off the coast of Abu Dhabi, the supercomputer will be one of the fastest in the region and was ranked in the June 2012 listings of the TOP500, an industry ranking of HPCs around the world.

Supercomputer performance is generally measured by Floating Point Operations Per Second (FLOPS), which reflect the system's ability to perform a number of 64-bit floating point operations, or linear equations, per second. BuTinah runs at approximately 70 teraFLOPS, and consists of 512 super-dense compute nodes contained in 15 temperature-controlled cabinets. Each compute node has a memory capacity of at least 48 gigabytes, with eight large memory nodes that have 192 gigabytes of RAM, and a dedicated one-terabyte node for the Center for Genomics and Systems Biology. In addition to these, there are 16 nodes with NVIDIA graphics processing units (GPUs) used for very specialized calculations, and 16 visualization nodes, which play an integral role in translating data into images, with additional support nodes providing archival storage, networking, backup, management, and log-in functions for the system. The HPC's temperature is managed through internal water-cooled modular systems that run air conditioning through the cabinets and through a closed, cold aisle of cabinets facing each other.

BuTinah will improve efficiency of running computational experiments by assisting with both serial jobs, which use one processor at a time, and parallel jobs that require the support of multiple processors.

"If someone has a serial requirement, needing only one processor, but has 100 jobs with each taking a week to run, it would take 100 weeks to complete the job using a regular PC," NYUAD HPC Manager Muataz Al-Barwani explained. "The HPC provides a form of task farming, allowing the researcher to submit all 100 serial jobs to be processed at the same time and have the results within a week. For parallel jobs that cannot be completed on a single processor, the researcher can break down the problem and spread it across multiple processors; the HPC can then perform all of the calculations and combine the results."

The HPC system has more than 6,000 processors, with the average research user requiring 100 to 1,000 processors for a project at a given time. The system resources are managed by a scheduler that accepts requests and allocates system usage based on available capacity. Researchers can then connect to the HPC using their personal computers to run experiments and computations on their applications that have been installed on the HPC.

"This system not only provides an essential and efficient resource for NYUAD research centers and faculty members, it provides an important opportunity for research collaborations between NYUAD and other institutions across the UAE and the Gulf region," NYUAD Chief Information Officer Yousif Asfour said.

BuTinah is connected to Ankabut, the UAE's national research and education network, providing high-speed connectivity between educational, research, and non-profit organizations in the country.

PUBLICATIONS & PATENTS

The lists in the following section include publications and research work conducted by full-time NYU Abu Dhabi faculty upon joining NYUAD. The list of publications includes those from the University's first two academic years: 2010–11 and 2011–12.

CONSOLIDATED PUBLICATIONS 2010–12

Books

De Genova, N. & **Peutz, N.** (Eds.). (2010). *The deportation regime: Sovereignty, space, and the freedom of movement*. Durham, NC: Duke University Press.

DeJong, D.N. & **Dave, C.** (2011). *Structural macroeconometrics* (2nd ed.). Princeton, NJ: Princeton University Press.

El Saddik, A., Orozco, M., Eid, M. & Cha, J. (2011). *Haptics technologies: Bringing touch to multimedia.* Springer Series on Touch and Haptic Systems. Berlin, Heidelberg: Springer-Verlag.

Falkenberg, R. (2012). *The land of unlikeness: Hieronymus Bosch, the garden of earthly delights.* Zwolle, NL: WBooks.

Stearns, J. (2011). *Infectious ideas: Contagion in premodern Islamic and Christian thought in the western Mediterranean*. Baltimore, MD: Johns Hopkins University Press.

Szelényi, I. (2010). *Essays on socialism, post-communism and the new class*. Beijing: Chinese Academy of Social Science.

Szelényi, I. & Kolosi, T. (2010). *How to become a billionaire?* Budapest: Corvina Publishing House.

Edited Books and Book Chapters

Burt, J., Bartholomew, A. & Feary, D. (2012). The ecological role of man-made structures in the Gulf. In B. Riegl & S. Purkis (Eds.), *Coral Reefs of the Gulf: Adaptation to Climatic Extremes* (pp. 171–186). Dordrecht, NL: Springer.

Calhoun, C. & **Derluguian, G.** (Eds.). (2011). *Business as usual: The roots of the global financial meltdown.* New York, NY: New York University Press.

Calhoun, C. & **Derluguian, G.** (Eds.). (2011). *The deepening crisis: Governance challenges after neoliberalism*. New York, NY: New York University Press.

Calhoun, C. & **Derluguian, G.** (Eds.). (2011). *Aftermath: A new global economic order?* New York, NY: New York University Press.

Derluguian, G. (2011). The post-Soviet recall to periphery. In C. Calhoun & **G. Derluguian** (Eds.). (2011). *Aftermath: A new global economic order?* (pp. 209–234). New York, NY: New York University Press.

Derluguian, G. (2011). World-systems analysis: An annotated guide. In J. Manza (Ed.), Political sociology. *Oxford Bibliographies Online*. Retrieved on September 10, 2012, from www.oxfordbibliographies.com

Derluguian, G. (2012). The social origins of good governance: Reinterpreting the 1968 crisis in Frente da Libertação de Moçambique (FRELIMO). In E. Morier-Genoud (Ed.), *Sure road? Nationalisms in Angola, Guinea-Bissau and Mozambique* (pp. 79 -102). Leiden, NL: Brill.

Derluguian, G. & Wallerstein, I. (2011). Putting Russia in world-system perspective. In M. Lipman & N. Petrov (Eds.), *Russia in 2020* (pp. 25–44). Washington, DC: Carnegie Endowment for Peace.

Di Bello, P., Wilson, C. & **Zamir, S.** (Eds.). (2012). *The photobook from Talbot to Ruscha and beyond*. London, UK: I.B. Taurus.

El Saddik, A., Orozco, M., Eid, M. & Cha, J. (2011). Computer Haptics. *Springer Series on Touch and Haptic Systems*: *Haptics Technologies*, pp. 105–143.

El Saddik, A., Orozco, M., Eid, M. & Cha, J. (2011). Touching the future: HAVE challenges and trends. *Springer Series on Touch and Haptic Systems*: *Haptics Technologies*, pp. 183–194.

Fahlenbrach, K., **Klimke, M.,** Scharloth, J. & Wong, L. (Eds.). (2012). *The establishment responds: Power, protest and politics since 1945*. New York/London: Palgrave Macmillan.

Falahi, K., **Mavridis, N.** & Atif, Y. (2012). Social Networks and Recommender Systems: A World of Current and Future Synergies. In A. Abraham and A. Hassanien (Eds.), *Computational social networks: Tools, perspectives and applications* (pp 445–465). London, UK: Springer Verlag.

Feary, D., **Burt, J.**, Cavalcante, G.H. & Bauman, A.G. (2012). Extreme physical factors and the structure of Gulf communities. In B. Riegl & S. Purkis (Eds.), *Coral reefs of the Gulf: Adaptation to climatic extremes* (pp. 163–170). Dordrecht, NL: Springer.

Feldman, W. (2011). Central Asian literature, Kazakh literature, Turkish literature, Turkmen literature. In *Encyclopedia Britannica*. Retrieved on September 10, 2012, from www.britannica.com.

Horta, P. (2010). Richard Burton's Sindh: Folklore, syncretism and empire. In M.A. Cook and M. Boivin (Eds.), *Interpreting the Sindhi world: Essays on society and history* (pp. 150–168). Oxford, UK: Oxford University Press.

Klimke, M. (2012). 1968: Europe in Technicolour. In D. Stone (Ed.), *The Oxford handbook of postwar European history* (pp. 243–261). Oxford, UK: Oxford University Press.

Kristian, D., Burns, J. A., **Dimitri, A.**, Nirenstein, L., Noujnykh, T. & **Scicchitano, D.** DNA damage and transcription elongation: consequences and RNA integrity. In N. Geacintov & S. Broyde (Eds.). *The chemical biology of DNA damage* (pp. 399–430). Wiley-Liss, New York.

Menoret, P. (2011). Leaving Islamic activism behind: Ambiguous disengagement in Saudi Arabia. In J. Beinin & F. Vairel (Eds), *Social movements, mobilization, and contestation in Middle East and North Africa* (pp. 43–60). Palo Alto, CA: Stanford University Press.

Neuber, W. (2011). Die Familie als Diskurs. Textliche Konstruktionsformen in Familienbüchern der Frühen Neuzeit, am Beispiel des Beckschen Familienbuchs (Klosterneuburg, Cod. 747). In *Literatur — Geschichte — Österreich. Probleme, Perspektiven und Bausteine einer österreichischen Literaturgeschichte*. Thematische Festschrift zur Feier des 70. Geburtstags von Herbert Zeman. Hg. v. Christoph Fackelmann u. Wynfrid Kriegleder. Wien/ Berlin (2011). S. 320–332.

Neuber, W. (2010). HarsdörffersGespenster. In Georg Philipp Harsdörffers, Kunstverständige Discurse. *Beiträge zu Kunst, Literatur und Wissenschaft in der Frühen Neuzeit. Hg. v. Michael Thiemann u. Claus Zittel* (pp. 325–335). Heidelberg: Manesse.

Neuber, W. (2011). Exscribo ergo sum. Self-Reflexion and meditiation in early modern German family books. In K. Enenkel & W. Melion (Eds.), *Meditatio — Refashioning the self. Theory and practice in late medieval and early modern intellectual culture* (pp. 109–124). Leiden/New York: Brill.

Seung-Hoon, J. (2011). Animals: An Adventure in Bazin's Ontology. In D. Andrew (Ed.) with Herve Jouvert-Laurencin, *Opening Bazin: Postwar film theory and its afterlife* (pp. 177–185). Oxford, UK: Oxford University Press.

Seung-Hoon, J. (2012). The surface of the object: Quasi-interfaces and immanent virtuality. In D. Martin-Jones & W. Brown (Eds.), *Deleuze and film*. Edinburgh, UK: Edinburgh University Press.

Seung-Hoon, J. (2011). Black hole in the sky, total eclipse under the ground: ApichatpongWeerasethakul and the ontological turn of cinema. In K.E. Taylor (Ed.), *Dekalog 4: On East Asian filmmakers* (pp. 140–50). New York, NY: Columbia University Press.

Stearns, J. (2011). The legal status of science in the muslim world in the early modern period: an initial consideration of fatwas from three Maghribi sources. In A.Q. Ahmed, B. Sadeghi & M. Bonner (Eds.), *The Islamic scholarly tradition: Studies in Islamic history, law, and thought in honor of Professor Michael Allan Cook on his seventieth birthday* (pp. 265–90). Leiden, NL: Brill.

Szelényi, I. (2010). Capitalism in China? Comparative perspectives. In Yin-wah Chu (Ed.), *Chinese capitalisms: Historical emergence and political implications*. Hong Kong: Palgrave Macmillan.

Szelényi, I. (2011). The rise and fall of the second Bildungsbürgertum. In P. Reill (Ed.), *Core, periphery and globalization* (pp. 165–181). Budapest, Hungary: Central European University Press.

Tabbaa, Y. (2011). Halab (Aleppo). In *Encyclopedia of Islam*, (3rd ed.). Leiden, NL: Brill.

Zamir, S. (2011). Scenes of picturing: Gerald Vizenor's phototext. In A. Robert Lee & D. Masden (Eds.), *Gerald Vizenor: Texts and contexts* (pp. 166–85). Albuquerque, NM: University of New Mexico Press.

Zamir, S. (2012). 'Art Science': The North American Indian as phototext. In P. Di Bello, C. Wilson & S. Zamir (Eds.), *The photobook from Talbot to Ruscha and beyond* (pp. 35–51). London, UK: I.B. Taurus**.**

Zamir, S. & Di Bello, P. (2012). Introduction. In P. Di Bello, C. Wilson & S. Zamir (Eds.), *The photobook from Talbot to Ruscha and beyond* (pp. 1–15). London, UK: I.B. Taurus.

Creative Works

Al Khalil, M. (2011). Islamic historical and cultural commentary for production of a film segment on Masdar City, Abu Dhabi. The film was directed by Nathaniel Kahn and produced by Radical Media in New York for the Discovery Channel, and was aired in December 2011.

Charlier, C. Solo double-CD, *Telemann Gem Session*, with the complete set of Canonic Sonatas by Georg Philipp Telemann for 2 Flutes, recorded in October 2011. Release recitals in New York (March 2012), Brazil (several cities and states, tour scheduled for May, June, and August 2012), Sri Lanka (accepted invitation for tour in 2013).

Charlier, C. Recording of solo flute double-CD, *Telemann Gem Session*, in New York, October 2011.

Charlier, C. CD Release recital (*Telemann Gem Session*), at St Joseph's Church, March 2012. Flute and cello (with Fábio Pellegatti) — Baroque music (repertoire from the CD), and choreography.

Charlier, C. 12 arrangements for flute and cello of Brazilian music genres, registered/copyrighted, performed in Brazilian tour in December 2011 and January 2012, accompanied by cellist Fábio Pellegatti.

Charlier, C. 9 transcriptions and arrangements of songs by Marcio Miele in bossa nova style (voice, flute, and guitar), resulting from research in Brazilian genres (like choro, modinha, marchina, baião, folklore, children songs, samba, pop rock, Brazilian swing, urban pop romantic song), performed in Brazilian tour in December 2011 and January 2012.

Helmrich, L.R. Screening of *Position Among the Stars* (2010) at Durban International Film Festival/ Talent Campus, South Africa, July 2011; EIDF Seoul, South Korea, August 2011; Abu Dhabi International Film Festival, Abu Dhabi, UAE, October 2011; Brisbane International Film Festival, Brisbane, Australia, November 2011; INDOCS, Beijing, China, December 2011; DOCEDGE, Kolkata, India, January 2012; Sheffield Doc/Fest, June 2012; Guth Gafa International Film Festival, Donegal, Ireland, June 2012; Los Angeles Film Festival, California US, June 2012; Centro de Capacitación Cinematográfica in Mexico City, Mexico, July 2012.

Helmrich, L.R. Screenings of Indonesian Trilogy, *Eye of the day* (2001), *Shape of the moon* (2004), and *Position among the stars* (2010) at MoMa (Museum of Modern Art) New York, US, September 2011.

Klimke, M. (Co-curator). Exhibition, *An American in Deutschland: Photographs of Leonard Freed*, September 15–November 15, 2011, German Historical Institute, in collaboration with Smithsonian National Museum of African American History and Culture, Washington DC Jewish Community Center Ann Loeb Bronfman Gallery, Goethe-Institute, and Comet PingPong.

Klimke, M. (Co-curator). Exhibition, *The Civil Rights Struggle, African American GIs, and Germany*, shown at Robert and Sallie Brown Gallery and Museum, University of North Carolina, Chapel Hill (September 9–October 29, 2011); Franklin & Marshall College, Lancaster, PA (November 3, 2011–December 31, 2011).

Majithia, S. (Curator). *Journeys*, student-panels, an initiative of NYUAD Arts and Humanities. Solicited essays from Humanities courses, selected from more than 50 essays, edited, and prepared students for presenting essays during event. Sponsor: Arts and Humanities. 2011–2012.

Polendo, R. (2012). *The Ramayana*. Produced by: NYU Abu Dhabi Institute/ TDIC/ NYU Abu Dhabi Arts and Humanities/Theater Mitu/Manarat al Saadiyat. (Directed, conceived, adapted, and written by Rubén Polendo).

Polendo, R. (2012). *Juarez: A Documentary Mythology* (Research/Workshop). Produced by: Theater Mitu/Arizona State University/ NYU Abu Dhabi. (Conceived and directed by Rubén Polendo).

Polendo, R. (2011). *Death of a Salesman (Re-Mount)*. Produced by: NYU Abu Dhabi Institute/ Theater Mitu. (Conceived and directed by Rubén Polendo).

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