

## The Enduring Challenge of National Security

by **Jon Greene** | Program Manager and Acting Technical Director Center for Naval Systems and National Security Thrust Leader | 540-231-8566 | [greenej@vt.edu](mailto:greenej@vt.edu)

**“The society that separates its scholars from its warriors will have its thinking done by cowards and its fighting by fools.”**

*--Thucydides*

The Institute for Critical Technology and Applied Science national security research thrust area is focused on establishing Virginia Tech as a leader in research activity that is responsive to the needs of the armed forces and protection of our nation.

The events of September 11, 2001 demonstrate that international terrorism can strike where we live. Today, we continue to face threats from non-state actors. If history is any indicator, sooner or later we will face competitor states in battle. As modern technology enables a global marketplace, it also enables a global battlefield, replete with high-tech weapons and delivery systems that are complicated by asymmetric threats such as cyber-attack and suicide bombers. In this world it is imperative that we heed the words of

Thucydides and ensure that we, in academia, recognize and respond to the needs of today's warriors.

The foundation of the efforts underway at ICTAS to address these needs is a series of partnerships recently established with government and industry. The first and foremost of these partnerships is revitalization of a long-standing strategic relationship with the Naval Surface Warfare Center at Dahlgren. Truly a national treasure, Dahlgren is arguably the most successful system integrator in the world. Mr. Carl Siel, Technical Director at NSWC Dahlgren, discusses this critical relationship and offers a Dahlgren perspective later in this issue.

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Photo courtesy of US Navy

The newsletter of the Institute for Critical Technology and Applied Science at Virginia Tech

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# National Security: A Virginia Tech Tradition



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From the earliest days of the institution we now know as Virginia Tech, there has been significant emphasis on military service and our contribution to national security.

In 1872, the Virginia Agriculture and Mechanical College was founded with Charles Landon Carter Minor selected as the first president. One of President Minor's first faculty hires was General James H. Lane, the youngest general in the Army of Northern Virginia at one point, to serve as professor of natural philosophy, chemistry and military tactics.

A strong military tradition continued into the 20th century, and in February 1943, the college was selected for an Army Specialized Training Program, through which 3,387 men were processed. Later, five other military units were assigned to campus.

During World War II, 7,000 Virginia Tech alumni were in service, 16 rising to the ranks of flag or general officer. Three hundred were killed in battle, 755 were decorated, and 3 were awarded the Medal of Honor and posthumously recognized by the naming of Femoyer Dormitory, Monteith Hall, and Thomas Hall honoring their service.

Until 1964 Corps of Cadet membership was mandated for all male students at Virginia Tech. Today, Virginia Tech remains one of only six Senior Military Colleges (and one of only two major universities, hosting a Senior Military College... the other being Texas A&M). These institutions, established under federal law, are required to provide military and leadership education similar to that available at the United States Service Academies.

Each year we commission about 150 officers in the Army, Navy, Air Force and Marine Corps and graduate 50 more future civilian leaders in the "Corps Only"

program. The Class of 2014, at over 350 strong, will push the Corp of Cadets to 840, the largest corps since 1969.

In view of this rich tradition, I think it is only appropriate that we are devoting this edition of "The ICTAS Connection" to our role in national security. With the founding of the Ted and Karyn Hume Center for National Security Technology, the appointment of Virginia Tech along with Howard University as an Intelligence Community Center for Academic Excellence (IC CAE), and the founding of the ICTAS Center for Naval Systems (CNavS), Virginia Tech has laid the foundation for continued presence and leadership in research and educational programs to support our national defense.

The Hume Center will prepare students to work at intelligence agencies and assist faculty interested in intelligence research by providing fellowships and scholarships to students, arranging lectures and mentorships, and providing help for students seeking agency internships and employment. The IC CAE initiative will create students with increased cultural awareness, improved technical competencies, and broader knowledge of the mission of national security agencies by modifying courses to include topics relevant to the intelligence community, providing travel abroad opportunities, training students in critical skills, hosting colloquia and assisting students in placement in intelligence jobs. CNavS nurtures our long standing relationship with Naval Surface Warfare Center Dahlgren and seeks to develop relationships with other DoD entities.

We have invested significantly in facilities, faculty and staff to achieve excellence in this field and we will continue to do so as we move forward to face the national security challenges of this century and beyond.



# National Security: Embracing the Need



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During the Energy & Nanotechnology Conference at Rice University on May 3, 2003, the noted scientist and Nobel prize winner R.E. Smalley presented a list entitled, "Top Ten Problems of Humanity for Next 50 Years", as follows: (i) Energy, (ii) Water, (iii) Food, (iv) Environment, (v) Poverty, (vi) Terrorism & war, (vii) Disease, (viii) Education, (ix) Democracy and (x) Population. All of these problems have a few characteristics in common. They are challenging and complex, have a high degree of uncertainty, and do not fit neatly into one or another disciplinary silo. They require multiple perspectives and a healthy dose of innovation.

As a catalyst for interdisciplinary research and an agent of innovation, the Institute for Critical Technology and Applied Science is uniquely positioned to tackle some of these pressing problems. To this end, the institute has organized its research at the intersection of a few powerful technologies-- Nanotechnology, Biotechnology, Information Technology and Cognitive Science--to develop solutions for a sustainable future. Much of this research is conducted under the umbrella of the following eight research thrusts:

1. Nanoscale Science and Engineering
2. Nano-Bio Interface
3. Cognition and Communication
4. Sustainable Energy
5. Renewable Materials
6. Sustainable Water
7. National Security
8. Emerging Research

It is no coincidence that four of our eight thrust areas, including that of National Security, speak directly to humanity's top ten problems listed above. They exploit the transformative power of the platform technologies listed as the first three thrust areas to develop innovative solutions. The last thrust area in the list above, Emerging Research, is intended to serve as a breeding ground for the next generation of science and technology that might offer novel solutions to problems facing society.

In many ways, the National Security thrust area which is the focus of this newsletter, is unique. First, the problem set is diverse and draws from all of the other thrust areas (and from a number of other science and technology

fields.). Next, rather than being organized around a technology, this thrust is organized around a research customer (the federal government in particular, the Department of Defense and, to a lesser degree, the defense industry). Finally, the research is conducted under constraints we don't face in many other areas; these include publication restrictions, export controls, classification of research, and contractual agreements rather than grants (many with carved-in-stone deliverables and due dates).

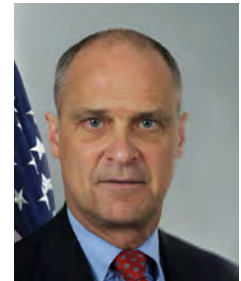
While some of these constraints present challenges in a conventional academic environment, the problems of national security in today's world dealing with global terrorism also offer a great opportunity in scientific research and technical innovation. In our work with Naval Surface Warfare Center (NSWC) Dahlgren over the last eighteen months or so, we have experienced both the challenges and opportunities. I am pleased to note that during this period, we have made huge strides in our collaboration with Dahlgren through a series of agreements. We have founded the Center for Naval Systems and assembled a team with impressive credentials in academia, the military, and industry to sustain and grow our relationship with Dahlgren and to seek additional relationships within the Department of Defense. This team conducted approximately \$4 million in research with NSWC Dahlgren in the first year. In addition, we developed additional contract vehicles with Johns Hopkins University/Applied Physics Laboratory, NSWC Crane (subcontracting to Gryphon Technologies), and Space and Naval Warfare System Center Atlantic.

Encouraged by our success with NSWC, we have also expanded our research collaborations in other domains of national security. For example, the Office of the Director of National Intelligence named Virginia Tech and Howard University as an Intelligence Community Center of Academic Excellence to encourage, mentor and support students from all majors that have interest in pursuing national security careers. Finally, with a generous donation from Ted and Karyn Hume, we were able to found a Center for National Security and Technology in their names to develop future leaders for the federal government focusing on the intelligence and defense sectors.

I hope you will enjoy this issue of the ICTAS Connection and will join us in our efforts to apply transformational technologies to develop a sustainable and secure homeland.

# Collaboration Brings Innovative Solutions to Our Warfighters

by Carl Siel, Jr. | Technical Director, Naval Surface Warfare Center, Dahlgren Division



Academic institutions are key to the Navy's strategy to stay abreast of current technology and understand the realm of the possible for the future. Moreover, in the current fiscally constrained environment, it is important for the Navy and academia to look for more synergistic ways to provide cutting edge technology to the warfighter using progressive relationships and agreements.

The Dahlgren Division is a naval Research, Development, Test and Evaluation (RDT&E) institution with a \$1.2B business base, founded in Naval Warfare and focused to meet the needs of the Department of Navy (DoN) and to support Joint and National initiatives that have naval implications. The Dahlgren Division exists to develop and support concepts, technologies, and systems that enable naval surface forces to conduct their missions effectively and safely across the complete spectrum of operations. NSWCDD works closely with the warfighter to fully understand operational challenges and requirements, particularly in the areas of naval fire power, integrated air and missile defense, maritime expeditionary warfare and irregular warfare. The Division also works closely with the academic community and the business community to track emerging technologies that may offer new solutions for operational challenges or new capabilities for force application or force protection. Partnership with private sector industrial capabilities and production capacities provides the critical linkage that results in the highest quality, affordable and timely warfighting capabilities being provided to our men and women in uniform.

The Dahlgren Division has a long history of hiring Virginia Tech (VT) graduates and has an on-going active program of graduate education with VT. The research association with VT started many years ago and became more formalized in 1983 with the signing of a Memorandum of Understanding (MOU) among the Naval Sea Systems Command (NAVSEA), NSWCDD, and VT leading to the establishment of a Systems Research Center (SRC) located at Blacksburg. The SRC was established to conduct research and exploratory development in areas primarily relevant to combat systems on surface ships, recognizing that the benefits derived can extend to subsurface and air platforms. An associated multi-year contract resulted in over 50 task orders for research work at Virginia Tech.

In 2005, the NSWCDD leadership began a restructuring that put research and S&T into the forefront of Dahlgren's strategic vision. Along with the

development of the Chief Technology Officer and Chief Engineer positions the Technical Partnering Office was stood up that spawned a new view of full-spectrum Defense and University partnerships to help meet our mission goals. About that same time, VT began an initiative to create a research institute that crossed academic disciplines. The Institute for Critical Technology and Applied Science (ICTAS) evolved. This interdisciplinary approach at VT aligned well with the broad interdisciplinary research interests at NSWCDD.

In November 2008, NSWCDD and VT (ICTAS) signed a new Memorandum of Understanding (MOU) to formalize the scope and depth of future research engagement and to establish organizational links. The scope of the MOU spans all 29 of NSWCDD's published Technical Capabilities and provides the framework under which our relationship has expanded to various mutually beneficial innovative research activities.

Additional agreements were signed that further facilitate research exchanges between the two organizations. A Non-Disclosure Agreement (NDA), signed in January 2009, allows scientists, professors and students to freely discuss their technical work without fear of inappropriate disclosure. An Educational Partnership Agreement (EPA), signed in March, 2009, encourages education in Science, Technology, Engineering and Mathematics (STEM). Under the auspices of the EPA, technical interchange meetings have been held both at VT and NSWCDD resulting in development of various research projects. Several Cooperative Research and Development Agreements (CRADA) are being developed to encourage joint research in areas of mutual interest. Areas such as Nano composites, Quantum effects, Chem-bio defense, Robotics and Human-Systems Integration are being discussed. Many opportunities for collaboration are now possible to meet mutual innovative research objectives including:

- Evaluation of existing technologies for innovative uses in the naval environment.
- Access to and use of each party's unique laboratories and facilities.
- Joint publication of studies, evaluations and lessons learned.
- Acceleration and expansion of promising technologies for warfighter benefit.

Understanding the need to also engage VT for funded research, NSWCDD instituted a five-year Indefinite Delivery/Indefinite Quantity (IDIQ) contract in 2009 under which 12 task orders are already in place including support for Railgun, Water Surface-piercing Gas Jet research, gun slide testing, real-time scheduling algorithms and Unmanned Systems. Recently, Ground Unmanned Support System (GUSS) tasking addressed a Marine Corps need to provide an autonomous ground vehicle capable of transporting supplies, ammunition and casualties during dismounted operations and convoy movements. Virginia Tech, in partnership with NSWCDD, reached into its Mechanical Engineering Department for a professor and students and reached out to its Corporate Research Center to team with a small business to deliver four GUSS vehicles that supported a variety of Marine Corps missions during the 2010 Rim of the Pacific (RIMPAC) exercise held from June 23 to August 1, 2010 at a test range in Hawaii. The NSWCDD/VT team successfully demonstrated the robot's ability to provide logistics support for resupply and casualty evacuation while operating in a "follow-me" mode.

This summer, under the 2010 Office of Naval Research (ONR)-funded summer programs, two professors and two students from Virginia Tech spent ten weeks at NSWCDD engaged in Naval missions including Agile Development and Rapid Prototyping, Naval Open Architecture framework and Multicore Real-time Resource Management techniques. The latter work will continue as a new IDIQ contract task.

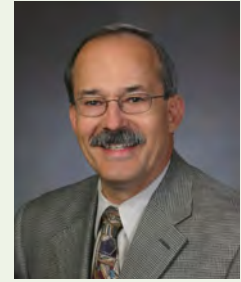
The GUSS project and the Multicore Real-time Resource Management project are just two of the mutually beneficial innovative research projects and activities developed as a result of an on-going partnership between NSWCDD and Virginia Tech's Institute for Critical Technology and Applied Science (ICTAS). We are committed to upholding our strong relationship and partnership with Virginia Tech and look forward to continuing our joint efforts to fulfill the Navy's mission as well as help develop the next generation of scientists and engineers to support the naval community.

*Demonstration of Ground Unmanned Support Surrogate (GUSS) at ICTAS Research Day*



# National Defense Laboratory Education Partnership Agreements and the Opportunities Provided

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In his recently published book, *Crisis on Campus*, Mark Taylor points out that the average cost of four years of college has increased 202 percent since 1981 – more than 2.5 times the increase in the consumer price index (1). Later he calculates that, at the current annual rate of inflation in the cost of post-secondary education, 7 – 8 percent, students graduating just ten years from now will have paid an average of more than \$328,000 for their undergraduate degrees (2). Especially when taken in light of the current global economic situation, these figures are staggering and have precipitated recent articles questioning the value of a college education (3).

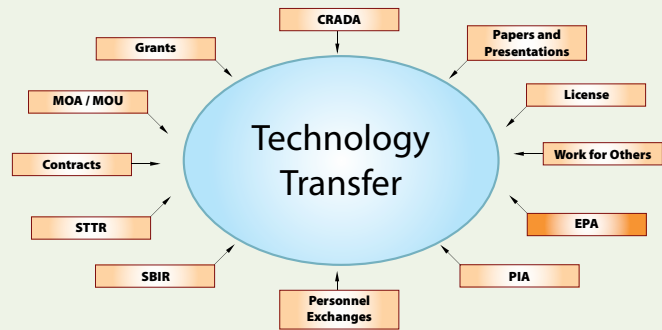
Certainly this is not contributing positively towards improving the diversity of the student body and, since a growing number of college students are working an increasing number of hours to help pay these costs, it is reasonable to assume that the quality of their learning experience suffers measurably. Just as the increasing cost of health care has had a disproportionate impact on the health of the less-fortunate, so the skyrocketing cost of education is having just as disproportionate an impact on the education of the same group. The effects are magnified since there is a direct relationship between the two.

Obviously the problem is multi-faceted but it certainly has far-reaching implications, one of which is directly related to national security – where will we find the future technically trained workforce to staff our national defense laboratories? With the “baby-boomers” retiring in increasing numbers this is an immediate problem requiring immediate attention in parallel with a long term plan. Title 10, Section 2194 of the U.S. Code is a well-thought out initial approach to both. The opening paragraph states

*“The Secretary of Defense shall authorize the director of each defense laboratory to enter into one or more education partnership agreements with educational institutions in the United States for the purpose of encouraging and enhancing study in scientific disciplines at all levels of education. The educational institutions referred to in the preceding sentence are local educational agency, colleges, universities, and any other nonprofit institutions that are dedicated to improving science, mathematics, and*

*engineering education.”*

These “education partnership agreements” (EPAs) are viewed by the Defense Department as one necessary component of their technology transfer mission (4).



The EPAs authorize the following actions and activities (5):

- Loaning/transferring appropriate surplus equipment such as computers and scientific instruments to educational institutions
- Licensing appropriate intellectual property to institutional faculty and students for appropriate use and possible entrepreneurial innovation
- Loaning laboratory personnel to teach science courses or to assist in the development of science courses and materials
- Involvement of faculty and students of the institution in defense laboratory research projects and assisting in the development of programs to grant appropriate academic credit for that work
- Provide academic and career advice and assistance to students

When entering into an EPA, the Defense Department gives priority to those serving minorities and women and those involving historically Black colleges and universities.

In addition to the EPAs with defense labs specifically covered by Title 10, Section 2194, Section 2192 also provides opportunities to faculty and students in science, technology, engineering, and mathematics (STEM) education. Section 2192 specifically states



*“The Secretary of Defense, in consultation with the Secretary of Education, shall, on a continuing basis—*

*(1) identify actions which the Department of Defense may take to improve education in the scientific, mathematics, and engineering skills necessary to meet the long-term national defense needs of the United States for personnel proficient in such skills; and*

*(2) establish and conduct programs to carry out such actions.”*

The Office of Naval Research (ONR) Funding Opportunity Announcement (FOA) Number 10-023 of 12 July 2010 is a specific example of a broad funding opportunity under this section which is seeking proposals extending anywhere from Kindergarten through graduate school. The description of this funding opportunity follows:

*“The Office of Naval Research (ONR) seeks proposals as provided under the authority set forth in subdivision (1) of subsection 2192 (b) of title 10 in support of education programs in science, technology, engineering and mathematics (STEM). The ONR mission of STEM is to: foster an interest in, knowledge of, and study in science, technology, engineering and mathematics nationwide to ensure an educated and well-prepared workforce, which meets the naval and national competitive needs. In support of this mission, the following five goals have been identified:*

- **Inspire** the next generation of scientists and engineers. [Grades K-10]
- **Engage** students in STEM-related hands-on learning activities using Navy content. [Grades 3-12]
- **Educate** students to be well-prepared for employment in STEM disciplines in the Navy or in supporting academic institutions or the Naval contractor community. [Higher Education]
- **Employ, retain and develop** Naval STEM professionals. [Higher Education, Professional Development, Faculty]
- **Collaborate** across Naval STEM programs to maximize benefits to participants and the Navy.

The purpose of this announcement is to receive proposals in support of the Office of Naval Research’s mission of scientific outreach and education in working to develop the next generation of scientists capable of providing

support to the continued development of critical technologies in support of the Department of Defense. The objective of these activities will be to:

1. Establish and ensure successful, sustainable, and affordable long-term Navy wide programs targeted at elementary and secondary schools and institutions of higher learning.
2. Establish and maintain a pipeline of students, particularly women and members of minority groups, who will apply for and participate in Navy education and outreach programs.
3. Increase the number of domestic students (particularly students from under-represented groups) completing STEM degrees through enhancing student interest and attitudes toward science, technology, engineering, and mathematics.
4. Strengthen peer, family, and school support for such interests.
5. Ensure long-term inclusiveness of women and minorities in science and technology programs.
6. Increase the number of students taking college-prep science and mathematics courses.
7. Demonstrate appropriate curricular connections with the applicable state and national standards of learning for science, technology, engineering, and mathematics (STEM).”

Part of the ICTAS Mission is “[to] enhance the educational experience of both undergraduate and graduate students” and a specific goal is to “support research and educational programs to reach out to developing communities locally and globally.”<sup>(6)</sup> These integrate well with the programs discussed above which provide excellent opportunity for mutually beneficial collaboration with defense research labs as well as opportunities to improve the STEM education pipeline. The broad nature of these initiatives indicates a willingness to entertain innovative ideas. The Center for Naval Systems (CNavS) desires to provide assistance to VT personnel interested in pursuing these opportunities.

<sup>(1)</sup> Mark C. Taylor, *Crisis on Campus, A Bold Plan for Reforming Our Colleges and Universities*, Alfred A. Knopf, New York, 2010, pg. 101

<sup>(2)</sup> *Ibid.* pg. 103

<sup>(3)</sup> *Is College Still Worth It?*, U.S. News & World Report, September 2010, pg. 6

<sup>(4)</sup> Lorraine Flanders, Office of Research and Technology Applications, NSWC Dahlgren Division, ICTAS presentation, 1 September 2010

<sup>(5)</sup> *Ibid*

<sup>(6)</sup> <http://www.ictas.vt.edu/vision.shtml>, September 5, 2010

# Introducing the 2010 Doctoral Scholars



## Zhe Bao

Zhe Bao is a Ph.D. student in the department of Biological Sciences at Virginia Tech and an ICTAS Doctoral Scholar. She is advised by Dr. Erik Nilsen of the Ecology, Evolution and Behavior group.

Zhe grew up in Tangshan, a city near Beijing, China and received a bachelor's degree in biological science and master's degree in ecology from Beijing Normal University. Zhe presented the results of her master work during the 94th Annual meeting of the ESA (Ecology Society of America).

In addition to devoted study of her major area of interest, Zhe's research is focused on the interaction between an invasive tree species and its functional similar native tree in the forest, the mechanism under the result of competition, and the impact on local community and ecosystem function.

Zhe also enjoys hiking, playing badminton and yoga, photography, drawing, and music. Zhe loves observing and exploring the natural world and thinking about environmental problems and their potential solutions, all of which have close linkages to her research topic.



## James Dale

James Dale is a Ph.D. student in the department of Geosciences at Virginia Tech and an ICTAS Doctoral Scholar. He is a member of the NanoBioEarth Lab under the supervision of Dr. Michael Hochella.

James grew up in California, and completed his bachelor's degree in chemistry at Chapman University in 2008.

After completing his undergraduate studies, James continued his research in the Environmental Geochemistry Lab at Chapman University under Dr. Christopher Kim's guidance on the sorptive properties of heavy metals onto nanocrystalline goethite aggregates. This work culminated in a presentation during the 239th ACS National Meeting in San Francisco, CA and subsequent submission of a manuscript to *Geochimica et Cosmochimica Acta*.

James' research interests lie in the transport, fate and remediation of metals and the roles nanoparticulate minerals play in these processes.

James grew up in southern California. Outside of the lab, he enjoys snowboarding, hiking, biking, rafting, brewing beer and spending time with his dog.



## Jung Ki Hong

Jung Ki Hong is a Ph.D. student in the Macromolecular Science and Engineering Program at Virginia Tech and an ICTAS Doctoral Scholar. He is advised by Dr. Maren Roman in the department of Wood Science and Forest Products.

Jung Ki grew up in Daegu, South Korea. He received a B.S. in forestry from Yeungnam University, South Korea in 2005 and an M.S. in forest products from Virginia Tech in 2010. During his master's studies, Jung Ki was a Wood-Based Composites Center Arclin Fellow. His master's degree research examined the effects of cellulose nanocrystals on the rheology, curing behavior, and fracture performance of phenol-formaldehyde wood adhesives.

Hong's current research interests focus on potential biomedical applications of cellulose nanocrystals, including the development of polymer-based bone scaffolds and the reinforcement of ligaments.





### **Chennan Hu**

Chennan Hu is a first year graduate Virginia Tech in the department of Physics and an ICTAS Doctoral Scholar. Chennan's advisor is Dr. Uwe Tauber.

Chennan graduated from the University of Science and Technology of China with a Bachelor of Science degree in physics/optics. Chennan spent two years performing diode laser research in the Key Lab of Quantum Information, China Academy of Science, as an undergraduate. He is currently pursuing research interests in micro/nano scale materials and micro-electromechanical systems.

Chennan's other interests include motorcycling, roller skating, fishing, table tennis, billiards and hanging out with friends.



### **C. Nathan Jones**

C. Nathan Jones is a Ph.D. candidate in the department of Biological Systems Engineering and ICTAS Doctoral Scholar, concentrating in Land and Water Resources Engineering. He is advised by Dr. Durelle Scott and Dr. Cully Hession.

Nathan grew up central Arkansas, spending much of his childhood wondering in the hills and streams of the Ozarks. He received his bachelor's degree in biological engineering from the University of Arkansas. During Nathan's undergraduate work, he was involved in research projects ranging from watershed modeling and stream restoration to nutrient removal in wastewater treatment processes. Nathan plans to continue his research in the field of ecological engineering, with a focus on the linkages between hydrology and biogeochemistry.

Spending most of his free time in the outdoors, Nathan's lifelong goal is to help protect and conserve our world's natural resources.



### **Konstantinos Krommydas**

Konstantinos Krommydas is a Ph. D. student in the department of Computer Science and an ICTAS Doctoral Scholar. He is advised by Dr. Wu-chun Feng of the SyNeRGy Lab in the Computer Science department.

Konstantinos grew up in Volos, Greece, where he received his bachelor's degree in computer engineering from the University of Thessaly. Konstantinos's research experience and interests lie in the area of computer systems and high performance computing. His side research interests include computer architecture and multimedia. Recently, he gave an oral presentation on "Mapping and optimization of the AVS video decoder on a high performance chip multiprocessor" during the International Conference on Multimedia and Expo (ICME'10) in Singapore. He is interested in exploring the potential of new generation graphics processing units and multiprocessors in computationally intense applications.

In his free time Krommydas likes playing the guitar and participating in outdoor activities, such as cycling and hiking.

*Continued on next page*

## 2010 Doctoral Scholars (continued)



### Daniel Vanden Berge

Daniel Vanden Berge is a Ph.D. student in the Geotechnical program of the department of Civil and Environmental Engineering at Virginia Tech and an ICTAS Doctoral Scholar. He is currently advised by Dr. Thomas Brandon and Dr. J. Michael Duncan.

Dan is originally from Grand Rapids, Michigan. He received his bachelor's and master's degrees in civil engineering from Michigan Technological University. After his schooling at Michigan Tech, he practiced geotechnical engineering for seven years at a mid-sized private consulting firm in the Cleveland, Ohio area. During that time, Dan obtained his professional engineering license in the states of Ohio and Pennsylvania. Dan's research interests lie in the fields of slope stability analysis, soil shear strength, and the use of reliability analyses in geotechnical engineering.

At home, Dan enjoys spending time with his wife and children, reading, and cooking. His interests also include hiking, camping, and participating in activities in his church and community.



### Phoebe Williams

Phoebe Williams is a PhD candidate in the Molecular Plant Sciences Department and an ICTAS Doctoral Scholar. She is completing first year lab rotations and is currently advised by Dr. Boris Vinatzer, in the Plant Pathology and Weed Sciences department.

Phoebe grew up in Charlottesville, VA and received her bachelor's degree from the College of William and Mary. She has worked both in research and science education in Virginia, Montana, and New Hampshire since graduation. Phoebe is broadly interested in how organisms adapt to their environment at the genetic and molecular levels, specifically, how organisms respond to human induced environmental change and how this knowledge can be applied to conservation and green technologies.

Williams enjoys exploring the outdoors and many forms of dance.



### Daniel W. Youngstrom

Daniel W. Youngstrom is a Ph.D. candidate and ICTAS Doctoral Scholar in the Biomedical and Veterinary Sciences program through the Virginia-Maryland Regional College of Veterinary Medicine. He is advised by Dr. Jennifer Barrett and will be conducting research in the field of tissue regeneration at the Marion duPont Scott Equine Medical Center.

Dan, originally from Massachusetts, received his undergraduate degree in biophysics from the University of Michigan in 2010, with research experience in the fields of physical biochemistry and molecular pharmacology.

In his free time, Youngstrom enjoys exploring the outdoors with his newly rescued canine companion, Jay.



# Welcome recent additions to the ICTAS team



**Wade DePolo, Postdoctoral Associate** | [wdepolo@vt.edu](mailto:wdepolo@vt.edu)

Depolo came to Blacksburg in July 2010 from the Institute for Advanced Learning and Research in Danville, VA where he served as a research scientist. Depolo works with Dr. Gene Joseph, ICTAS research professor, exploring the area of melt electrospinning. Depolo assumes responsibilities for installing the melt extrusion equipment necessary to the research, as well as the installation and operation of co-extrusion equipment, which is expected to be available in December 2010.



**Junbo Hou, Postdoctoral Associate** | 231-1743 | [junbo80@vt.edu](mailto:junbo80@vt.edu)

Hou came to Blacksburg in July 2010 from the department of Physical Chemistry at the University of Leoben in Austria where he served as a researcher. Hou works with Dr. Mike Ellis, ICTAS sustainable energy thrust leader, exploring transformational research in electrochemical energy conversion and storage systems including polymer electrolyte fuel cells, solid oxide fuel cells, batteries, and organic solar cells.



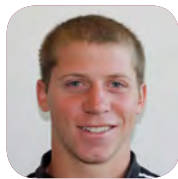
**Chase Loomer, Student Facilities Assistant** | 231-8997 | [dcloomer@vt.edu](mailto:dcloomer@vt.edu)

Loomer is an undergraduate student in the department of Building Construction, expected graduation May 2011. Loomer serves ICTAS as a facilities assistant, responsive to all facility-related needs for three ICTAS buildings including construction, maintenance, renovation, and security.



**Robert Moore, ICTAS Interim Associate Director for Research** | 231-6015 | [rbmoore3@vt.edu](mailto:rbmoore3@vt.edu)

Moore is a full professor in the department of Chemistry and the Macromolecules and Interfaces Institute, where he is an active researcher in the area of ion-containing polymers for energy and materials applications. He also serves Virginia Tech as affiliate professor in the department of Materials Science and Engineering. Moore earned a Ph.D. in analytical chemistry from Texas A&M University, followed by a postdoctoral fellowship in physical polymer chemistry at McGill University. Prior to joining the faculty of Virginia Tech, he served for 17 years as a professor of polymer science and engineering at the University of Southern Mississippi. He is a Fellow of the ACS Division of Polymer Chemistry (POLY), and currently holds the elected position of 2010 Chair-Elect.



**Bryan Murray, Center for Naval Systems Intern** | 231-8997 | [brmurray@vt.edu](mailto:brmurray@vt.edu)

Murray is pursuing a Master of Science degree in Electrical and Computer Engineering, expected completion May 2012. His research interests include energy generation, specifically distributed or secure grid independent systems. Murray serves ICTAS as an intern with the Center for Naval Systems, applying ECE techniques to the research and development process.



**Keith Nunn, Facilities Assistant** | 553-6130 | [keith60@vt.edu](mailto:keith60@vt.edu)

Nunn joined ICTAS in August 2010 following employment with Crothall, a facilities services company, in Oklahoma City, Oklahoma. Nunn also earned more than 6 years' previous experience with Virginia Tech including VT Facilities and Planning and Design and Construction, where he was a part of the team implementing the current VT HokieServ (the university's maintenance tracking program). Nunn supports all facilities needs for ICTAS. Specific responsibilities include maintaining request tracking, serving as primary contact for all security related issues and requests, and assisting with new construction and renovations.



**Matthew Tryon, Center for Naval Systems Intern** | 231-8997 | [tryon@vt.edu](mailto:tryon@vt.edu)

Tryon graduated with a bachelor's degree in industrial and systems engineering with minors in business and leadership in May 2010. He was commissioned as ENS in the United States Navy 14 MAY 2010. After commissioning, was stationed at the NROTC Unit at Virginia Tech and also served as an intern to ICTAS Center for Naval Systems, pending his September 2010 departure for flight school in Pensacola, Florida.

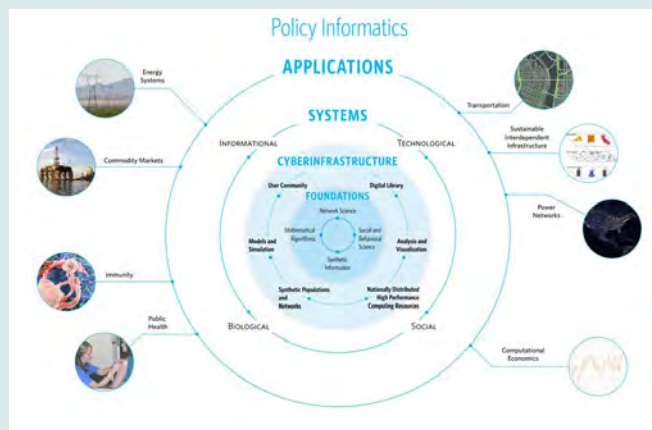


**Tom Walker, Center for Naval Systems Educational Partnership Manager** | 231-9539 | [twalker@vt.edu](mailto:twalker@vt.edu)

Walker came to Virginia Tech in 1988 after completing a 20 year career with the U. S. Navy, followed by four years as a U. S. Naval Academy instructor of mechanical engineering. Walker is an Associate Professor in the department of Engineering Education at Virginia Tech and co-Director of the First Year Program. As Education Program Manager for the Center for Naval Systems, Walker will develop and grow mutually beneficial education relationships with the Naval Surface Warfare Center Dahlgren and other Department of Defense and Department of Homeland Security organizations.

# Policy Informatics for National Security and Sustainability: The Power of Networks

by **Madhav Marathe** | Deputy Director, Network Dynamics and Simulation Science Laboratory (NDSSL) | (540) 231-8832 | [marathe@vt.edu](mailto:marathe@vt.edu)



*The novel use of high-performance computing assets for addressing practical societal problems represents a unique capability developed by the Network Dynamics and Simulation Science Laboratory (NDSSL) at the Virginia Bioinformatics Institute at Virginia Tech. NDSSL team members design, develop and implement modeling tools to understand large biological, information, social, and technological systems.*

In today's world, human behavior, social networks, and civil infrastructures are closely intertwined. Coupled social, technical, informational and organizational systems or STIOs do not stand-alone. They consist of many interacting physical, technological, and human or societal components and are spatially distributed, managed by different federal, state, or commercial entities and operate at multiple time scales. Examples of such systems include regional transportation systems, regional electric power markets and grids, the Internet, ad-hoc telecommunication, communication and computing systems, content delivery networks, social networks, search networks and public health services. What all of these systems have in common is that they are networked – individual agents or components interact only with a specified set of components. The links in such networks can be physically real or a matter of convention such as those imposed by law or social norms, depending on the specific system being represented. Thus STIO networks consist of one or more social networks interacting with underlying technological and physical networks.

## National Security and Policy

National and international societal infrastructures and urban populations are specific STIO networks relevant to combating natural as well as human-initiated crises, sustainable planning and national security. National security strategy and the formation of the Department of Homeland Security reflect the important national security and policy needs in these areas. A system to analyze such networks must support decision makers at all levels, in a variety of domains, performing functions such as policy analysis, planning, course-of-action analysis, incident management, and training. Recent global scale events that have received attention in the media as well as academic circles are current and past financial crises, collapse of the coupled infrastructure system caused by the power grid failure, e.g., the Northeast blackout of 2003, potential pandemics caused by influenza-like illness, new national security problems posed by stateless adversaries and terrorist organizations, and global security and sustainability problems arising from potential climate change and population growth. Individuals, institutions, and governments could not prevent the Northeast black out. We are struggling as a society to combat and control global terrorism. Governments across the world are collaborating and aggressively developing interventions to control the current financial contagion and responding to reduce the economic burden and human suffering of the current H1N1 outbreak. And in the case of climate change and population growth, a clear consensus is yet to emerge as to the course of action and potential impacts.

## Challenges and Opportunities

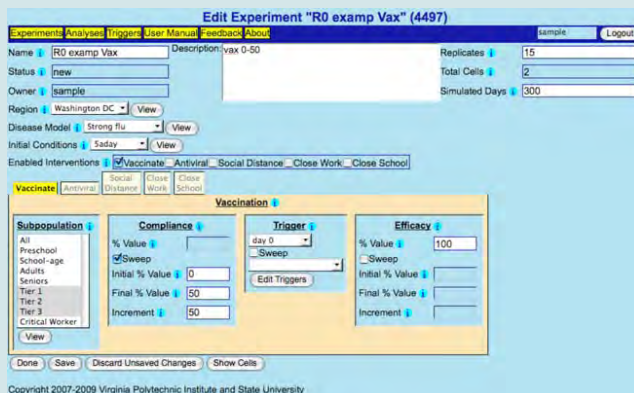
The need to represent and analyze urban and national STIO networks for supporting short and long-term policy questions poses significant scientific and technical challenges. First, these networks share a number of unique features that distinguish them from physical networks. They include irregularity, structures that vary with time, diversity among individual components, and selfish or cooperative game-like behavior by individual components. Adding to the complexity of the features of these networks are the network structure, the dynamical process on the network, and the behavior of constituent agents that co-evolve over time. Reasoning, prediction and controlling these networks pose significant challenges.

## Approach

Recent quantitative changes in high performance and wireless computing capabilities have created new opportunities for collecting, integrating, analyzing and accessing information related to such large complex networks. The advances in network and information science that build on this new capability provide entirely new ways for reasoning and controlling these networks. Together, they enhance our ability to formulate, analyze and realize novel public policies pertaining to these complex networks.

Over the past 15 years, the NDSSL has been pursuing a comprehensive research and development program for representing, analyzing and reasoning about co-evolving STIO networks. This effort supports decision makers that span high level policy makers to first responders in the event of a crisis. It is also intended to support multi-disciplinary teams of scientists who wish to work collaboratively to understand various facets of these complex systems.

Complementing the mathematical and computational theory is a pervasive global modeling, information and decision support computing environment (Comprehensive National Incident Management System or CNIMS). CNIMS is intended to provide scientists, policy makers and engineers novel ways to study large complex STIO networks by making high performance computing-based solutions easily accessible to them. The computational theory plays a crucial role in the development of CNIMS. It underwrites the development of efficient high performance computing-oriented models, provides a formal specification for the service architecture, and is the basis of the data management architecture within CNIMS.



## H1N1 Pandemic Planning and Response

One recent example of how the work of the NDSSL can impact outcomes for society is H1N1 pandemic planning and response. The social, economic and public health impact of the pandemic are now well documented. The Initial effort of NDSSL was in direct response to the early reports of the emergence of the H1N1 influenza virus that eventually caused a global pandemic. In the early days of the outbreak, infections were confined to Mexico, California, and Texas and then spread to New York. The rapid spread combined with initial overestimates of its mortality rate raised serious concerns of a repeat of the

1918 influenza pandemic. Initial reports about the disease characteristics were unreliable, with wide variations placed on important disease parameters like proportion symptomatic and duration of infectious periods. As the H1N1 pandemic started to unfold, a comprehensive high-performance computing oriented decision support system called Simdemics, which was developed by NDSSL researchers, was used to quickly run a series of studies that explored the impacts that the variations in these parameters would produce in a large population in the United States. A graphical user-interface called DIDACTIC, which was built on top of Simdemics and configured for the Department of Defense, is shown in Fig.2. A quick report was drafted about the impact of disease characteristics on the size and shape of the expected epidemic curve. Several variants of disease models were added to Simdemics. As H1N1 influenza continued to spread in the United States, the Department of Health and Human Services teamed up with the Defense Threat Reduction Agency (DTRA) to place DIDACTIC in the hands of government analysts in the United States to provide day-to-day modeling results. This integration inside the 24-hour decision cycle, which assisted the federal government's response to this emerging crisis, would not have been possible without the development of highly optimized modeling software as well as the web-enabled interface. While running these sophisticated experiments, the modelers and analysts did not have to know what was going on behind the scenes of the graphical interface. Models were being run on a set of large high performance computing clusters located hundreds of miles away, complicated diffusion processes were running on networks with more than 100 million nodes and 5 billion edges, nine large population centers in the United States with more than 100 million individuals, spanning more than one-third of the continental United States, in terms of area, were being probed, and their computations were being managed to recover from faults, delays and errors in a seamless manner. For the user, the process is no different than typing a query in Google. For example, the analysts were able to perform course-of-action analyses to estimate the impact of closing schools and shutting down workplaces. Better situational awareness was also enabled by calibrating the model to the real world data with different disease characteristics to estimate the likely pathogen behaviors. Many of the studies naturally led to an investigation that spanned multiple networks. This included understanding built urban infrastructure, the transport network, economic networks, health care networks and various social networks. Detailed synthetic representation of these networks was critical for analyzing many of the questions.

The work of the NDSSL demonstrates the importance and feasibility of placing sophisticated modeling tools in the hands of public health decision makers and highlights the role that highly detailed modeling can play during a response to an emerging crisis. The development of the decision support environment led to new kinds of research in public health epidemiology and also motivated basic and applied research in network science, computational science, social and behavioral science, as well as discrete mathematics.

# Cognitive Radio Network Testbed (CORNET) in ICTAS

by S.M. Hasan, D. DePoy, T. R. Newman, J. H. Reed, and T. Bose

Wireless communications technologies are constantly being improved in order to provide a higher quality of service for the end user. Cognitive Radio technologies are one possible means for advancing wireless communications for the next-generation of intelligent devices. Integrating cognition into wireless applications such as dynamic spectrum access (DSA), wireless distributed computing (WDC), and even traditional protocol stacks, has already been shown to provide additional benefits related to quality of service in communication. The majority of cognitive radio related research has been limited to theoretical frameworks and simulations, or in a few cases demonstrating prototype DSA devices on a small scale. In order to continue advancing in this area, larger scale experiments that are reproducible and able to be moved beyond theoretical simulations are required.

Virginia Tech has constructed a testbed, called Virginia Tech Cognitive Radio Network (CORNET), for the development, testing, and evaluation of cognitive engine techniques and cognitive radio network applications. This testbed facilitates the performance of Software-Defined and Cognitive Radio related research for the purpose of rapid next-generation communication system prototyping using a medium scale size network of flexible wireless nodes. This testbed provides the infrastructure for researchers at Virginia Tech and partner institutions to evaluate independently developed cognitive radio engines, sensing techniques, applications, protocols, performance metrics, and algorithms in a real world wireless environment, in contrast to a computer simulation or single node-to-single node environment.

The hardware required for each cognitive radio node in the testbed consists of the following basic elements: a small PC and a Universal Software Radio Peripheral (USRP). The USRP uses an experimental in-house developed daughterboard, based on an experimental Motorola RFIC capable of spanning from 100 MHz to 4 GHz with a bandwidth up to 20 MHz. This gives the cognitive radio nodes flexibility in the RF domain and a standard hardware interface to work with. In addition to the requested cognitive radio node hardware, a technician is needed to support the development of the daughterboards, along with a support engineer to manage the setup and deployment of the testbed.

A key feature of VT-CORNET is the actual deployment of the nodes throughout the ICTAS<sup>HO</sup> building on the Virginia Tech campus. The testbed consist of 48 radio nodes mounted on the ceiling and distributed amongst 4 floors. This “real world” environment gives researchers, whose local resources may not allow for larger scale practical hardware testing, a platform to test their work in a real wireless network environment. To enhance the research capabilities of the physical network, a separately developed virtual network of simulated cognitive radio nodes will be attached in order to provide opportunities for large scale testing. Figure 1 shows radio node locations in each floor and Figure 2 provides the overall node topology throughout the ICTAS<sup>HO</sup> building.



Figure 1: Radio node locations in each floor of the ICTAS building.

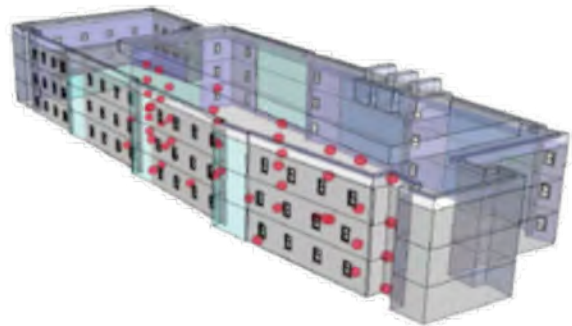


Figure 2: CORNET node topology throughout the ICTAS buildings.

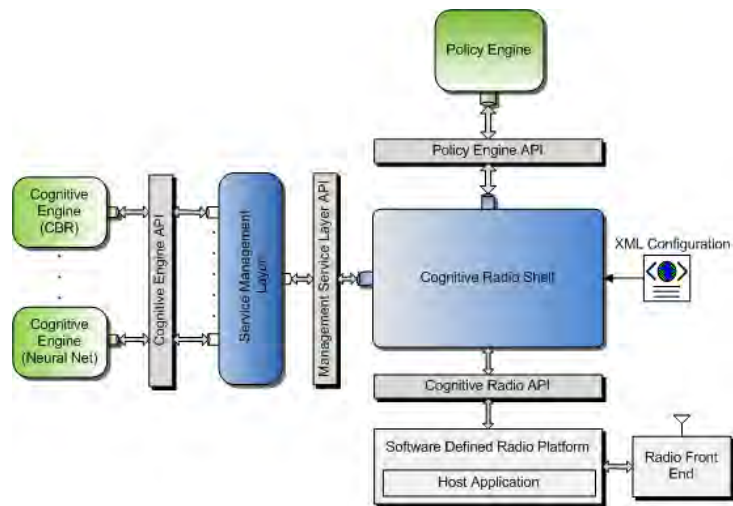


Figure 3: Overall CROSS system block diagram showing all mandatory and optional components and the associated API layers between them

In addition to the hardware architecture, Virginia Tech is also working on developing an open source software architecture for this testbed called Cognitive Radio Open Source System (CROSS). The CROSS architecture is a modular cognitive radio system framework that provides portability and interoperability between components that may be individually developed even in different programming languages. Not only will this allow for flexible development for the cognitive radio system, but will allow developers to focus entirely on the component of choice and not have to worry about developing or modifying components that have no relevance to their specific focus of research.

The current CROSS consists of 5 categories of components, several of which are optional. The 5 primary components of the system are as follows: Cognitive Radio Shell (CRS), Cognitive Engine (CE), Policy Engine (PE), Service Management Layer (SML), and Software-Defined Radio Host Platform. Figure 3 shows the general CROSS system block diagram, displaying all mandatory and optional components. In addition to these components, custom components may be developed in the future.

Images from **ICTAS Research Day**  
September 28, 2010



# Energy Harvesting

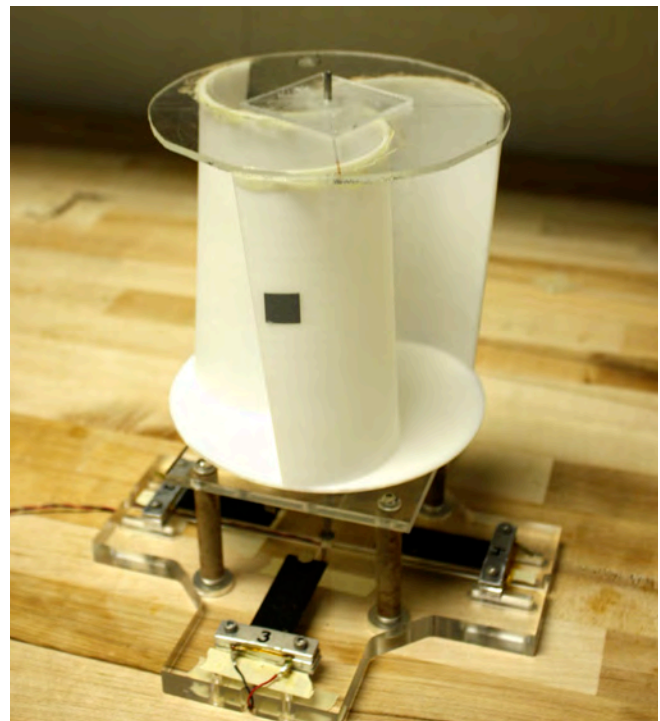
by **Shashank Priya** | Assoc Professor AY, Materials Science & Engineering |  
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One of the major questions facing the wireless sensor industry is “How to power the sensors?” “Who will replace billions of batteries?” The powering of the densely populated sensor nodes in a network is a critical problem due to the high cost of wiring and replacing batteries. In many cases, these operations may be prohibited by the infrastructure. Harvesting the energy available locally may supplement the battery or even replace them. Thus, the development of multi-scale energy harvesters will solve critical problem facing the sensor industry in the implementation of the wireless networks and open the possibility of several autonomous self – powered applications including industrial health monitoring, condition based maintenance, perimeter security nets, border intrusion sensor nets, micro-robotic vehicles and UAV’s, aircraft structural health monitoring, and implantable medical devices. There are several potential sources for harvesting energy including mechanical vibrations, pressure vibrations, acoustics, air flow, human body, temperature gradient, light, RF signals, and ocean waves. Unused power exists in various forms such as industrial machines, human activity, vehicles, bridges and various other environment sources. Ambient, unused energy around us (just waiting to be harvested) is continually transmitted by various sources such as radio and television towers, satellites, cellular phone antennas, and various portable electronics. All these sources have been of potential interest to both academia and industry. Several commercial prototypes of energy harvesting devices have been launched in this decade from US companies such as MIDE, Ferro Solutions, Smart Material Inc., Texas MicroPower, Powercast, MicroStrain, etc. According to Dr. John Blottman from NUWC, “The Navy has identified the future in terms of autonomy and autonomous distributed systems and has been investing in surveillance systems that are persistent, extending the operational life several orders of magnitude beyond what is expected with current sonobuoy technology. As the energy needs of micro electronic systems are reduced, the opportunity for persistent autonomy is realized. Persistence demands severe energy conservation, and energy harvesting to extend the service life of a sensing system beyond that possible with current battery technologies.” At Virginia Tech, we have launched Center for Energy Harvesting and Materials Science (CEHMS), a collaborative effort with University of Texas at Dallas and industry, to address these critical existing needs. We anticipate that the research and development at CEHMS will launch a new generation of products

and industries which will contribute to the national economy and development.

Over past six years, our research has been focused on developing mechanical to electrical energy harvesting devices targeting wind flow and vibrations through piezoelectric, inductive, and magnetoelectric mechanisms. We have demonstrated Piezoelectric Windmill® technology that utilizes bimorph transducers to convert wind flow in to electricity at very small start-up speeds. Further, we have demonstrated modular electromagnetic turbines that can be assembled on-spot to generate few hundred milliwatts of electrical power. The whole windmill can be packaged in the 2 liter Nalgene bottle. Figure 1 shows an example of a small-scale windmill developed in our laboratory.



*Figure 1: Piezoelectric windmill being developed for the National Institute of Standards and Technology to power the bridge monitoring sensor network.*

Researchers at VT have also made breakthroughs in design of the piezoelectric



# SEMINAR SERIES

The **ICTAS Seminar Series** is a continuing lineup of speakers sponsored by ICTAS, designed to shed light on current topics of interest to the research and educational communities. Speakers represent a wide range of organizations including educational institutions around the country, as well as government and commercial organizations. It is the goal of the Seminar Series to provide knowledgeable speakers who lend a unique perspective to their particular field of expertise.

Below is the complete current schedule for fall semester, 2010. Check [www.ictas.vt.edu](http://www.ictas.vt.edu) for updates, new speakers, flyers and other information.

composition that can enhance the performance of existing devices. We were able to obtain a piezoelectric ceramic composition exhibiting the magnitude of  $d_{33}$  and  $d_{31}$  as  $55.56 \times 10^{-3} \text{ m}^2/\text{C}$  and  $291 \times 10^{-12} \text{ C}/\text{N}$  respectively, yielding the magnitude product  $d_{33} \cdot d_{31}$  as  $\sim 16168 \times 10^{-15} \text{ m}^2/\text{N}$  which is significantly higher than the reported values in literature. Using this composition, we are now trying to develop MEMS and NEMS devices. Figure 2 shows the example of inductive energy harvester being developed for P&W which has been optimized to provide the performance close to theoretical power density. The main areas of research we are trying to address are (i) Wide bandwidth operation (low to high frequency with median at 100 Hz), (ii) Self-tuning capability to implement the same harvester in variety of conditions, and (iii) Frequency pumping to convert the available vibration into high frequency oscillations.



*Figure 2: Electromagnetic vibration energy harvester being developed for Pratt & Whitney.*

VT has a large research program in the area of bio-inspired materials and systems. We strongly believe that by understanding the principles and mechanisms adopted by nature, one should be able to develop efficient and elegant engineering systems. Along this line, we have initiated research on bio-energy generation by pursuing the feeding and metabolic activity of jellyfish. Partially funded by ONR, this research will lay the foundation for capturing and converting the food particles in dynamic ocean environment and converting them to electricity.



**Friday, September 17, 2010, 2:00 - 3:30 pm**

"Part 1:  $\mu\text{GC}$  Beyond Miniaturizing Gas Chromatography" with **Masoud Agah**, Associate Professor, The Bradley Department of Electrical and Computer Engineering, Virginia Tech

Friday, October 29, 2010, 2:30 - 4:00 pm

"Part 2: The promise of 3D Microfluidics in conjunction with atomic force microscopy for Cellular Biology and Cancer Prognosis" with **Masoud Agah**



**Tuesday, November 16, 2010, 2:30 - 4:00 pm**

"X-ray CT Imaging at Micrometer and Nanometer Scale" with **Steve Wang**, Lead Scientist, of TXM and Nano-CT Program, Argonne National Laboratory



**Thursday, December 9, 2010, 10:00 - 11:30 am**

"Evolution of Turbine Vane Endwalls" with **Karen Thole**, Department Head, Department of Mechanical and Nuclear Engineering, The Pennsylvania State University

# Update on ICTAS Buildings



## ICTAS<sup>HQ</sup>

### (Headquarters location on campus at Stanger Street)

As we approach our two year anniversary in the headquarters building, we celebrate a fully occupied facility, brimming with research activity. Tenants include:

- First floor – Center for Injury Biomechanics; Sustainable Water Infrastructure Management; Energy and Material Transport; Targeted Delivery of Nanomedicine; Cognitive Radio Network
- Second floor – Biobased Materials; Environmental Nanoscience and Technology; Targeted Delivery of Nanomedicine
- Third Floor – School of Biomedical Engineering and Sciences (SBES)
- Fourth Floor – ICTAS Administration; Sustainable Energy; Carbonaceous Nanomaterials, Center for Injury Biomechanics



## ICTAS<sup>CRC</sup>

### (Virginia Tech Corporate Research Center location)

The Nanoscale Characterization and Fabrication Laboratory (NCFL), located on the first floor of the ICTAS-CRC building, is currently in the fourth year of operation. Recently, new instruments were installed, further enabling testing at the nanoscale. The new instruments are a Field Emission Auger Electron Spectrometer and a Quadrupole Secondary Ion Mass Spectrometer.

A new laboratory, the Nuclear Safeguards and Security Lab (NSSL), will soon open in the same building. This facility will engage in gamma spectroscopy analysis, algorithm development for detector radiation measurement, special nuclear material detection and identification for homeland security and counter-terrorism applications, as well as develop novel nuclear safeguards processes. Nuclear engineering professor Mark Pierson, Virginia Tech department of Mechanical Engineering, and a to-be-named colleague will lead the NSSL.



## ICTAS<sup>LSC</sup>

### (Life Sciences Corridor campus location)

Construction at the LSC location began in April 2009 and is currently 85% complete. The current project scope includes enough points to obtain a LEED Silver certification, making this the first research building on the Virginia Tech campus to gain LEED certification. Substantial completion is slated for year-end 2010 and occupancy is expected early in 2011.



## ICTAS<sup>NCR</sup>

### (National Capital Region Ballston location)

ICTAS will expand into the National Capital Region facility in the Ballston, Virginia area. The seven-floor, 144,000 square foot building, designed by Cooper Carry to meet the Silver U. S. Green Building Council's LEED™ Building Rating Systems, will be located on the 800-900 block of North Glebe Road. ICTAS will occupy approximately 7,000 square feet in this facility. The anticipated construction completion date is June 2011.

2010 ICTAS  
*Research Day*  
 INSTITUTE FOR CRITICAL TECHNOLOGY AND APPLIED SCIENCE · VIRGINIA TECH



Nicholas White narrates the Center for Injury Biomechanics lab tour



Dr. Rafael Davalos addresses tour participants



ICTAS Director Roop Mahajan with poster session award winners



Keynote Speaker, Dr. Anthony Atala, addresses the morning session



General session

Institute for Critical Technology and Applied Science  
at Virginia Tech  
410 ICTAS, Stanger Street (MC0193)  
Blacksburg, VA 24061

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ICTAS Connection is published by the Institute for Critical Technology and Applied Science at Virginia Tech. Roop L. Mahajan, Director

Please send comments and address corrections to Ann Craig, [annc@vt.edu](mailto:annc@vt.edu).

Ann Craig, editor | Alex Parrish, graphic designer

## The Enduring Challenge of National Security *continued from front page*

Professor Tom Walker, the Center for Naval Systems Educational Partnership Manager and a key player in the Virginia Tech/Dahlgren relationship, offers an article discussing the opportunities that Educational Partnership Agreements provide. Offering perspective, Dean Benson points out that Virginia Tech has a long-standing tradition of leading the effort to connect our scholars with our warriors. Roop Mahajan attributes university leadership with founding recognition that a sustainable future is dependent on the ability to defend our homeland and way of life.

Other university centers purposed to address particular aspects of the fundamental issues necessary to maintain national security include The Ted and Karyn Hume Center for National Security Technology and the Intelligence Community Center for Academic Excellence. These organizations, along with the ICTAS Center for Naval Systems, help provide “impedance matching” between academia and the national security community, linking scholars and warriors to accomplish three critical tasks:

- Providing “ready to field” technologies to warfighters.
- Bridging early research and development into fielded capabilities.
- Developing the next generation of scientists and technologists for national security.

While the science and technology needs of the national security arena will require a broad range of research topics, there are a few specific areas where DoD needs are clearly in sync with the university’s research strengths. We plan to invest in these areas with the intent of developing strong and coherent research programs. Mr. Siel’s article refers to the recently completed Ground Unmanned System Support (GUSS) project as representative of one such area. Others that we will examine for investment are also addressed in this issue; for example, network analysis and simulation (discussed by Dr. Madhave Marathe), and cognitive radio (team-authored and led by Dr. S.M. Hasan), and energy harvesting (authored by Dr. Shashank Priya).

Virginia Tech is committed to a leadership role responsive to these needs and continues to “Invent the Future” in this field, leading our nation and our world to a sustainable and secure tomorrow.

