ICTAS Connection

http://www.ictas.vt.edu

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Opportunity for Collaborative Interdisciplinary Research is Expanded by Move to New Campus Building

More than two years after the official notice to proceed with construction was issued, the new building at the corner of Turner and Stanger Streets will soon be home to an array of people, equipment, laboratories, and offices focused on interdisciplinary research.

The building was designed by Burt Hill Kosar Rittleman Associates of Washington DC and contracted for construction by Branch & Associates, Inc. of Roanoke, VA. The capital construction project was led by Virginia Tech Capital Design and Construction Project Manager, Van Coble. The building includes four stories of research laboratories, offices, and workspaces spread over more than 99,000 gross square feet of space. The total project cost is just over $45 million.

In addition to serving as headquarters for ICTAS, this building will provide laboratory and office space for 20 or more collaborative research programs and related administrative areas as follows:

- **Center for Injury Biomechanics**
- **Sustainable Water Infrastructure Management**
- **Energy and Material Transport**
- **Targeted Delivery of Nanomedicine**
- **Cognitive Radio Control Room**
- **Renewable Materials**
- **Nanoscience and Technology of the Environment**
- **School of Biomedical Engineering and Sciences**
- **Biomedical Imaging Division**
- **Musculoskeletal Tissue Regeneration Laboratory**
- **Cellular Engineering Micro Systems**
- **Laboratory for Biomaterials and Tissue Engineering**
- **Biomedical Optics and Devices Laboratory**

Side View of the Newest ICTAS Building

- **Bioheat Transfer and Nanotherapeutics Laboratory**
- **Laboratory of Vascular Biology**
- **Skeletal Tissue Engineering and Mechanotransduction**
- **Sustainable Energy**
- **Carbonaceous Nanomaterials**
- **Center for Injury Biomechanics**

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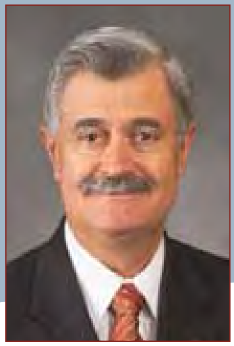
ICTAS –
Our Hand on the Future



Gerhardt Schurig
Dean, VMRCVM

The Institute for Critical Technologies and Sciences (ICTAS) is a welcome new entity here at Virginia Tech, one that will profoundly advance our efforts to "Invent the Future."

Innovation pervades it. From its interdisciplinary organizing structure to the systems it has devised for exploring new scientific frontiers, ICTAS is a powerful catalyst for discovery in a university that has long been committed to solving problems and inventing a better future for the society it serves.

ICTAS is an enabling entity, one that will bring together the creative minds of faculty who represent a broad spectrum of scientific disciplines. Our increased understanding of the molecular processes of life has elucidated the growing convergence of many disciplines, from nanotechnology to pharmacology and of course many others. This understanding undeniably underscores the virtue – and the power – of interdisciplinary collaboration.

By creating opportunities for cross-disciplinary collaboration in a synergistic environment, ICTAS is uniquely suited to develop tangible, new technologies that are critical to advance the sciences that will ultimately benefit the human race, the animal kingdom, and the environment.

Leadership is a key ingredient in a creative venture such as this, and we are fortunate to have a scientist like Roop Mahajan guiding this enterprise. Roop is a well recognized and accomplished scientist in his own right; but more than this, he is an innovator and he is profoundly committed to stimulating an interdisciplinary approach to the projects that will be undertaken by ICTAS. His scientific achievements, interpersonal characteristics, and commitment to collaboration basically guarantee innovation, synergies and success.

ICTAS will also be of great importance to the continued development of Virginia Tech's programs in the biomedical sciences. As its name implies, "applied sciences" can become a major engine for the growth of translational medicine – the rapid application of basic research findings into practical solutions for medical problems affecting people and animals.

It behooves us all to embrace the enabling approach that is symbolized by the structural foundations of ICTAS. The institute has the capacity to play a transformational role in the university's historic commitment to explore, understand and apply the products of scientific discovery in a way that creates a better world.

Its time is now, and properly supported, we shall all – from our scientific community here in Blacksburg throughout the vast populations we serve - gain from its impact long into the future.

DIRECTOR'S CORNER

Roop Mahajan
Director, ICTAS

Minds at Work - Successes Large and Small

The past year has been one of consolidating and advancing initiatives in the infrastructure, learning, and discovery domains. Our state-of-the-art Nanoscale Characterization and Fabrication Laboratory (NCFL) has continued to be a valuable resource for our researchers to push the envelope of science at the micro- and nano-scales and has also expanded its base of industrial customers. The construction of the ICTAS headquarters building on campus has been on schedule, and the re-design of the third planned building has been completed.

This TriboIndenter, used for measuring the hardness and elastic modulus of thin films and coatings, is just one of the devices used in ICTAS-sponsored research.

In the learning domain, we have expanded our support of Ph.D. students from different disciplines across campus. The first cohort of eleven ICTAS Doctoral Scholars has made strides in pursuit of doctoral studies and a few of the scholars have already been recognized for stellar research at a national level.

I continue to be impressed by the wide range of expertise of our faculty members and their willingness to collaborate. These strengths have enabled us to pull together the creativity of our faculty to form interdisciplinary teams to generate and submit proposals to large signature programs including the National Science Foundation Materials Research Science and Engineering Center (MRSEC) Program, the Engineering Frontiers Research Center (EFRC) Program, the Engineering Research Center (ERC) Program, the Science and Technology Center (STC) Program, the Integrated Graduate Education Research Training (IGERT) Program, Department of Energy (DOE) Programs, National Institute of Health (NIH), United States Department of Agriculture (USDA) and Environmental Protection Agency (EPA) Programs, to name a few. Our success in these competitions is growing as demonstrated through a recent award of a National Science Foundation Center for Environmental Implications of Nanotechnology to Virginia Tech lead Michael Hochella, partnering with Berkeley, MIT, Rice, Yale and Brown in a $10 million five year effort. I am confident that through continued collaborations and aggressive pursuit of large scale societal needs, we can establish Virginia Tech as a leader of research and a formidable force of technological transformation.

I would like to take this opportunity to welcome Dr. Chris Cornelius who joined us on May 19, 2008 as Associate Director for Research.

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DISCOVERY DOMAIN

A Melding of Minds and the ICTAS Mission

Paul Gatenholm joined Virginia Tech on a permanent basis approximately one year ago. He came to the United States from Sweden, bringing with him a mature interest and well-developed plan for continuing research in the area of healing biomaterials. Rafael Davalos came to Virginia Tech from Sandia National Laboratories about two years ago, bringing with him a keen interest and maturing plan for a program of research in the area of cellular engineering. Enter Roop Mahajan, a widely recognized researcher in his own right, who came to Virginia Tech from the University of Colorado to accept the challenge of augmenting the existing Virginia Tech research culture of primarily single or multi-disciplinary research to include growth in interdisciplinary research. Mahajan met each of these accomplished researchers on separate occasions and mentally recorded potential for the two to integrate their research and introduce a new plane of discovery. Mahajan's introduction of the two individuals to each other became the catalyst that inspired consideration of ways the two technology areas might have cross routes. Several meetings and collaborative discussions later, Gatenholm and Davalos have achieved early stage development and testing of a process approach to integrative technology that is being referred to by many in the field as "revolutionary bio fabrication."

A Powerful Enabler

One of the major limitations in tissue engineering and regenerative medicine is control of architecture and morphology of scaffolding materials. Although it has gained acceptance in practice, the use of natural and synthetic polymers as scaffolding material for regenerative medicine is far from perfected in terms of clinical translation for most tissue applications. Biofabrication of natural polymers like spider silk and bacterial cellulose has the potential to overcome the control limitations and revolutionize tissue engineering. This process is very different from traditional manufacturing processes and revolutionary in potential for application.

Cellulose nanofibril networks that are produced by bacteria Acetobacter xylinum is a biomaterial with unique biocompatibility, mechanical integrity, hydroexpansivity, and stability under a wide range of conditions. It is an ideal biomaterial because of the similarity of size of nanofibrils with collagen. The discovery that dielectrophoresis devices can be used to control motion of Acetobacter xylinum in multiple directions with simultaneous production of nanocellulose is the basis for development of a new electromagnetic controlled biofabrication process.

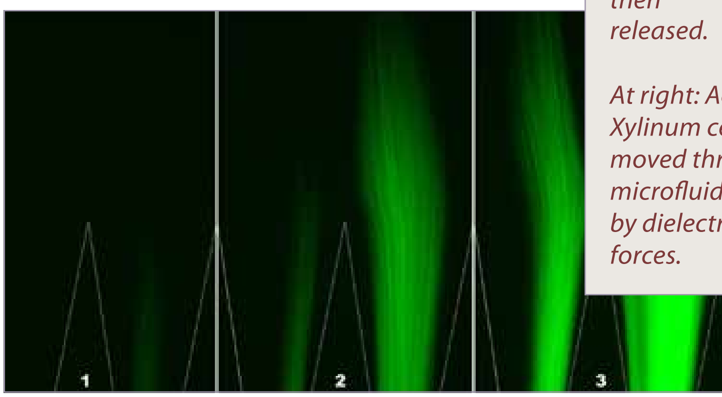
One of the attractive features of Acetobacter xylinum is that it attaches to surfaces through extruded cellulose ribbon. This behavior can be utilized to produce hollow

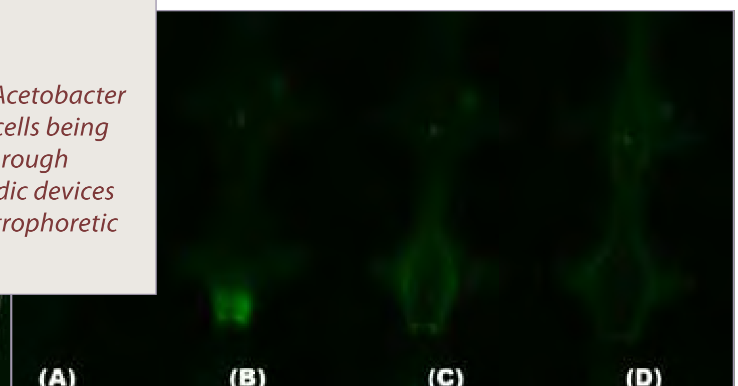
Paul Gatenholm and Rafael Davalos display a tiny spinning wheel, symbolizing their work in mircoweaving.

DISCOVERY DOMAIN

forms of bacterial cellulose. This means that bacterial cellulose can be molded into desirable shapes for a given applications, offering a three dimensional matrix of microfibrils. Recent testing of this knowledge has been to develop technology for preparation of bacterial cellulose tubes for use as vascular grafts in pigs, rats and sheep. This testing continues with substantial governmental funding in Sweden, currently in translation into preclinical trials.

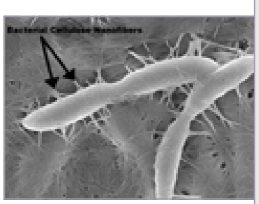
Paul Gatenholm and Rafael Davalos have achieved early stage development of a novel biofabrication process, dubbed dielectrophoretic microweaving, which allows precise control of bacterial motion. This precise control of architecture and morphology of scaffolding materials can be used to fabricate tissue scaffolds for regenerative medicine, responding directly to what was heretofore a major limitation. Dielectrophoretic microweaving could become the technology of choice for reproducible and inexpensive manufacturing of scaffolds with customizable three-dimensional architecture for clinical applications.

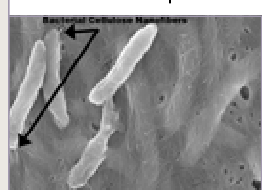




At left: Acetobacter Xylinum cells being concentrated (B) and then released.

At right: Acetobacter Xylinum cells being moved through microfluidic devices by dielectrophoretic forces.





Right and Left: Field Emission Scanning Electron Beam (FESEM) images of Acetobacter Xylinum cells on the surface of a Bacterial Cellulose (BC) scaffold. Arrows point to the cellulose nanofibers being created by the cells.

Bacterial cellulose (BC) material exhibits a unique water holding capacity which is caused by the presence of hydroxyl groups onto surfaces of cellulose fibrils. This is thought to be one of the reasons for good biocompatibility of the material. BC has also been evaluated as potential scaffold for tissue engineering of cartilage. The ability of bovine chondrocytes to attach to nanofibrils of cellulose has been verified making BCs a very attractive biocompatible material, readily formed into shapes for applications in tissue engineering.

Through research conducted by their shared graduate student, Mike Sano, the team has already demonstrated the ability to manipulate production of bacterial cellulose at the nanoscale by controlling, during cellulose deposition, the motion of the bacteria using electric fields.

The plan is to develop the technology such that the bacteria deposit cellulose during oscillatory and reversing motion in order to assemble cellulose layers into custom three-dimensional architectures. This technology can be used to demonstrate computer aided fabrication of a three-dimensional network with good mechanical properties, the ability to support a micro-scale fluid flow, and the ability to allow cells to attach.

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FACILITIES NEWS

ICTAS-CRC

Nanoscale Characterization and Fabrication Laboratory (NCFL)

The FEI Titan FE-STEM was moved from a campus location to a permanent home in the NCFL early in 2008. A technician trained specifically for operation of this equipment traveled from Charlottesville, Virginia on a part-time basis to assist with researcher needs. Ensuring the availability of trained assistance limited opportunities for scheduling use of this particular equipment. A search for a permanent technician to host the FEI Titan concluded at the end of September 2008. Although scheduling will still be required, the availability of an on-site technician is expected to improve scheduling opportunities.

Dr. William Reynolds, NCFL Director, offered a mini-course entitled “Introduction to the Nanoscale Characterization and Fabrication Laboratory” as part of the Virginia Tech Faculty Development Institute (FDI) fall series. The intent of the course is to introduce participants to the capabilities of the NCFL and offer information on how the capabilities may be integrated into planned research activities. For more information about course content, please contact Dr. Reynolds email: reynolds@vt.edu.

ICTAS

ICTAS headquarters administration, the School of Biomedical Engineering and Sciences, and eighteen exciting interdisciplinary research program areas moved into a new campus building during October 2008. The 99,411 square foot building, designed with collaboration and creative thinking in mind, will also eventually house Café X. In addition to gourmet coffee, the café will offer light fare and an environment to explore the unknown. The building address is Stanger Street and the new mail code is 0193. An opening event, including building tours, is in planning stages for Spring Semester 2009.

ICTAS-LSC

The preliminary design phase of ICTAS II (now called ICTAS-LSC) is complete. ICTAS-LSC will be constructed in the Life Sciences Corridor at the intersection of Washington Street and Duck Pond Drive. Construction is expected to begin in spring 2009.

ICTAS-NCR

As part of the overall leadership of interdisciplinary research, ICTAS is considering a plan to establish a base for VT research efforts related to the local ecology in the National Capital Region. Specifics related to this effort are in early planning stages as part of the overall Virginia Tech initiative and presence in the National Capital Region building.

Front view of the Newest ICTAS Building.

TECHNOLOGY NEWS

ADA Technologies Opens Office in Blacksburg

ADA Technologies, Inc. opened an office in the Virginia Tech Corporate Research Center (CRC) adjacent to the Virginia Tech campus in Blacksburg, Virginia in June 2008. The focus of the new office is on ADA's research and development efforts in nanotechnology, including Environmental, Health and Safety; Nanometrology; and Nanomedicine. Tom Campbell, Ph.D. and senior research scientist in charge of ADA's Nanotechnology R&D Program, is managing the new office.

"We've already been working with the CRC on many joint projects and it quickly became evident that having a more permanent presence at the CRC would be advantageous to us," said Dr. Campbell. "The office's strategic placement on the Virginia Tech campus will enable us to more closely collaborate with key players in the nanotechnology field, including Virginia Tech's prestigious Institute for Critical Technology and Applied Science."

"We welcome ADA to its new office on the Virginia Tech campus," said Roop Mahajan, Ph.D., director, Institute for Critical Technology and Applied Science (ICTAS). "I am very optimistic that collaboration between ADA and ICTAS will result in both of the organizations reaching high levels of achievement, while generating opportunities for growth in cutting-edge research and local employment."

"Establishing a new office at Virginia Tech is extremely important to the ongoing success of ADA's Nanotechnology Program," said Clifton H. Brown, Jr., ADA's president/CEO and a Virginia Tech graduate. "It's an honor to be affiliated with such a well-respected university and one with which I have such close ties and high regard."

About ADA Technologies, Inc.

ADA Technologies, Inc. is a research, development, and commercialization company that specializes in creating and converting innovative technologies to commercial successes. The firm is headquartered in Littleton, Colorado, with offices on the University of Wyoming campus in Laramie and the Virginia Tech Corporate Research Center, Blacksburg, VA. ADA has received more than 130 research grants totaling more than $40 million. ADA has received numerous honors, including: 2006 Tibbetts Award, 2006 & 2007 Colorado Technology Fast 50, 2006 & 2007 Best Companies to Work For in Colorado and Colorado's Top Technology Company 2005. **For more information, please visit www.adatech.com or call 303-792-5615.**

Director's Corner

(Continued from front page)

An accomplished researcher with more than a decade of experience with Sandia National Laboratories and industry, Chris is already a valuable asset to the institute in advancing its mission.

As we move to next year, our challenge will be to maintain the momentum we have achieved and spur growth in new areas. To this end, we have identified Complex Network Systems and Humanoid Hospital as two new areas for investment and growth. Technology continues to march at a rapid pace and we need to be vigilant and opportunistic to place Virginia Tech in a position at the forefront of emerging technologies. This is reflected in our decision to have a strong presence in the National Capital Region to network with federal agencies including NSF, DARPA, DOE, NIH and other centers of technology and innovation.

We are excited about our future and the promise it holds for making lasting contributions to society through transformative technologies. The potential is unlimited, fueled by the creativity and productivity of the minds of our greatest resource – our people.

STUDENT NEWS

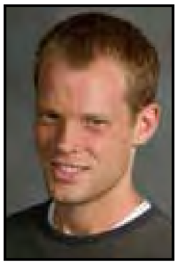
Introducing the 2008 ICTAS Doctoral Scholars

On September 3, 2008 ICTAS held a meeting and reception honoring the 2008 ICTAS Doctoral Scholars. Each of the 2007 and 2008 Doctoral Scholars were invited to participate along with advisors, department heads, associate deans and deans, the Graduate School dean, the University Provost, and select ICTAS staff.

Following a brief welcome and introduction from ICTAS Director Roop Mahajan, each scholar was offered an opportunity to speak briefly about his or her background, including academic and research interests. Light refreshments were available to participants as they informally socialized following introductions.

The ICTAS Doctoral Scholar Program is a cooperative program supported by departments, colleges, the Graduate School and ICTAS. The program was established in 2007 to honor exceptional Ph.D. applicants through award of full financial support for the Ph.D. qualifying period.

Adam Bowman



Adam is a Ph.D. candidate in the Department of Mathematics. His academic advisors are Drs. Martin Day and George Hagedorn. In 2004, Adam was awarded a B.A. in mathematics and physics, magna cum laude, from the University of Pennsylvania. In the intervening four years, he spent time interning in the Applied Sciences Program at NASA Headquarters in Washington D.C., playing music professionally in Philadelphia, and teaching physics and chemistry at a high school in his hometown of Lebanon, Virginia.

In his spare time, Adam likes to read (particularly popular science, religious philosophy, and logic), run, play tennis, and write.

Adam's current research interests are mathematical physics and financial mathematics. He is also interested in probability theory.

Mehdi Ghommem

Mehdi Ghommem is a Ph.D. candidate in the Engineering Science & Mechanics at Virginia Tech and a polyvalent engineer from Tunisia Polytechnic School. He was born and raised in Tunis Tunisia and received his high school diploma (Baccalaureat in Mathematics) in 2002 with honors, and then joined the Preparatory Engineering School of Tunis (IPEIT). After taking a national exam for entry into engineering schools, Mehdi was one of the students to enter Tunisia Polytechnic School (rank: 2/1200), EPT, the leading engineering school in Tunisia, in September 2004. EPT accepted about fifty students selected among the top 4 % of the engineering student community in Tunisia. Mehdi spent a total of 3 years (junior level, senior level and first year graduate) pursuing a multi-disciplinary intensive engineering program with a combination of courses from mechanical, civil, electrical and industrial engineering followed by a specialization in one of the following options: (1) Mechanics and Structures, (2) Signal and Systems and (3) Scientific Management. Mehdi graduated with a major in Mechanics and Structures in June 2007 (rank: 2/50).

During the academic year 2006/2007, Mehdi was also enrolled, in parallel with his engineering studies, in a Master of Science program in Computational Mechanics at EPT. This graduate program was launched in September 2003 in collaboration with the Department of Engineering Science and Mechanics of Virginia Tech and with funding from the U.S. State Department. He earned his Master degree in January 2008, and his M.Sc Thesis was entitled "Modeling and Nonlinear Dynamics of Vibrating Beam

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Microgyroscopes.” Currently, Mehdi is a Ph.D. candidate in the ESM Department under the supervision of Prof. Muhammad R. Hajj and Prof Ishwar K. Puri.

Syed Mazahir

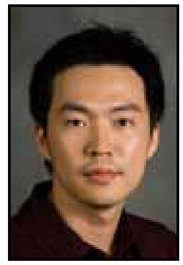
Syed is a Ph.D. candidate in the Department of Chemical Engineering and will join the department in spring semester 2009. Syed comes to Virginia Tech with a background in engineering as well as business. He started his career at a chemicals firm. As a chemical engineer there, he worked to improve the heat recovery in one of the polymer manufacturing units. He then moved on to consulting where he researched trends and technologies in various industries and analyzed complex data to make recommendations to the clients. He is currently working at a Wall Street firm where he develops the analytics of various financial and commodity derivatives traded on the Wall Street.

Syed earned his B.S. in Chemical Engineering from Indian institute of Technology, Delhi, India and Masters in Mathematics of Finance from Columbia University. His undergraduate research project involves modeling and optimization of chemical activation of biomass char and characterization of its absorptive capacity for use as an alternative to coal-based absorbents. As a summer intern at United Nations Industrial Development Organization (UNIDO), he worked on a project aimed at reducing greenhouse gases from glass industry in India, where he collected and analyzed emissions data from various glass manufacturing factories.

Syed enjoys reading and traveling. He was actively involved in dramatics while in college and acted in various plays. He has also held leadership positions in college and organized various college activities and festivals.

Suwan Myung

Suwan Myung is a Ph.D. Candidate in the department of Biological Systems Engineering in the College of Agriculture and Life Science. Suwan’s advisor is Dr. Y.-H. Percival Zhang, BSE department assistant professor.



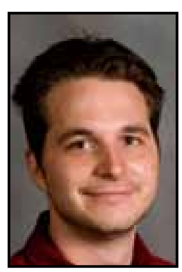
Suwan earned a B.S. in the Industrial Chemistry at the Sangmyung University in Seoul, South Korea and a M.S. in the Chemical Engineering at the Yonsei University in Seoul, South Korea. Suwan developed an enzyme immobilization method using silica-chitosan beads and preparation of composite polymer-membrane during M.S. coursework and this became her M.S. thesis topic entitled “Immobilization of Protease and Preparation of Composite Membrane for Membrane-Coupled Bioreactor.”

After achieving the M.S., Suwan entered the Membrane and Separation Research Center at the Korea Research Institute of Chemical Technology (KRICT) in South Korea. At KRICT she studied manufacturing method of water treatment membranes like reverse osmosis, nano-filtration, ultra-filtration and micro filtration membrane.

During Suwan’s spare time she enjoys playing tennis, jogging and watching baseball game and movies.

Suwan’s research interest is biomass conversion for biofuels, specifically enzymatic hydrogen production from biomass and biorefinery. Her first research project in the Ph.D. program is to clone, express and purify enzymes.

Thomas Rogers-Cotrone



Thomas grew up on a farm and was a “home-schooled” student during his entire pre-college education. In 2004, he was accepted into Virginia Tech as an undergraduate student and was awarded a B.S. degree in Animal and Poultry Sciences. He was involved in an undergraduate research project that involved investigation of the neurochemical control of feed in-take. This experience cultivated an interest in the field of neuroscience. In 2007, he was accepted into Virginia Maryland College of Veterinary Medicine as a dual degree student where he is pursuing both a DVM and a Ph.D.

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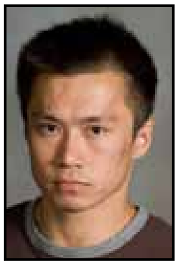
Outside of school life, Thomas enjoys being outdoors doing anything that is active, especially taking long walks around town and on-campus.

On occasions when he is forced indoors with time to spare, Thomas enjoys playing piano and woodworking.

Thomas's general research interests are in the field of neuroscience, particularly in the treatment of neurologic diseases such as Parkinson's and Alzheimer's. His graduate advisors are Drs. Marion Ehrich and Brad Klein, and his Ph.D. research focus is on the use of nanoparticles in treatment of different neurological problems (e.g. treatment of the neurotoxic effects of organophosphates).

Noppadon (Tik) Sathitsuksanoh



Tik is a Ph.D. candidate in the Biological Systems Engineering Department at Virginia Tech and is advised by Dr. Percival Zhang. Sathitsuksanoh earned his B.S. in Chemical Engineering from Thammasat University in Thailand. He earned a Masters in Chemical Engineering and Applied Economics from Auburn University under the supervision of Drs. Henry Thompson and Hyeongwoo Kim.

While pursuing a M.S. at Auburn, Sathitsuksanoh spent his spare time swimming with USMS and training with a triathalon club.

Tik's previous research experience includes synthesis of semiconductor materials, hydrogen production via reforming and characterization of catalysts/adsorbents. Sathitsuksanoh's research is currently focused on scaling-up and optimization of COSLIF pretreatment for bioethanol production.

Muyao Shen

Muyao is a Ph.D. candidate in the department of Biological Sciences at Virginia Tech. and is currently performing her first rotation in Dr. Diya Banerjee's lab. She received a B.S. in Biological Sciences from Fudan University in 2008.

Muyao's research interest is primarily the development of organisms. This interest was the primary influence that led her to choose the Cellular and Developmental Biology (CDB) group at Virginia Tech.

Muyao's hobbies include many different areas such as reading, music, painting, travelling, and playing badminton. She also enjoys chatting with people and sharing happiness with friends.

Matthew Steele-MacInnis

Matthew is a Ph.D. student in the Department of Geoscience at Virginia Tech. His academic advisor is Dr. Robert Bodnar, leader of the Fluids Research Group in the Department of Geoscience and University Distinguished Professor.

Matthew is from Newfoundland, Canada. When he is not in the lab, his interests include sea-kayaking, scuba diving, cross-country skiing and running. He also likes to set out on long-distance hiking trips, and in recent years he has hiked several thousands of miles in Newfoundland, Great Britain and the Canadian Rockies. At home, he likes to cook and to read books on history.

Matthew's research interests are diverse, including all aspects of the geochemistry and petrology of igneous and metamorphic rocks, hydrothermal systems and economic mineral deposits.

Karthik Pillai

Karthik is currently a Ph.D. candidate in the interdisciplinary Macromolecular Science and Engineering program in the Wood Science and Forest Products Dept. He comes to the United States from the southern state of Kerala in India, having grown up in the port city of Cochin. He earned his undergraduate degree in Forestry from the Kerala Agricultural University and then moved to the University of Idaho, where he received a Master of Science degree in Forest Products, with focus

STUDENT NEWS

on wood chemistry. His masters project involved the study of in-vitro differentiation of wood cells and its chemical characterization.

In his spare time Karthik listens to a lot of music. Though not a trained musician, he enjoys a wide genre of music from Indian classical to heavy metal. Reading and keeping up with current world affairs is also an interest. Recently he has become an ardent Hokie football fan, which is especially interesting considering that football was a relative unknown to Karthik until he came to Virginia Tech.

Karthik's current Ph.D. project is based on the idea of biomimetics to create composites from bio-based materials, especially lingo-cellulosics. Dr. Scott Renneckar from the Wood Science department is his major advisor and mentor in this project.

Xiaoyue (Selina) Zhang

Selina is currently a Ph.D. student in the Grado Department of Industrial and Systems Engineering. Selina earned her B.S. degree in Industrial Engineering from Tsinghua University, China. She performs research in the locomotion research laboratory under the supervision of academic advisor Dr. Thurmon Lockhart.

In her spare time, Selina enjoys playing the piano, reading and writing, and graphics design. Recently, she also got interested in Wii games, especially those gait training games showing interesting applications of the research area in which she is involved.

Selina's research interests include fall detection and prevention, ambulatory measurement, analytical techniques for gait data and human vision. She is currently exploring the application of Posturo-Locomotion-Manual Test for gait study and will take a part in a project of continuous, non-invasive gait monitoring and analysis.

Opportunity for Collaborative Interdisciplinary Research is Expanded by Move to New Campus Building

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"We are very excited about the potential for collaboration and discovery that this building offers" said Roop Mahajan, ICTAS Director since 2006.

"This amount of space, equipped with state-of-the-art equipment for interdisciplinary research purposes, is unprecedented at Virginia Tech, representing a significant investment and dedication to the growth of research at Virginia Tech. It is also important to note that this building is a collaborative effort, built by funds invested not only by the Commonwealth as one might expect, but also by individual and corporate donors."

All of this from a seed of inspiration planted in the 1990's by then Associate Dean for Research in the College of Engineering, Malcolm McPherson, in a presentation he made to the College of Engineering's Advisory Board. In response to Dr. McPherson's presentation, a feasibility study was authorized by the College of Engineering's Advisory Board. The results of the study supported initiation of development efforts and soon pledges were garnered in support of the institute.

This building is the second of three buildings planned as part of the institute. The first houses the Nanoscale Characterization and Fabrication Laboratory (NCFL) and is located in the Corporate Research Center adjacent to the Virginia Tech campus. Inaugurated during September 2007, the NCFL offers more than $10 million in highly specialized equipment and is staffed with technicians to assist researchers in manipulating materials at the smallest dimensions – down to individual atoms. The third building has just passed the preliminary design phase and will be located in the Life Sciences corridor of the main university campus, initially housing advanced laboratories in Cognition and Communication.

TECHNOLOGY FOCUS

Cognitive Radios and Cognitive Radio Networks

The Cognitive Radio (CR) Networks team led by Dr. Tamal Bose and Dr. Jeffrey Reed has assembled a network of intelligent radios able to dynamically choose the communication frequency and avoid interferers. CRs work by sensing the environment, responding to new situations and requirements, and learning from experience. The novelty of CR technology is in the reconfigurability of the system. Typically built upon software-defined radio (SDR) technology, a CR can reconfigure the radio operating parameters during run-time to adapt to the changing environment. As shown in **Figure 1**, in addition to the ability to reconfigure, CRs are also aware of their environment and have the ability to learn by retaining knowledge of current and previous settings. The primary research application for CRs is currently dynamic spectrum access applications. Spectrum congestion is a concern for both military and commercial applications. Recent studies have shown that spectrum congestion is mainly caused by inefficient use of the spectrum rather than its availability. CRs, which can dynamically change the current operating frequency after detecting another user in the same frequency band, are being targeted as the primary solution to this problem. A large amount of research is being focused on different techniques for both sensing and classifying signals in a wide variety of frequency bands. From the TV bands located in the 400 MHz, to the unlicensed UNII 5-GHz bands, CR techniques are being developed to maximum communication potential while at the same time making efficient use of the spectrum.

CR networks consist of several CRs where each observes the surrounding environment and, based on gathered information and network objectives, makes a decision on how to operate most efficiently in the networked environment. Similar to distributed computing, networks of CRs that work together improve the robustness and reliability of detecting and classifying signals. DSA is just a single application that is currently getting a lot of attention. Several other applications exist where CR technology and CR networks are promising solutions. An example is

Figure 1. *Cognitive Radios are flexible, intelligent radios capable of multiple functions.*

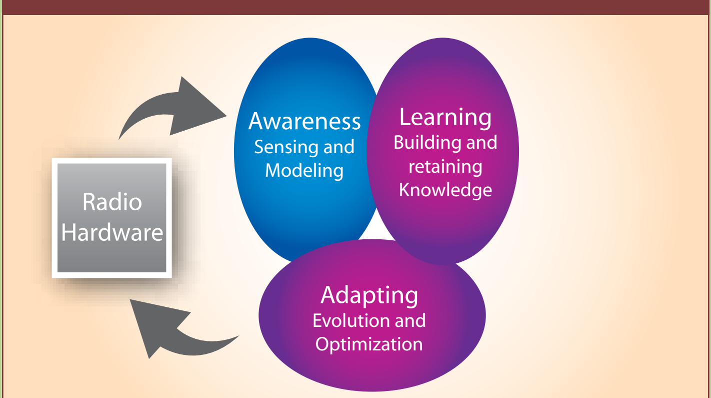
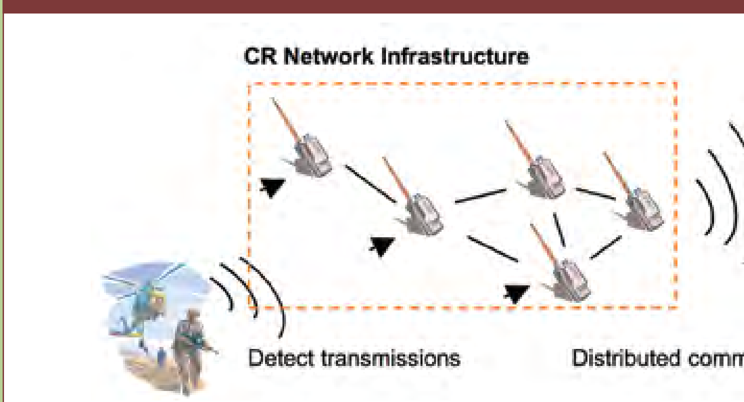


Figure 2. *Cognitive network technology is promising for many ap*



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distributed communication using CR-distributed MIMO technology. A CR network can form a multiple antenna system by using multiple CR nodes to improve system performance. These examples are illustrated in **Figure 2**. While individual CR engines and frequency spectrum techniques have begun to emerge in the past few years, CR networks are in their infancy and require a great amount of research and testing to validate their purpose. Testing new techniques on individual CRs is trivial in that only a single laptop and RF front end are needed.

The CR team at Virginia Tech, with ICTAS support, has deployed a small CR network demonstrating the ability of autonomous network convergence and dynamic spectrum sensing with five radios.

CR Network Testbed

The initial testbed provides a platform for developing testing procedures, the organization of technical teams for deployment, experimental design, practical evaluation, and rapid deployment of CR technologies. Developing this infrastructure gives us the advantage of attracting early deployment of CR-based technologies and algorithms. Future plans include increasing the size of the network to 48 nodes and deploying these cognitive nodes in the newly built ICTAS building. These nodes will be programmable via wired connections from a central control station. The control center will deploy algorithms (including physical, medium access control, and network layer protocols) to be tested on the radios. The strength of cognitive radios lies in their ability to adaptively select the appropriate frequency of operation, power transmission, modulation, and other operating parameters, according to their observed environment. The testbed will allow researchers from Virginia Tech and partner institutions to experiment with different cognitive engines, the "brain" of the CR that controls the intelligent adaptation, as well as with different adaptable parameters across the protocol stack.

To support experiments with mobility, some nodes may be mounted on tracks. Each node will consist of these basic elements: (a) a small PC and (b) a Universal Software Radio Peripheral (USRP), as shown in **Figure 3**. To provide the testbed users with the most flexible operating environment available, we have begun to develop a daughterboard based on an experimental Motorola

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pplications.

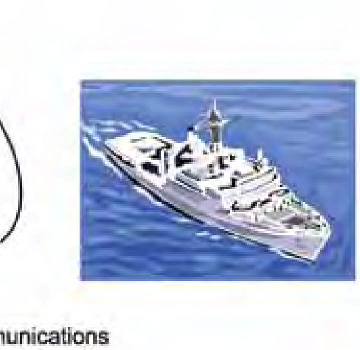

Figure 3. *A single CR node consists of a small PC and a USRP RF front end.*

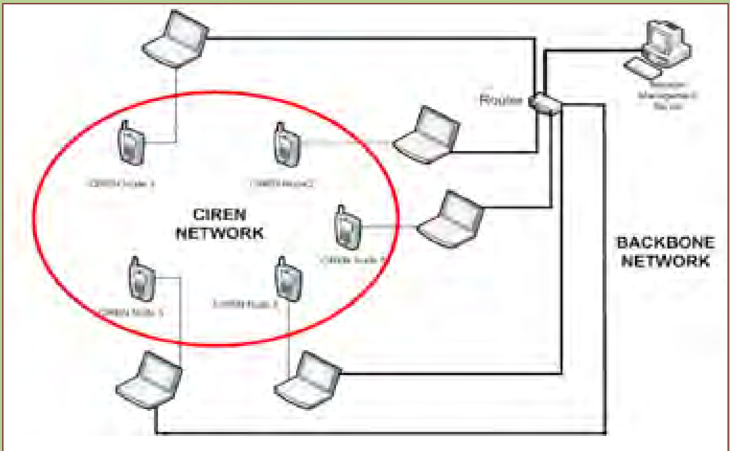

Figure 4. *Initial DSA network application has already been demonstrated on a 5-node network.*

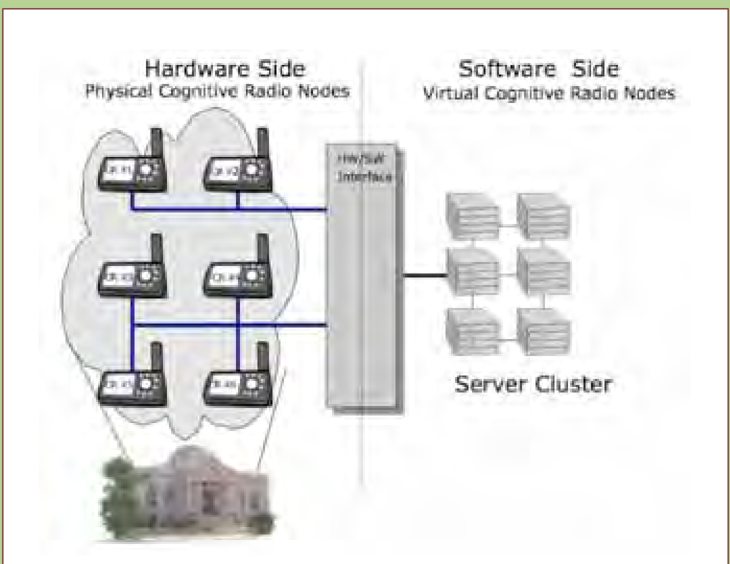

Figure 5. *Hybrid CR Network Testbed*

RF IC capable of spanning from 100 MHz to 4 GHz with a bandwidth up to 20 MHz. This gives the CR nodes flexibility in the radio frequency (RF) domain and a standard hardware interface to work with.

A key feature of the testbed is the actual deployment of the nodes throughout the new ICTAS building. The testbed will consist of 48 nodes mounted on the ceiling and distributed amongst four floors. This “real world” environment will give researchers, whose local resources may not allow for large-scale practical hardware testing, a platform on which to test their work in a real wireless network environment.

Initial stages of the testbed development have already begun. A small 5-node CR network has been built, and a DSA application, named the Cognitively Intrepid Radio Emergency Network (CIREN), has been deployed for initial demonstration. CIREN features allowing primary user detection and secondary user rendezvous have been demonstrated.

Future Plans for Large-Scale CR Network Testbed

Expanding the testbed to 48 CR nodes is Phase 1 of the testbed network. Using these 48 physical nodes, we can simulate small- to medium-scale networks and distributed spectrum-sensing applications, along with a number of different experimental wireless protocols and cognitive engines. Phase 2 involves expanding the 48-node testbed to a much larger scale, including a possible network size of up to 1 million nodes. This large-scale network is achieved not by adding additional physical nodes but by taking advantage of research being done in Virginia Tech’s Computer Science Department. Current

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research in epidemiology investigating the movement of disease through human populations uses high-powered computing clusters to simulate a large population and the dynamic interaction between population movement and the disease spreading. This work can be leveraged to simulate CR nodes instead of human populations. This collaboration would enable a CR testbed that can simulate nationwide applications. Such large-scale applications may include spectrum policy research, where nationwide spectrum use and the policy needed to create efficient use of the spectrum on a wide scale can be investigated. This type of large-scale CR network testbed has yet to be realized by any other organization to date, giving Virginia Tech an opportunity to do groundbreaking work in CR networking.

For the large-scale network testbed to be realized, several research objectives must be investigated. Initially, adapting the current epidemiology virtual nodes to implement virtual CR nodes must be done. The major research issue is how a CR node can be emulated in such a way that is not too complex yet encapsulates the essence of a CR. In parallel, an interface between the 48-node physical network and the virtual CR nodes, allowing information to pass between the two major components, needs to be developed. The hybrid system shown in Figure 5 gives a high-level visual representation of the infrastructure.

The CR team seeks to develop a revolutionary flexible research testbed that can be used for small-, medium-, or large-scale CR network research. In addition to providing a new research testbed for work done at Virginia Tech, we also see this testbed as a community resource. We will develop a community web interface for the hybrid network that will allow various outside researchers to load cognitive engines and network policies onto the radio nodes and to self allocate a number of virtual nodes for their simulations. In this way, this testbed, made possible by ICTAS support, will likely become a well-used community research resource that will greatly impact CR network research.

A Melding of Minds and the ICTAS Mission

(continued from page 5)

The further development of the dielectrophoretic microweaving process will enable fabrication of three-dimensional networks of cellulose nanofibrils for tissue scaffolds to be used in regenerative medicine. The experience and innovation of these two researchers and their contagious enthusiasm for refining the new process they have created is ideally suited to the task of overcoming major limitations with tissue engineered organs and is also representative of the types of partnerships that ICTAS was created to foster.

Virginia Tech and Wake Forest (Principal Investigator Dr. Paul Gatenholm, VT, Co-PI Dr. Rafael Davalos, VT, Co-PI Dr. Joel Berry, WF) recently partnered in a proposal submission to the National Institutes of Health entitled, "Dielectrophoretic Microweaving – Biofabrication of Tissue Scaffolds with Customizable 3D Architecture" requesting support of $1.8 Million to continue development of this unique process.

ICTAS SPRING SEMINAR SERIES

ICTAS offers knowledgable speakers with current topics of concern to the research community in the latest seminar series, coming in the spring of 2009.

Watch Connection for updates, or stay up-to-the-minute with updates at www.ictas.vt.edu.




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Cornelius named Associate Director for Research

Christopher Cornelius joined ICTAS May 19, 2008 as the Associate Director for Research. Cornelius serves as chief technical officer and advisor to the Institute's Director, Roop Mahajan, and shares with him responsibilities for technical administration, setting strategic directions and allocating resources on behalf of the Institute. He also continues as an active researcher in synthetics and materials.

Cornelius comes to Virginia Tech from Sandia National Laboratories (SNL), a National Laboratory operated for the U. S. Department of Energy by Sandia Corporation. During his eight year tenure with SNL, Cornelius achieved recognition and respect in both the industry and academic communities for excellence in technically diverse rigorous research and publications, teaching, and mentoring of post-doctorate, graduate and undergraduate students.

"We are extremely pleased to welcome Chris Cornelius to the Institute," said Mahajan. "Chris will play a key role in leading and managing the institute including the very important role of nurturing the collaborative culture through team leadership. I believe we are fortunate to have attracted Chris at a time when he has made a decision to redirect his career strategy toward academia. The unique combination of a rigorous research program, strong interests in collaborative research, and a desire to share the joy of research while contributing to a student's professional growth and career interests are a perfect fit for our institute and our long term strategy for research growth at Virginia Tech." He added, "Chris's connections with industry, national laboratories and faculty colleagues will enhance our global perspective, providing invaluable exposure and dimension to our programs."

Cornelius

"I'm excited to join Virginia Tech as a researcher and to share in the vision of ICTAS. I'm looking forward to contributing to the development of the Institute's imprint in science for many years to come," Cornelius said.

__Chris Cornelius__ can be reached by phone at (540)-231-6015 or by email at chcornel@vt.edu.

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