ICTAS Connection

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

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Reunion

by **Ivica Ico Bukvic** | **Assistant Professor, Music, and Director of the DISIS Interactive Sound & Intermedia Studio** | **540-231-6139** | *ico@vt.edu*

Judging from my background, I am sure many will perceive the following contribution as a genuine outlier to the ICTAS ecosystem. Those who frequent the ICTAS building may recognize my name as one of the authors of the *Nupuy* interactive aural installation that greets residents and visitors alike. Being primarily an artist, when I was approached to write this essay, I felt both excited and honored to have been given such an opportunity. And then, I was given the theme: science meets art.

Seeking inspiration, I kept repeating this statement in my head, struggling to put my thoughts in writing, until I came to realize that we live in a society in which the arts have been artificially separated from the sciences with such surgical precision we now have to make a genuine effort towards joining them back together. And the more I thought about this, I realized that the arts in an ideal world do not need to meet the sciences because they are already one and the same.

This concept of treating the arts and sciences as one is nothing new. As far back as the 11th century, we've had education that thrived upon the notions of Trivium and Quadrivium, placing music next to geometry, arithmetic, and astronomy. More so, all thinking arts at the time were considered liberal arts, which would by definition place computer science and many other allied disciplines under the same category as the arts of today. How and where we lost this integrative approach is something that is not quite clear to me. What however seems clear is that society as a whole is likely to lose more than it will ever gain from the separation of the arts and sciences. This is particularly apparent in education with initiatives such as STEM (science, technology, engineering, and mathematics) that continually fail to acknowledge the importance of the arts. That is not to say there are no efforts underway to counter this unfortunate trend. The upcoming Center for the Arts at Virginia Tech and the very opportunity to share my reflections through this ICTAS newsletter are but a few of the growing number of initiatives the Virginia Tech

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INSIDE

VirginiaTech
Invent the Future®

Emerging Technologies Thrust

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Looking back, at the beginning of the 20th century, the country was just beginning to be electrified, radio and telephone were novel gadgets, TV and computers did not exist, and the average human life span in the United States was only 46 years. Much of society's transformation since then has come about through the unparalleled technological breakthroughs powered by science and engineering. One could argue that in the last century mankind has seen more change than at any point in history. However, if the early years of the 21st century are any indicator, we can expect large unprecedented and fast-paced change made possible once again by the confluence of powerful technologies.

In a landmark report sponsored by the National Science Foundation and the Department of Commerce, Roco and Bainbridge [i] presented a consensus view among leading experts from government, academia, and the private sector that four powerful "converging" technologies–nanotechnology, biotechnology, information technology, and cognitive science–are poised to unleash new understandings of matter at the atomic scale, as well as of the complex workings of the human brain, creating opportunities for new industries and enhanced human capabilities. After careful deliberations, we selected these four converging technologies, anchored by the principles of sustainability, to guide ICTAS research, as reflected by seven of the eight thrust areas: Nanoscale Science and Engineering, Nano-bio Interface, Cognition and Communication, Sustainable Energy, Sustainable Water, Renewable Materials, and National Security. However, recognizing that we live in exponential times where new technologies with the potential for a transformative impact on society emerge fast and furiously, we have added Emerging Technologies as the latest of our thrust areas, with the goal of being ahead of the curve in developing and promoting such technologies. For example, in a recent *Wall Street Journal* op-ed, Mills and Ottino [ii] name pervasive wireless communication, big data, and smart (additive) manufacturing as three major emerging technologies. As featured in later sections of this issue of *Connection*, all three technologies have become part of our Emerging Technologies thrust.

We also recognize that the above list is by no means comprehensive and is likely to miss as-yet unidentified technologies which may have an extreme future impact–the so-called Black Swans, as defined by *New York Times* best-selling author Nassim Nicholas Taleb in his book *The Black Swan*. Taleb cites three recently implemented technologies that greatly impact our world today–the computer, the Internet, and the laser–and notes that all three were unplanned, unpredicted, and unappreciated upon their discovery, and remained underappreciated well after their initial use.

The ICTAS Emerging Technologies thrust area, therefore, has been designed to create an environment and a breeding ground for future Black Swans–an environment in which engineers, scientists, and humanists from different disciplines can come together to move beyond the predictable and incremental advances in current technologies to the transformative science and technology of the future. Even though these technologies are in the early stages of their development, they have the potential to become either a significant component of one of the eight established ICTAS thrusts or to gain status as a new thrust. One of the mechanisms that we deploy to identify the next Black Swan is to hold a monthly "Black Swan Seminar," where engineers, scientists, and humanists can come together to identify and explore future disruptive transformative technologies.

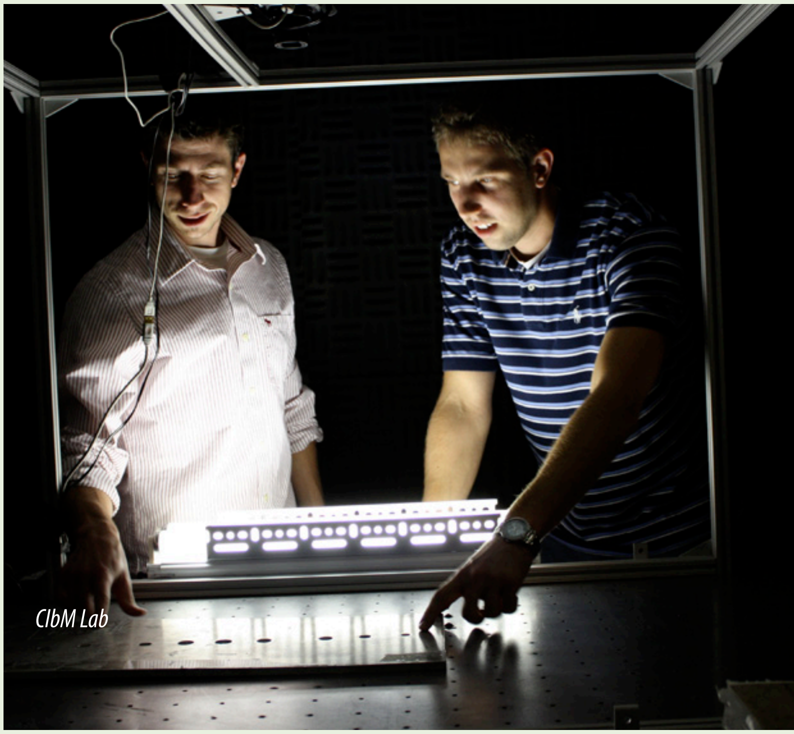
Appropriately, the seminar series is held in ICTAS's Cafe X where a free-flowing and unencumbered exploration of "X," the unknown, is the expectation. Facilitated by a researcher, a seminar generally focuses on a broad field of inquiry and is triggered by the question, "What technology/innovation idea will transform your field in 7 years?" Or, by a more in-your-face question, "What advances in your field will make you unemployable/irrelevant in 7 years?" Participants are generally spared the tyranny of the PowerPoint. Instead, visuals, conceptual images of the future, artifacts, and even scribbled notes on napkins are the norm. Sessions typically hatch a few cygnets which then are nurtured with the hope that one or more will develop into the next transformative technology. These seminars are open to all who want to innovate and stay ahead of the times.

In addition to the ICTAS Emerging Technologies thrust, this newsletter

also covers the Occupational Safety & Health Research Center and the ways in which this center discovers and disseminates innovative ways to separate humans from occupational hazards.

Enjoy reading about recent advances in emerging technologies research at ICTAS, and contact us if you would like to explore and invent the future with us.

[i] Roco, M., and Bainbridge, W., 2002, *Converging Technologies for Improving Human Performance,* National Science Foundation / Department of Commerce-sponsored report. [ii] Mills, M., and Ottino, J., January 30, 2012, "The Coming Tech-led Boom," *Wall Street Journal.*



CIbM Lab

Emerging Technologies Research Groups

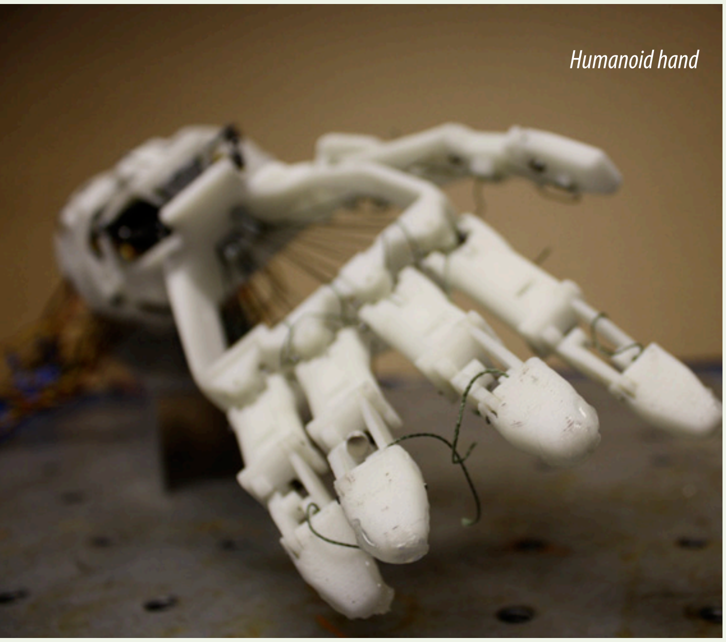
Innovation-based Manufacturing. This research area falls within the auspices of the Center for Innovation-based Manufacturing which is focused on the development of new innovation methodologies and related application to challenging manufacturability problems across multiple areas such as renewable energies, micro- and nano-manufacturing, and medical devices. The specific efforts for Innovation-based Manufacturing within the Emerging Technologies Thrust are devoted to defining manufacturing concepts of the future.

Discovery Analytics. At ICTAS, the Discovery Analytics Center brings together faculty from multiple domains across the sciences, engineering, and humanities who tackle knowledge discovery involving exabyte-scale problem domains or the "big data rush."

One emerging area in big data is social media analytics. Modern communication forms such as social media and microblogs are fueling new data-driven methods by which we can comprehend and influence the progression of events. Researchers are turning to micro-blogging as a strategy for predicting elections, stock markets, box office returns, and populist uprisings.

A second area benefiting from data analytics methods is intelligence analysis. One emerging trend is to use open-source data to capture population-level changes in communication patterns and content and to use such trends to generate alerts about social, economic, and political phenomena. Data analytics methods are being integrated with model-based approaches to create entire systems for predicting strife, social unrest, and events such as the Arab Spring.

A third example of big data in action is the unprecedented push to incorporate information technology into healthcare. The current challenge is to harmonize diverse collections of data and analyze them with methods that allow extracting new, nontrivial, and nonobvious knowledge about patient(s), condition(s), and even entire healthcare establishments. Electronic medical record data mining can lead to delivering quality healthcare at significant (one-third) cost savings.



Humanoid hand

Humanoid Hospital. A world-class, state-of-the-art training and simulation facility is now being developed. The Humanoid Hospital will consist of fully functional human-like patients (robots) tailored to mimic any specific or combined state of the healthy/diseased body. The hospital will serve as a training facility for students, nurses, and doctors, and also as a fertile environment for scientists and physicians to conduct research on various aspects of engineering, computer science, psychology, physiology, pathology, diagnosis, treatment, and tissue engineering.

Humanoid face

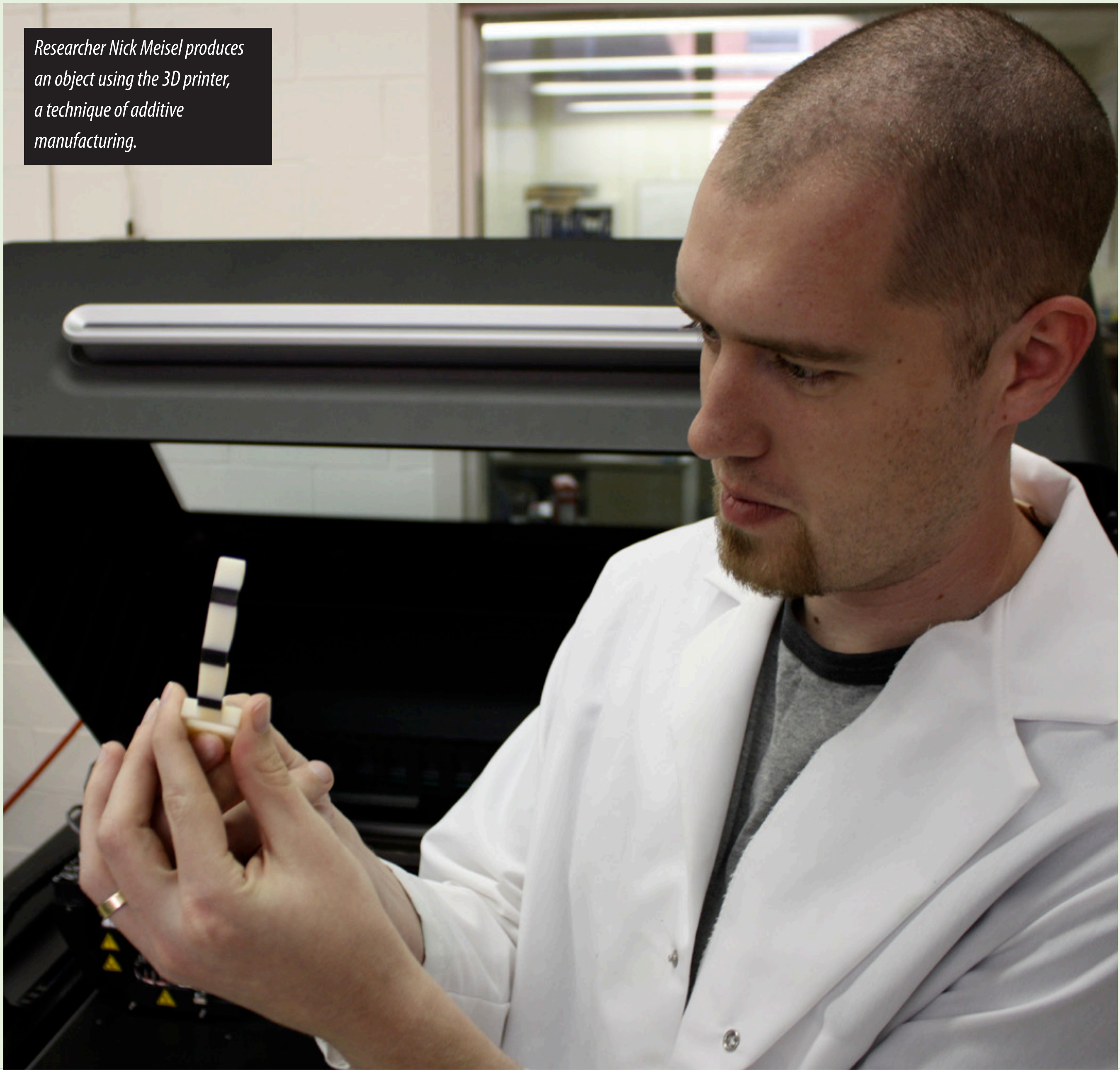
Micro/Nano-Satellite Systems. A major transformation is occurring in space and atmospheric science. The prior paradigm of occasional, single, large satellite missions to explore geospace is being enhanced by the emergence of small, rapidly developed Micro/Nano-Satellite Systems. An important class of these small satellite systems is the CubeSat. CubeSats have a size of roughly 10-30 x 10 x 10 cm. As many as 100 CubeSats can be launched from a single launch vehicle. From such a fleet of spacecraft, high spatial and temporal observations over a large region can be obtained. This allows for important new sampling and observation opportunities, for example, the first ever simultaneous sampling of the entire ozone layer or magnetosphere. Alternatively, Micro/Nano-Satellite Systems can be used for rapidly developed, focused science or technology development applications. In such a case, there are numerous opportunities to fly Micro/Nano-Satellite Systems as a secondary payload.

Additive Manufacturing (AM). The AM interdisciplinary research group has on-going research in fabricating geometrically complex objects in a layer-by-layer fashion from novel materials including metals, ceramics, biomaterials, and nanomaterials. 3D Printing of nanomaterials has been a core focus of this group and has resulted in the production of novel quantum dot nanocomposites.

Bio-Inspired Science and Technology (BIST). BIST is envisioned to provide leadership in ideas for bioinspiration and to define directions for turning it into a mature science and engineering discipline. Specific scientific goals are the development and application of novel, objective, and formalized methods to describe biodiversity in biological form and function, as well as their linkage. The goals of this research are to make the "design principles" implicit in the outcomes of evolutionary diversification accessible to engineering; to reproduce or borrow from the principles of biological form and function for engineering use; and to devise nonlinear disruptive customized/adaptive technology based on biodiversity.

Pervasive Wireless Communication. Wireless technologies are becoming prolific. Even in developing nations, the most sophisticated wireless systems are deployed, enabling rapid changes of economic and social status of traditionally underdeveloped regions. In regions that have historical low levels of education and training, wireless technology has permeated. For example, new applications such as wireless banking have circumvented corruption in many regions, including Afghanistan, to allow for loans and payments to be made safely and securely. Some emerging applications made possible by emerging wireless technologies include: telemedicine and healthcare monitoring, remote education, public safety monitoring and data management, micro loans and banking, and distributed markets for agricultural goods. In addition, a new area called machine to machine (M2M) communications has begun to emerge and is bringing with it new applications such as environmental sensing, including the sensing of pathogens and water quality, sensors for agricultural management and soil evaluation, energy and transportation management, and device and infrastructure maintenance.

The social ramifications of this technology are immense, changing semiskilled or unskilled laborers into skilled laborers able to perform complex tasks by calling on the intuitive interface made possible by high-speed wireless data. It is also a technology that can speed the adoption of wireless, as well as improve the productivity factor of those with limited training and education.



Researcher Nick Meisel produces an object using the 3D printer, a technique of additive manufacturing.

Research Building Certified Gold by U.S. Green Building Council

Virginia Tech's Institute for Critical Technology and Applied Science has been awarded a Leadership in Energy and Environmental Design Gold certification for its ICTAS II building. The certification is established by the U.S. Green Building Council and verified by the Green Building Certification Institute and is the nation's pre-eminent program for the design, construction, and operation of high-performance green buildings.

This is Virginia Tech's first research building to be awarded the Gold certification and only the second building on campus to achieve Gold certification. The Henderson Hall Renovation and Theatre 101 project received Gold certification in 2010.

"This state-of-the-art research laboratory building is an excellent example of what can be achieved when an owner, such as Virginia Tech, a design firm, SmithGroup, and a construction manager, Skanska USA, work together over the life of a project," said Joe Hoeflein, Capital Project Manager for the university's design and construction services in the Department of Facilities Services. "Our team was recognized for using the latest in technology and innovations to build an amazing work place. It truly exceeded our high expectations as well as those of the institute staff."

"I am proud of the team effort that made this prestigious certification possible," said Roop Mahajan, Director of the Institute for Critical Technology and Applied Science. "This award carries a special significance since the building was designed for conducting leading-edge research for a sustainable future. Our talented researchers will find this high-performance green building to be conducive to creative research and experiments in a broad range of research areas including environmental biochemistry and pathogen ecology, nanostructures and nanobiology, bioinspired science and technology, and humanoid hospital."

"Buildings are a prime example of how human systems integrate with natural systems," said Rick Fedrizzi, President, Chief Executive, and Founding Chairman of the U.S. Green Building Council. "The ICTAS II building project efficiently uses our natural resources and makes an immediate, positive impact on our planet, which will tremendously benefit future generations to come."

"As one of the nation's leading technological universities, we firmly believe that we must incorporate the emerging green building technologies in our own construction efforts," said Richard C. Benson, Dean of the College of Engineering at Virginia Tech, and Chair of the institute's Shareholder Committee. "Due to our concern for the well-being of the occupants of the building as well as the need to reduce overall energy costs, we are focused on providing the Commonwealth with long-term savings in our environmentally friendly building programs."

"The ICTAS II building incorporates traditional Hokie Stone and pointed arches and an interior notable in the extensive use of recycled wood products and exposed fittings," said Mahajan. The building opened in January 2011. A LEED Recognition ceremony was held at ICTAS II on April 19.

VT President Charles Steger and ICTAS Director Roop Mahajan unveil the LEED™ plaque at the April 19 ceremony.

VT President Charles Steger and ICTAS Director Roop Mahajan unveil the LEED™ plaque, while Sherwood Wilson, VT Vice President for Administrative Services; Alan Grant, Dean, College of Agriculture and Life Sciences and ICTAS Stakeholder; Paul Winistorfer, Dean, College of Natural Resources and Environment and ICTAS Stakeholder; and Bill Claus, President, Sustainable Blacksburg, look on.

Denny Cochrane, VT Sustainability Program Manager, speaks with Sherwood Wilson, VT Vice President for Administrative Services, prior to the unveiling ceremony.

Dr. Amy Pruden-Bagchi, Associate Professor in Civil and Environmental Engineering, describes the research being conducted at ICTAS II.

Reunion *continued from front page*

community is currently undertaking to facilitate seamless reintegration of the arts and sciences. Yet, such efforts are still by and large islands of hope rather than a part of a prevalent change.

The good news is Virginia Tech is not alone in this. In the corporate world, perhaps the best example of such an island where the arts have never left the sciences is the unprecedented comeback of the Apple computer company and its late visionary Steve Jobs. From the development of system APIs (application programming interface), to beautifully designed and well-thought-out tools, Apple's products in many ways serve as an epitome of not only what a product should look like, but also what a successful company should be like. Unlike the early missteps of Microsoft that were always catering towards greatest profit and thus the most common denominator in terms of its target audience, Apple's systems are designed from the ground up to satisfy the needs of the most demanding populations, the logic being if one caters to the demanding outliers, then the system should more than cover the modest needs of the average user. As a sound artist, one of my great concerns in the computer world is a system's ability to deliver low-latency audio. I seek sub-10-millisecond turnaround between the moments when sound enters and exits the system. For the longest time, Microsoft's Windows family of operating systems was simply incapable of producing stable latencies below 100 milliseconds until a third-party vendor partially solved the problem by requiring a custom driver and a dedicated hardware. Compare that to an OSX and iOS that transparently deliver impeccable out-of-the-box audio latencies across a wide array of computing devices that not only provide for a more satisfying and potentially productive environment but also serve as a great platform for exposing society to the importance of sound,

and it is not hard to guess why Apple became so successful in the music industry. In the **Linux Laptop Orchestra** or L2Ork, we have to use custom-built Linux notebooks that run custom real-time-enabled kernels, and thus provide just as impressive a low-audio latency, even on a low-power hardware such as the Intel Atom processor. Given Steve Jobs' background, I would argue that one can never envision these kinds of design models without having been exposed to the power of the arts. Ultimately, while the system, or the resulting latency, is not designed as an art piece, it in many ways reflects the profound impact potential of the arts–as a catalyst for the overall improvement of the quality of life, as well as a thought-provoking artifact.

Being an artist also means accepting failure as a common and welcomed opportunity for long-term growth. Apple has certainly had its fair share of flops. But even when their product faltered (as was the case with the notorious Cube), the artful clarity and means of delivering content to its users has generated a cult following that continues to eclipse any wrong turn or market downturn. One simply cannot deny that our eyes and ears can clearly recognize and distinguish aesthetic preference for the well-thought-out artifacts whose designs are indebted to an army of artists and designers.

So, the role of the arts is not only to enhance the quality of living by complementing social gatherings and architectural spaces with soothing music, dance, theatre, décor, paintings, or sculptures. Its role is also to encourage society to question things they might be taking for granted. Thus, perhaps the defining boundary between the arts and entertainment is also an invaluable asset that can help shape the world and the way we interact with it. Throughout the centuries, music has had a profound impact on things that hardly have much to do with music itself. Shostakovich's fifth symphony written under a fear-filled Stalin's regime, despite the composer's best attempts at hiding his own fear, exhibits many traits that help us decipher struggles he may have endured while composing the symphony. Here music helps us paint a historical image like a carbon-dating technique, providing an insight into Shostakovich's struggles that have etched themselves like fossils into the very fabric of a glorious symphonic work.

With this newfound revelation, I return to the ICTAS-commissioned work *Nupuy* (above) I co-authored with sculptor and Virginia Tech Professor Steve Bickley. Envisioning the art piece as an artifact, information resource, and intellectual catalyst, we created *Nupuy* to in many ways embody the forward-looking explorative character of ICTAS. Unlike traditional information kiosks, its content is an ever-evolving aural fabric that has no traditional visual cues. It encourages visitors to perceive embedded information through exploration of the physical, sound, and space. I wanted to challenge the audience to rely upon sensory input not commonly associated with this context and to encourage their re-evaluation as well as cross-pollination with physical shape and gesture of Bickley's sculpture. In my mind, *Nupuy* with its technological backend provides for a seamless integration between the arts and sciences. It is designed to challenge audiences by questioning the ways we digest information as well as the very purpose and meaning of art.

Nelson Rockefeller once said that "art is not necessary. It is merely indispensable." Art is here to stay. It is what makes us human. Let us forget about the occasional rendezvous and work instead together towards a permanent reunion of the long-lost siblings: art and science.

Ivica Ico Bukvic, D.M.A., is a composer, intermedia sculptor, researcher, and performer. His creations draw upon synergies among aural and visual, acoustic and electronic, and interactive works and installations, while his research focuses on scientific exploration of pragmatic and artistic potential of new multimedia technologies in a pursuit of the overall betterment of quality of life. His ostensibly eclectic creations and research vectors are tied together by ubiquitous interactivity. He is currently working at Virginia Tech as an assistant professor in music composition and technology. Bukvic is founder and director of the new Digital Interactive Sound and Intermedia Studio and the world's first Linux Laptop Orchestra, co-director and faculty in the new Collaborative for Creative Technologies in the Arts and Design interdisciplinary program (as the first artist faculty member of the Virginia Tech Center for Human-Computer Interaction), and a faculty member (by courtesy) in the departments of Computer Science and of Art and Art History. Unless all this tongue-twisting verbiage has already put you to sleep, please feel free to investigate some of his creations and/or services at *http://ico.music.vt.edu*.

Biodiversity in Bioinspired Science and Technology

by Rolf Müller | Associate Professor, Mechanical Engineering, and PI for ICTAS Bio-Inspired Science and Technology (BIST) Laboratory | *rolf.mueller@vt.edu*

Bioinspired Technology

Despite centuries of technological progress and incessant optimization of engineering designs, biological organisms still continue to outperform their man-made peers in many—but not all—respects. Furthermore, many of the skills in which biological systems excel are critical to key societal needs that call for the development of smarter, more adaptive, and sustainable technologies.

Engineers have long recognized that biological systems can be a valuable source of inspiration for technological innovation. Entire engineering fields such as aviation may never have gotten off the ground without biological systems that proved the feasibility of the endeavor and provided directions early on. Some bioinspired inventions, such as Velcro, have established themselves firmly in our daily life.

The tremendous engineering potential of biological systems largely stems from the process of evolution. Evolution can be regarded as a gargantuan optimization process that operates on a time scale of billions of years and evaluates many millions of designs (biological species) through an astronomical number of prototypes (individuals) under the full complexities of the real world. Although biological evolution follows its own rules, there are many cases in which skills that impact the survival of an organism also have important uses in engineering.

Although evolution has long established itself as the core unifying principle of the life sciences, bioinspired engineering rarely considers the evolutionary relationships between organisms as a guiding principle. Instead, discoveries in bioinspiration are usually derived from isolated case studies.

Biodiversity

One conspicuous result of evolution is a bewildering diversity of life forms. However, a large portion of the species that make up this diversity are not randomly scattered across the tree of life. Instead, they fall into large groups of closely related species. These groups are not often outcomes of a process call "adaptive radiation." In adaptive radiation, a set of functional principles that was present in a common ancestor species already has been varied and adapted to suite the requirements of different ecological niches.

Figure 1. *Example of adaptive radiation in bats.*

Adaptive radiation could hold a key to transforming bioinspired engineering science from a "hunter-gatherer discipline" to a mature engineering science: Instead of analyzing individual unrelated case studies and hoping for gifts of serendipity, a biodiversity-level analysis could allow the discovery of design principles. Such principles could be used to search for bioinspired solutions in a systematic fashion. Objective methods for mining engineering knowledge from the diversity in biological function could transform the course of bioinspired research.

Besides the discovery of new bioinspired principles for engineering, understanding how one principle could be adapted to many different uses could have just as powerful implications for the development of bioinspired engineering. The dazzling diversity of life is a vivid illustration of how effective evolutionary processes are when it comes to adapting to different circumstances. If some of this natural propensity for adaptation could be introduced to the development of novel technology, engineering would be empowered to address the technological challenges of an ever-changing world.

ICTAS BIST

The ICTAS Bio-Inspired Science and Technology (BIST) Laboratory conducts research that seeks to introduce a biodiversity-level perspective to bioinspired engineering science. To this end, it studies biological model systems which exemplify the impact of diversity on biological function. Based on the study of these model systems, BIST also seeks to develop objective methods for the engineering analysis of biological function across large and diverse sets of species.

Founded in 2011, BIST is working to establish itself as a hub to make digital qualitative data on biological function available to engineering research at Virginia Tech. In order to give bioinspired engineering science at Virginia Tech a competitive edge in taking advantage of biodiversity, the lab has established a collaboration with the Smithsonian's National Museum of Natural History in Washington, D.C. The National Museum of Natural History is home to one of the world's most extensive archives of biodiversity. Its extensive research collections with a total of about 124 million items are now open to Virginia Tech researchers, and BIST is actively working on ways in which museum specimens can be digitized and analyzed.

A second source of data on biological function from living animals is the Shandong University – Virginia Tech International Laboratory in Jinan, China, that operates as a "twin" of BIST on the eastern hemisphere. Through close collaboration with the International Laboratory, BIST researchers have access to animals from China's significant share of the world's biodiversity as well as to experimental facilities that allow a quantitative engineering analysis of biological function in these organisms.

Graduate Work

The BIST lab and its two graduate students, Anupam Gupta and Philip Caspers, have partnered with the Smithsonian to gain access to its rich archives in fluid-preserved bats that equal about 90% of the world's total known species of bats. With ICTAS's support, the BIST lab has a state-of-the-art microCT machine with which the graduate students have developed high-quality 3D surface models of bats for future engineering analysis. With these two resources, the BIST lab is in a unique position to become a center for bioinspired engineering analysis using the biological resources of the Smithsonian.

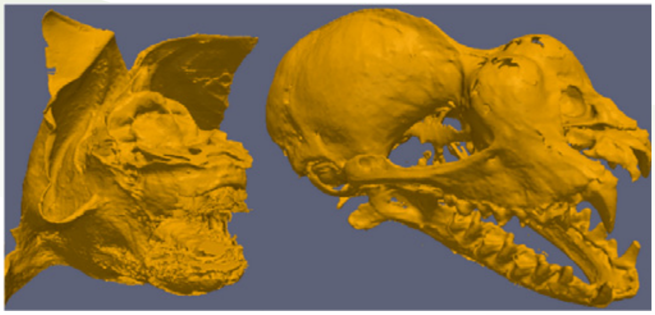


Figure 2. *Example surface models of skull and head of Hipposideros wollastoni.*

One hurdle to overcome in unlocking the fluid-preserved specimens is the presence of preservation artifacts in the fine thin-tissue structures of the bat's ears and noseleaf. For over 130 years, curators at the Smithsonian's National Museum of Natural History have collected and preserved in high-concentration solutions of alcohol and formeleyne thousands of bat species with fine tissue structures. However, over the course of many years, these fine tissue structures deformed and no longer represent their true life-like shape which is critical for further engineering analysis.

Figure 3.
Smithsonian fluid-preserved specimen exhibiting typical deformations.

As the specimens are national treasures and belong to the Smithsonian, manipulation of the tissue structures can cause damage to the specimen itself. Consequently, graduate students in the BIST lab are focusing on developing a method to digitally reverse the deformation artifacts in the pinnae and noseleafs of bats. Current work in the BIST lab is focused on developing a realist material model for the bat pinnae for reversing artifacts and methods to automatically classify and identify unnatural artifacts in the shape of pinnae and noseleaves. Graduate students have additionally partnered with experts in computer graphics and material modeling to achieve this goal.

This research holds exciting potential for bioinspired engineering in the future. All over the world, museums have preserved collections sometimes unusable in their current state. Digital reversal of morphological changes in the structure of the model system has the potential to unlock a vast untapped resource for engineering.

Dr. Jaime Camelio, Director, Center for Innovation-based Manufacturing

by **Corey B. Niziolek** | **Program Manager for the Center for Innovation-based Manufacturing**

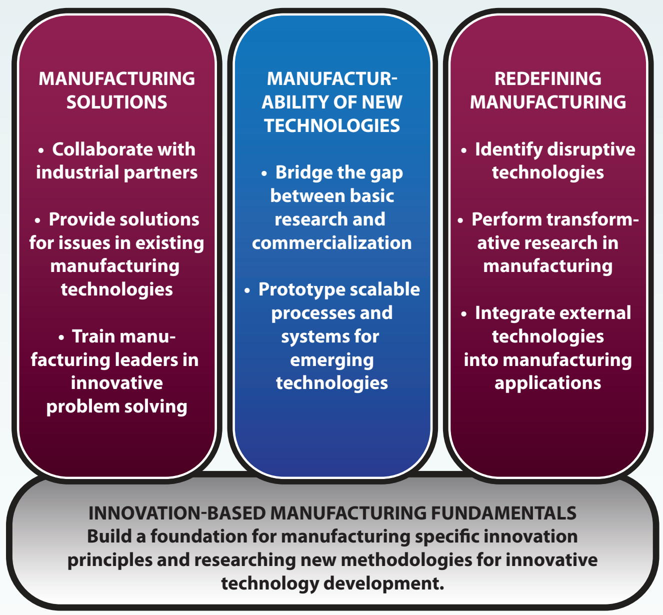
Dr. Jaime Camelio, an Assistant Professor in Virginia Tech's Department of Industrial and Systems Engineering, works to increase awareness of and education in entrepreneurship, innovation, and technology transfer.

Dr. Camelio serves as Virginia Tech Director of Manufacturing Systems for the Commonwealth Center for Advanced Manufacturing, a collaborative research center that sets the direction of future technology developments for advanced manufacturing applications in surface engineering and manufacturing systems. Commonwealth Centers are unique research collaborations between Virginia's leading engineering universities, the Commonwealth of Virginia, and global industrial partners. The Commonwealth Center for Advanced Manufacturing is a partnership between Virginia Tech, the University of Virginia, Virginia State University, and several global industrial corporations aimed at accelerating the transfer of laboratory innovations to manufacturing processes. Current research projects lie in Performance-based Process Monitoring for Rolls Royce, Multi-modal Part Inspection for Canon, and Adaptive Manufacturing for Sandvick Coromant.

Through his involvement with the Virginia Tech Center for High Performance Manufacturing (CHPM), Dr. Camelio has significant involvement with the Western Virginia Transportation Equipment Manufacturers Competitiveness Initiative. Dr. Camelio's current work in this center includes Asset Recovery/Capacity Modeling for Volvo Trucks and Performance Analysis of Aluminum Side Rails for Metalsa Roanoke, Inc. CHPM was established to conduct research, to develop tools and technologies, and to provide technical assistance that will help manufacturing firms become high-performance manufacturers.

CIbM Overview

Dr. Camelio serves as director for the ICTAS Center for Innovation-based Manufacturing (CIbM), a multidisciplinary center formed to solve current manufacturing issues and to help the university commercialize new technologies. The center's innovation-based manufacturing goal is to boost the commercialization potential of basic research constrained by the lack of adequate processes and systems and to provide new tools that improve current processes. CIbM actively works to define both manufacturing of the future as well as the future of manufacturing. To achieve its goals, CIbM actively pursues new pedagogical research in innovation principles related specifically to the four areas highlighted below.



Innovation-based Manufacturing Conference

This past fall, CIbM hosted the second annual Innovation-based Manufacturing Conference at Virginia Tech for students, faculty, and industry members. The event began with a general morning session showcasing respected speakers from the private and government sectors who focused on primary drivers behind innovation-based manufacturing and provided examples and case studies of organizations successfully managed using such principles. In the afternoon session, two parallel workshops introduced the use of innovation tools as a part of management philosophy.

To engage their interest and participation, a student competition was held. Given the conference's manufacturing focus, student teams were asked to submit concept ideas for physical, manufacturable products–"something that you can produce and drop on your toes." Five concept ideas were selected for the competition: 3D-printed unmanned aerial vehicle, innovative wood lamination process, student-designed espresso machine, power strip with consumption monitoring and control, and the competition winner proposed by a senior mechanical engineering student, an automatic tire inflation device. The winner was awarded $5,000 toward product development and a FirstOffice package of start-up services from VT KnowledgeWorks, a subsidiary of the Virginia Tech Foundation that encourages and enables creative entrepreneurship world-wide. The FirstOffice package provides office space and other resources including local and regional start-up press releases, commercial insurance offerings overview, human resources issues and answers, financial administrative setup, banking services primer, public relations tips, and Internet impact tips.

inVenTs Community

Dr. Camelio and the CIbM are collaborating with the Center for Enhancement of Engineering Diversity to create an inVenTs residential learning community. Funded by the National Collegiate Inventors and Innovators Alliance, this community will be open to students from various technical areas in engineering and the sciences. An interdisciplinary living-learning space in Lee Hall will enable these students to explore their ability to envision, create, and transform innovative ideas into action. Some unique benefits for inVenTs community members will include: connections at social events with other science and engineering students, access to a state-of-the-art design lab, and participation in design competitions hosted by the inVenTs Leadership Team. Mentoring and financial support will be provided so that student teams can work together on projects and host their own inVenTs competitions. The CIbM-supported inVenTs community will accept freshman students in the fall of 2012 and will be the fifth inVenTs community located on the Virginia Tech campus. Freshmen students already participate in inVents communities dedicated to the biological and life sciences, physical and quantitative sciences, and engineering. These learning communities promote academic success, provide interdisciplinary undergraduate training, and promote retention and diversity in the STEM majors (science, technology, engineering, and math).

Manufacturing Learning Center

Under Dr. Camelio's direction, CIbM continues to lower barriers in manufacturing by creating the first Manufacturing Learning Center at Virginia Tech, a prototyping machine shop equipped to support the Industrial Engineering Research Conference, student projects, and the further development and scaling of university-developed technologies through ICTAS.

Deep Dive Experiences

Through CIbM, Dr. Camelio offers Deep Dive educational experiences for undergrads, graduates, faculty, and industry partners alike. These unique experiences are one-day informal problem-solving sessions aimed at developing a workable solution for a specific problem by a group of interdisciplinary students. The Deep Dive begins with the definition of the problem, brainstorming for possible solutions, and assignment of student groups for the development of modules for the selected solution. The Deep Dive concludes with the integration of the group modules into a final solution. The collage below depicts the Deep Dive experience held February 25, 2012, in which students worked to design, machine components, and manufacture injection-molded plastic parts all in one day.

Researchers Study New Ways to Forecast Critical Societal Events

by Lynn Nystrom, Director, News and External Relations, Virginia Tech's College of Engineering

University and industry scientists are determining how to forecast significant societal events, ranging from violent protests to nationwide credit-rate crashes, by analyzing the billions of pieces of information in the ocean of public communications, such as tweets, web queries, oil prices, and daily stock market activity.

"We are automating the generation of alerts, so that intelligence analysts can focus on interpreting the discoveries rather than on the mechanics of integrating information," said Naren Ramakrishnan, the Thomas L. Phillips Professor of Engineering in Virginia Tech's Department of Computer Science. Dr. Ramakrishnan is leading a team of computer scientists and subject-matter experts from Virginia Tech, the University of Maryland, Cornell University, Children's Hospital of Boston, San Diego State University, University of California at San Diego, Indiana University, and from the companies CACI International, Inc., and Basis Technology.

Within Virginia Tech, the team spans the departments of computer science, mechanical engineering, statistics, and agricultural and applied economics, the Virginia Bioinformatics Institute, and the Institute for Critical Technology and Applied Science.

The project is supported by a potential $13.36 million 3-year contract from the Open Source Indicators (OSI) Program of the Intelligence Advanced Research Projects Activity (IARPA), a research arm of the Office of the Director of National Intelligence. Three teams were awarded contracts, with continuation after the first year contingent upon satisfactory progress.

"Research shows that many significant societal events are preceded by population-level changes in communication, consumption, and movement. Some of these changes may be indirectly observable from diverse, publicly available data, but few methods have been developed for anticipating or detecting unexpected events by fusing such data," said Jason Matheny, OSI Program Manager at IARPA. "OSI's methods, if proven successful, could provide early warnings of emerging events around the world."

Each OSI research team will be required to make a number of warnings/alerts that will be judged on their lead time, or how early the alert was made; the accuracy of the warning, such as the where/when/what of the alert; and the probability associated with the alert, that is, high vs. very high.

The Virginia Tech-led team calls its project EMBERS, for early model-based event recognition using surrogates. Surrogates are accessible pieces of information that mirror or precede events of interest. The team intends to organize a huge database of surrogates predictive of real events and to apply these surrogates to public data sources.

The focus of the IARPA program is on Latin American countries. A key theme in the EMBERS project is the use of models to capture population-level behavioral changes in these countries. Tracking or identifying individuals is strictly excluded from the research.

Dr. Naren Ramakrishnan

"The models must be expressive enough to capture many important behaviors. For instance, how many people and what other factors result in a protest becoming violent? When do a few reported cases of dengue fever become an epidemic? But we do not want a model that is so complex that it becomes intractable. So finding the right balance is important," said Madhav Marathe, professor of computer science and deputy director of the Network Dynamics and Simulation Science Laboratory at the Virginia Bioinformatics Institute and an EMBERS co-investigator.

Dr. Barbara Ryder

"Extracting valuable information from massive data sets is the new frontier of computing. This project demonstrates the power of well-led interdisciplinary teams in developing new knowledge discovery and data analytics algorithms and systems to address important problems," said Barbara Ryder, J. Byron Maupin Professor of Engineering and head of Virginia Tech's Department of Computer Science.

"Large-scale analytics is considered to be one of the emerging technologies that will have transformative impact on lives," said Roop Mahajan, director of the Institute for Critical Technology and Applied Science at Virginia Tech.

The team response to the IARPA solicitation was led by Jon Greene, director of National Security Research and Program Management at the Institute for Critical Technology and Applied Science. Christine Tysor at the institute will provide project management for EMBERS. "These individuals are invested in ensuring superior performance in all aspects of the formulation and execution of this project," said Dr. Mahajan.

"Naren Ramakrishnan has established a powerhouse team of leading experts from academia and industry. This team will use its expertise to deliver rapid ways to arrive at solid analytical decisions and quantitative predictions to our nation's intelligence analysts," said Richard C. Benson, the Paul and Dorothea Torgersen Chair and Dean of Virginia Tech's College of Engineering. "Virginia Tech is honored to be leading such an accomplished group of investigators."

Dr. Richard Benson

Welcome recent additions to the ICTAS team

Andrew Giordani, Secondary Contact for XPS and AFM | *andrew.giordani@vt.edu*

Andrew became a member of the ICTAS Team on August 10, 2011. Located at the ICTAS Nanoscale Characterization and Fabrication Laboratory in the Corporate Research Center, Andrew, who answers to the nickname "Gio," provides service work on the laboratory's Scanning Photoelectron Spectrometer Microprobe and teaches the Atomic Force Microscopy Lab to the Materials Science and Engineering graduate characterization class. Andrew is from Woodstock, Virginia, and earned his B.S. in mathematics and physics from Emory and Henry College. Gio and his fiancee will marry this summer on August 4.

Ibrahim Hassounah, Postdoctoral Associate

On May 29, 2012, Dr. Ibrahim Hassounah assumed a postdoctoral position with ICTAS researcher Dr. Eugene Joseph. Dr. Hassounah comes to Virginia Tech from the Czech Republic where he was employed as a research chemist at Elmarco s.r.o., a leading seller and supplier of industrial-scale nanofiber production equipment. Dr. Hassounah earned his Ph.D. in February 2012 from Aachen University in Germany. His thesis dealt with melt electrospinning of thermoplastic polymers.

Gang Liu, Research Associate | *gangliu@vt.edu*

Liu joined ICTAS on September 28, 2012. Dr. Liu completed his Ph.D. in mechanical engineering (thermal science) at Zhejiang University in June 2006. Dr. Liu earned both his B.S. (thermal power engineering) and his M.S. (enhanced heat transfer) in mechanical engineering from Shandong University in 1996 and 2000, respectively. From 2007 to 2012, Dr. Liu was employed as a research scientist at the General Electric China Co., Ltd. - Global Research Center in Shanghai. At ICTAS, Dr. Liu performs sustainable energy research sponsored by a 1-million-dollar grant from the American Electric Power Foundation.

Dr. James Schiffbauer, Postdoctoral Associate | *jdschiff@vt.edu*

Senior Research Assistant Dr. Schiffbauer earned his Ph.D. in geosciences in 2009 from Virginia Tech's Department of Geosciences. His resume includes a dual M.S. in marine biology and coastal ecosystem management from the Nova Southeastern University and a B.S. with honors in biology from the West Virginia University. From 2009-2011, Dr. Schiffbauer served as a NASA postdoctoral research associate at Virginia Tech. He completed a graduate research assistantship at ICTAS in 2009. Dr. Schiffbauer is located at the NCFL.

Karen Turner, Grants and Contract Specialist | *karent@vt.edu*

Karen, who joined ICTAS on January 10, 2012, is based in Suite 410 at ICTAS on Stanger Street. In her previous position, Karen served for 6 years as a Senior Grants and Contracts Manager for the Virginia Tech Transportation Institute. At ICTAS, Karen performs both preaward and post-award duties related to proposal activity. In fulfilling her assigned duties, Karen monitors awards to ensure that spending is in accordance with budgets and the allotted schedule, that personnel are properly assigned to projects, and that reporting complies with agency requirements. She also advises research team members on compliance with proposal guidelines as they relate to submission, preparation, and refinement of budgets and their justifications. Karen has been a Virginia Tech employee since 1994.

ICTAS Names Research Program Managers

Virginia Tech welcomes Ashwin Amanna, Dennis Grove, and Matt Hull as research program managers for the Institute for Critical Technology and Applied Science (ICTAS). Amanna, Grove, and Hull will manage six of the eight research thrusts that ICTAS supports: the Cognition and Communication and the National Security research thrusts (Amanna), the Sustainable Energy and the Renewable Materials research thrusts (Grove), and the Nano-Bio Interface and the Nanoscale Science and Engineering research thrusts (Hull). Researchers associated with ICTAS research thrusts pursue the technologies that will transform our lives. As research program managers, Amanna, Grove, and Hull will work closely with research thrust leaders and their team members to develop, organize, and implement program objectives and goals aimed at increasing external research funding that supports this pursuit.

Ashwin Amanna holds three degrees in electrical engineering– a Ph.D. and an M.S. from Virginia Tech and a B.S. from the University of California, Davis. From 1995 to 2009, he was employed by the Virginia Tech Transportation Institute (VTTI) where he served as an institute researcher, a project manager and operations director for the Smart Road, a wireless applications project manager for the VTTI Center for Technology Deployment, and a senior research associate. Prior to joining ICTAS, Amanna served as business development manager and senior research associate for Wireless@Virginia Tech, a wireless technology research center. Here he developed a marketing plan and implementation strategy and served as co-principle investigator on a major cognitive electronic warfare research project for the Air Force Research Laboratory and as co-principle investigator and co-director for a $2.5 million Intelligence Community Center of Academic Excellence project sponsored by the Office of the Director of National Intelligence.

Dennis Grove earned an M.B.A and an M.S. (organic chemistry) from Iowa State University and a B.S. in chemistry and physical science (physics) from Radford University. His resume includes managerial and administrative positions at the School of Forestry and Environmental Studies (Yale University), the Vector Ecology Laboratory (Yale University), the Applied Mathematical Sciences Program (Ames National Laboratory, Iowa State University), and the Department of Physics (Iowa State University). In these positions, Dennis provided financial and administrative oversight of faculty, staff, and student research group accounts; ensured compliance with federal, nongovernmental, and college research funding requirements; contributed to and implemented improved organizational business processes; and supported national and international projects with laboratory and fieldwork components. He also served as a research assistant at the Ames National Laboratory and at Radford University.

Matt Hull earned his Ph.D. (civil and environmental engineering) and M.S. (biology) from Virginia Tech and his B.S. (environmental science) from Ferrum College. His employment history includes serving as associate director of Virginia Tech's Center for Sustainable Nanotechnology (VT SuN); president, owner, and founder of NanoSafe, Inc.; fellow for the VT EIGER (Exploring Interfaces through Graduate Education and Research), a graduate student support and training program funded by the National Science Foundation (NSF); visiting researcher at CEREGE (a research and teaching environmental geosciences laboratory in Aix-en-Provence, France); and senior research scientist with Luna Innovations Incorporated. Dr. Hull's research portfolio includes funding from the Air Force, Army Corps of Engineers, NASA, EPA, and NSF. He has significant experience in managing large research projects at both the college and private levels, in moving research from the laboratory to production, and in raising private equity capital to support research efforts.

"We are pleased to welcome Ashwin, Dennis, and Matt," said Bob Moore, Associate Director for ICTAS Research and Scholarship. "They are proven problem solvers, have worked effectively with a wide range of principal investigators from multiple disciplines, and possess considerable experience coordinating large-scale collaborative research projects within a university environment. ICTAS fosters interdisciplinary transformative research for a sustainable future. We are confident that Ashwin, Dennis, and Matt will help us achieve our goal for substantial growth in interdisciplinary research that has significant societal impact."

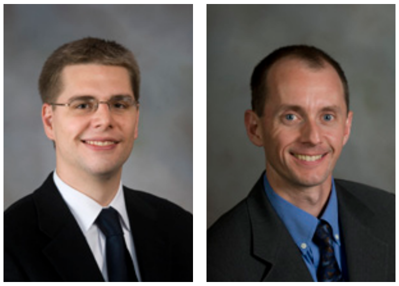
"I am very excited to be joining the ICTAS team," explained Ashwin Amanna. "At ICTAS, we understand that our research thrusts directly impact national security, as exemplified in the intersection between energy harvesting and the power needs of soldiers, electronic warfare's growing emphasis on cognitive communications, and multiscale decision-making theory applications to command and control on the battlefield. My goal as an ICTAS research program manager is to encourage researchers in my assigned thrusts to consider applications that they may not have previously considered, particularly those that support the mission needs of national security customers. These needs range from the basic science needs of the Office of Naval Research to the applied needs of the Department of Defense research labs."

"I am very happy to be at ICTAS," commented Dennis Green, "where I can contribute to transformative, interdisciplinary research for a sustainable future. ICTAS is an organization aimed at not only furthering research to build knowledge, but is also aimed at commercializing technologies that will bring jobs to our area and improve the world. As a research program manager, I am able to use my educational background, both in science and business. I really enjoy meeting with top-notch researchers across the university, learning about their cutting-edge work and helping them find interesting collaborators and exciting opportunities."

"Having been part of the ICTAS community for the past 4 years as a doctoral student, I am thrilled to become a member of the ICTAS team," stated Matt Hull. "ICTAS supports transformative research that addresses society's greatest challenges, and I have always envisioned myself being part of an organization dedicated to such a critical mission. I look forward to contributing to the continued success of ICTAS by working with faculty across Virginia Tech in areas like sustainable nanomanufacturing, nanomedicine, and integrated micro- and nanoscale devices."

Additive Manufacturing

by **Chris Williams** | **Assistant Professor, Mechanical Engineering and Engineering Education**
(540) 231-3422 | *cbwilliams@vt.edu*
and **Tom Campbell** | **ICTAS Associate Director for Outreach** | **(540) 231-8359** | *tomca@vt.edu*



Contrary to traditional manufacturing technologies that create parts through the subtraction of material from a workpiece, Additive Manufacturing (AM; also referred to as 3D Printing) is a group of emerging technologies that create objects from the bottom-up by adding material one cross-sectional layer at a time. At Virginia Tech, cutting-edge research in AM is underway in the Design, Research, and Education for Additive Manufacturing Systems (DREAMS) laboratory (*https://www.dreams.me.vt.edu*) directed by Professor Chris Williams.

The basic steps of AM are shown in Figure 1. AM begins with a three-dimensional solid model of an object, typically created by computer-aided design (CAD) software, or the results of a three-dimensional scan of an existing artifact. Then specialized software slices the solid model into cross-sectional layers. Next, the prepared computer file is sent to the AM machine to create the object layer-by-layer, following the toolpath generated by the software. Each AM technology has a unique principal solution for forming each layer; they range from jetting a binder into a polymeric powder, to precisely extruding a heated plastic filament, to using an electron beam to selectively melt metal powder.

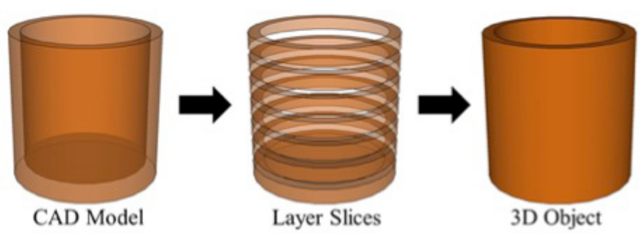


Figure 1. *General steps for creating a 3D object via AM.*

AM methods have several advantages over traditional manufacturing techniques. First, AM offers "design freedom" for engineers; because of its additive approach, it is possible to build geometries that cannot be fabricated by any other means. Moreover, it is possible with AM to create functional parts without the need for assembly. Also, AM offers reduced waste; minimal use of harmful chemicals, such as etching and cleaning solutions; and the possibility to use recyclable materials.

Despite these design and environmental advantages, the adoption of AM as a means for fabricating end-use components has historically been dampened by the technologies' narrow selection of available materials. Options within these material genres are typically limited to applications of models for form or fit testing, functional testing, presentation models, prototypes, and nonload-bearing products. Furthermore, variations in build process parameters, and even ambient conditions with some AM processes, can result in variations between parts built on different machines of the same AM technology. Overcoming these issues will require advances in both process control approaches and material selection.

Virginia Tech researchers are investigating means to enable AM technologies to take a lead role in innovation-based manufacturing by exploring all components of the process, including product (re)design (i.e., "Design for AM"), optimization of existing processes, development of novel processes, enhancement of material capabilities and compatibilities, and characterization of fabricated artifacts. The interdisciplinary expertise of Virginia Tech faculty allows for the exploration of novel applications (e.g., tissue engineering, robotics, cryptography, bioengineering), processes (e.g., multimaterial printing), and materials

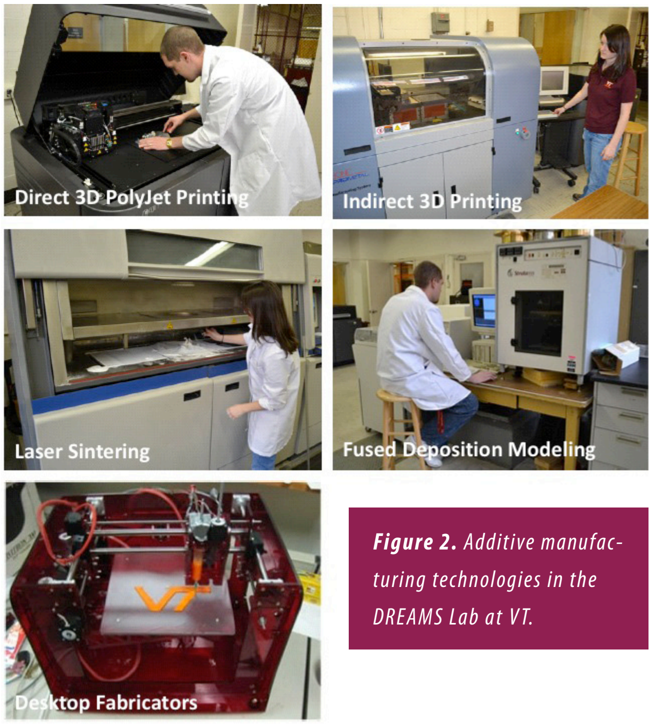


Figure 2. *Additive manufacturing technologies in the DREAMS Lab at VT.*

(e.g., nanocomposites). Through research on both process and application aspects of AM, Virginia Tech is becoming a leader in advancing the science, state of the art, and educational experience for students in AM.

The DREAMS Lab houses one of the most diverse collections of AM technologies in an academic setting in the United States **(Figure 2)**. The focus of DREAMS Lab is in three core areas:

- **Product Design:** DREAMS Lab researchers are currently developing methods and tools that will support designers in their use of AM technologies. A key interest is in cellular materials–a unique class of materials with complex topologies that offer strength and impact absorption at a relatively low mass. Student designers have used these methods to create novel products including a custom-fitting bicycle helmet liner and an autonomous quadrotor helicopter that can be fabricated completely via AM **(Figure 3)**.
- **Process and Materials Research:** Significant effort is put into researching AM processes and material systems. Current projects include 3D Printing copper via a metal-reduction process, creating lightweight metallic structures via electroplating, and creating ceramic tissue scaffolds via biomimetic mineralization. Most recently, DREAMS Lab researchers have been investigating a process for embedding fibers and circuits into printed parts in order to fabricate actuated mechanisms.
- **Education:** Members of the DREAMS Lab are engaged in numerous outreach projects, such as Kids Tech University and a recently installed exhibit at the Taubman Museum of Art in Roanoke, Virginia, that introduce K-12 students to STEM concepts through 3D Printing technologies.

Figure 3. *Cellular materials in a custom-fitting bicycle helmet and a 3D-printed ducted fan for a quadrotor helicopter.*

Hokie Bird printed by a 3-D printer.

Photo by Logan Wallace

The Laboratory for Engineered NanoSystems (LENS) led by Dr. Thomas Campbell at ICTAS focuses its research on developing new materials for AM via introduction of nanomaterials to the printing media. The integration of nanotechnology with AM has the potential to both complement existing techniques and create wholly new nanocomposites; it is thus a promising approach to alleviating some of the technologies' limitations. Nanotechnology is science, engineering, and technology conducted at the nanoscale, which is about 1 to 100 nanometers. When shrinking the size scale from macro- to nano-, or from bulk to molecule, materials can change their fundamental properties. For example, at the nanoscale, objects can exhibit unique optical, thermal, and electrochemical properties that differ from the properties of the corresponding bulk material or molecules. These properties strongly depend on the size and shape of nanostructures. There are a wide variety of nanomaterials, including carbon nanotubes, nanowires, buckyballs, graphene, metal nanoparticles, and quantum dots (QDs). These materials possess unique characteristics that allow applications in areas such as sensing, separation, plasmonics, catalysis, nanoelectronics, therapeutics, and biological imaging and diagnostics. Combining AM and nanotechnology will lead to a new application of nanomaterials that has not yet been explored by other researchers. By leveraging the tunable properties of nanostructures, the properties and thus applications of printed components can be expanded. Moreover, it may be possible with AM-produced nanocomposites to create objects with graded material properties by varying the nanostructure loadings during a part's synthesis. Combining multiple nanomaterials in the same AM part would then allow the transition from simple to more complex printed objects such as fuel cells, batteries, and solar cells. Recently LENS researchers prepared printing-media quantum dot nanosolutions to use in AM. The photos of prepared suspensions are shown on Figure 4. Investigation of the physical properties of these nanosuspensions such as viscosity, density, and surface tension is in progress. Assessment of these parameters is necessary to determine the feasibility of printing with these new nanocomposites. Moreover, preliminary results of curing higher concentrations are very promising—a cured sample of 1% QD concentration can be seen in Figure 5. Taken with a simple digital camera under UV light (365 nm), the sample's (25 mm diameter, 1 mm thick) fluorescence (the pink glow) is observable with the naked eye.

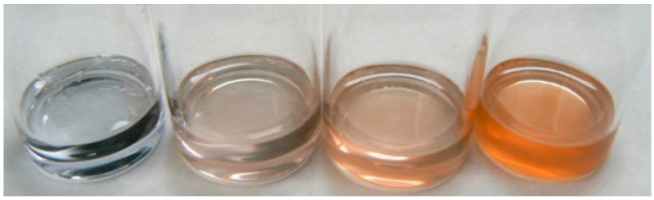


Figure 4. *As prepared suspensions of printing media/QDs with different loadings.*

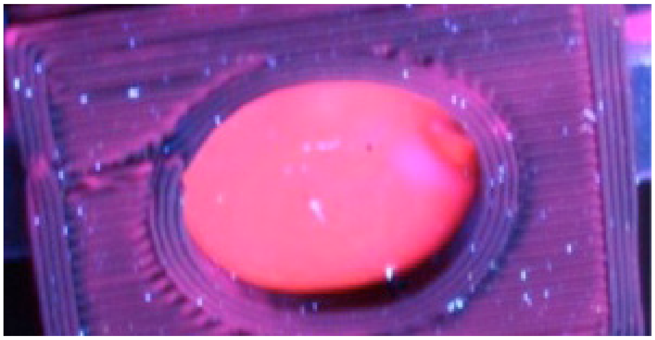


Figure 5.
Fluorescence of cured QD nanoink sample.

A Biomimicking Approach for Smart Assembly Systems

by **Lee Wells** | **Ph.D. student in Industrial & Systems Engineering**

As part of their National Science Foundation EArly-concept Grants for Exploratory Research (EAGER) project, Dr. Jaime Camelio and his Ph.D. student Lee Wells are developing a unique system-level quality control framework to allow the rapid introduction of advanced computing technology and analysis methods in manufacturing systems. The National Science Foundation (NSF) uses the EAGER funding mechanism to support early stages of exploratory work on untested, but potentially transformative, research ideas or approaches. NSF may consider such work especially "high-risk-high-payoff" in the sense that it involves radically different approaches, applies new expertise, or engages novel disciplinary or interdisciplinary perspectives.

The Camelio and Wells project entitled "A Self-Healing Approach for Smart Assembly Systems" was inspired by biological systems, as the developed control framework utilizes immunological principles as a means of developing self-healing algorithms and techniques for manufacturing systems. The principles and techniques obtained through this biomimicking approach will be used for autonomous monitoring, detection, diagnosis, prognosis, and control of station- and system-level faults.

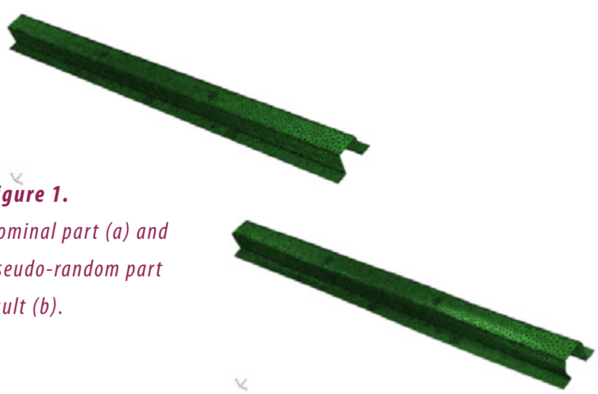


Figure 1.
Nominal part (a) and pseudo-random part fault (b).

Specifically, this work focuses on integrating immunological principles found in adaptive immunity into the manufacturing environment to create a part-by-part self-correcting manufacturing system. Adaptive immunity provides protection against invading organisms utilizing pre-existing knowledge of these invaders and developing responses tailored to maximally eliminate them. This form of immunity relies upon three key biological tools, namely B Cells, Th Cells, and vaccinations. When implemented in a manufacturing environment, these tools provide a continual source of immunity to three distinct fault categories: 1) Known Possible Faults - Through the implementation of vaccines, the system can defend itself against antigens that are known to exist but have not yet been encountered; 2) Known Faults - Through the memory capabilities of Th Cells and B Cells, the effectiveness of the immune response increases after every encounter with a specific fault; and 3) Unknown Faults - Through the pseudo-random production of B Cells, the system builds up an immunity against faults that are neither known to exist nor have yet to be encountered. Adaptive immunity provides a very robust system to reduce or eliminate a large range of faults that can occur in a manufacturing environment.

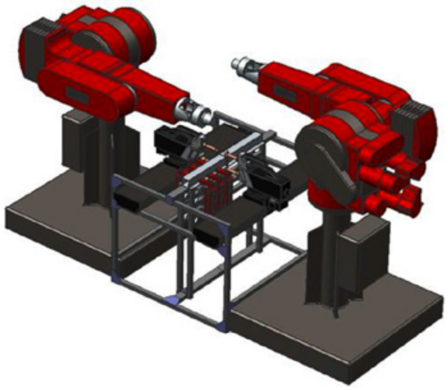


Figure 2.
Virtual design of self-healing test-bed.

Currently, this research is primarily focused on implementing these tools into compliant assembly systems. For compliant assemblies, developing self-correcting actions on a part-by-part basis is computationally exhaustive and therefore is not a viable option in a production environment. By imparting adaptive immunity into the assembly system, self-correcting actions are continually obtained for a wide array of faults. This is made possible through the pseudo-randomization of incoming part faults (Figure 1) which is analogous to the generation of B Cells. Currently, a test-bed for this research is under development in the Manufacturing Learning Center of the Center for Innovation-Based Manufacturing (CIbM).

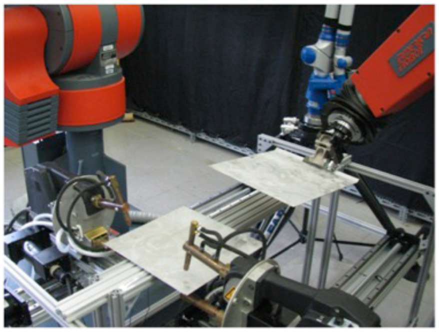
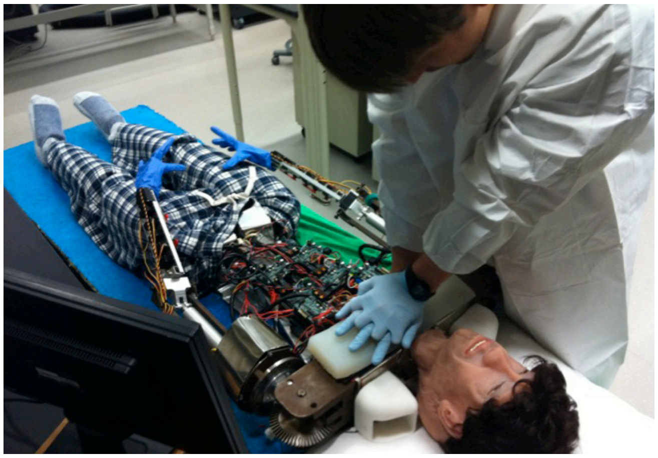


Figure 3.
Test-bed in CIbM Manufacturing Learning Center.

ICTAS Humanoid Hospital

by **Michael Okyen | Graduate Student in Mechanical Engineering**

In the 1960s, Laerdal, a Norweigan manufacturer of medical equipment and medical training products, released Resusci Anne, the first training manikin created to teach a new rescue breathing technique. In the United States, this training manikin is known as CPR Annie, as it serves as our main training tool for teaching the mouth-to-mouth method of CPR. Over the years, medical simulation manikins have become standard in medical training events across the world. Virginia Tech's ICTAS Humanoid Hospital (IcHHo) was established to produce further breakthroughs in this area. IcHHo's goal is to create medical training manikins that are fully functional human-like robots tailored to mimic any specific or combined state of the healthy or diseased human body.



Today, several companies, including Laerdal, Management & Engineering Technologies International, Inc., and Medical Education Technologies, fabricate medical manikins that do far more than the common CPR "dummies" do—they breathe, have internal organs, accept injections and catheters, and express simple speech. One can even simulate a mother giving birth. Most of these capabilities are organized into training scenarios that simulate actual medical conditions that participating doctors and nurses must treat correctly despite changing symptoms. However, what is missing from these training manikins is the ability to move and interact with medical professionals.

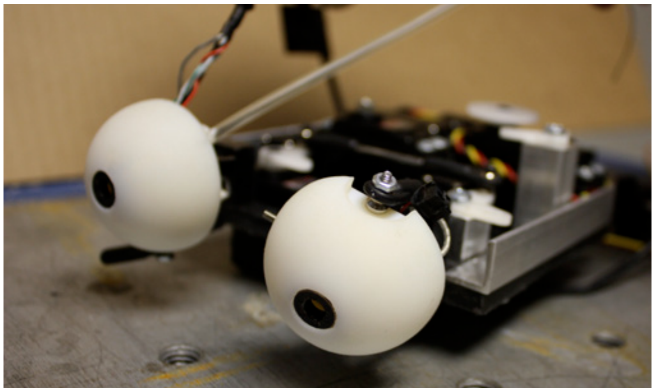
Under the direction of Dr. Shashank Priya, a Virginia Tech professor with dual appointments in the Mechanical Engineering and Materials Science Engineering departments, IcHHo, in conjunction with the Virginia Tech Carilion School of Medicine and Research, seeks to develop a training manikin that can move and provide feedback. For the past 4 years, graduate students assigned to IcHHo have been working to integrate cutting-edge robotics technology into a humanoid robot that will provide the next generation of medical training manikins. Some examples of IcHHo's use of robotics technology are evident in the hand, face, neck, eyes, vision, and body of its most recent robotic medical simulator.

DART Hand

The Dexterous Anthropomorphic Robotic Typing (DART) Hand is among the most advanced robotic manipulators. At human size, the hand has 19 degrees of freedom (DOF) or ways in which it can move. In a display of its dexterity, the hand was programmed to type on a keyboard and was able to achieve a speed of 20 words per minute. Its structure was fabricated using a rapid prototyping machine, and its actuation is powered by servo motors. Today this hand can undergo several medical exams on finger sensitivity and strength, and as the project moves forward, it offers the potential for many more medical training applications.

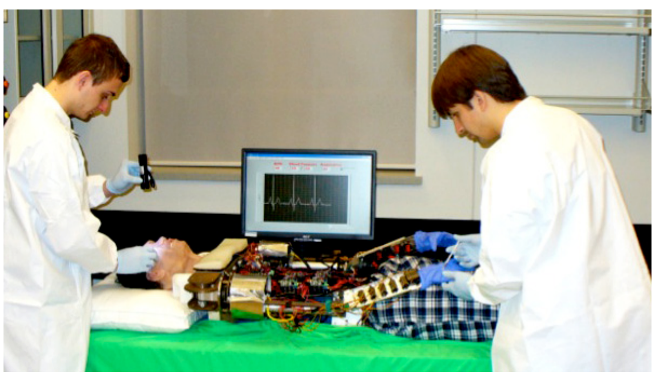
Face and Neck

Because one primary way doctors receive feedback is from a patient's body language, a focus of IcHHo research has been on the robotic face and neck. Similar to the DART hand, the robotic face has servo motors that act as facial muscles do by pulling the robotic skin in different areas. This movement allows the robotic face to make a variety of expressions, including happiness, sadness, anger, surprise, and disgust. In total, 17 different muscle groups were analyzed in creating the robotic face. The robotic facial skin is made of a silicon that feels and stretches like human skin, and a neck with 6 DOF allows the head to bend and rotate just like a human's. The robotic head does not lie statically on a bed. It can turn to look at a doctor, and its face can wince in pain or show limpness on one side as is sometimes seen in a stroke victim.



Eyes and Vision

Embedded in the eyes of the robot are high-definition cameras, and servo motors attached to each eye allow them to move at a speed comparable to that of the human eye. These cameras can be used to see what the doctor or nurse is doing during a simulation. Additionally, feedback allows the eyes to track objects around a room. When a light is shown into the pupils, each eye dilates individually. Several standard neurological examinations that involve testing vision and dilating eyes can be made to determine medical conditions, including pressure of the optic nerve and brain trauma. Eventually, IcHHo will incorporate into its robot the ability to track faces and to recognize their expressions.



Full Body

Each subsystem was combined into a full-body robotic medical simulator. The robot includes a pair of moving arms with an elbow and a shoulder that can rotate and adduct as well as legs that can flex at the hip, knee, and ankle. CPR can be performed on the robot's chest, and an indicator provides feedback that shows if the compressions are strong enough. A drug delivery system uses syringes with embedded chips to change the robot's simulated pulse rate, respiration, and blood pressure, depending on which drugs are administered. A patellar reflex sensor causes the robot to kick its leg when struck. The robot can also perform as a combative patient by thrashing its arms and legs to simulate a seizure. An intramuscular injection into the robot's leg that imitates the administration of a tranquilizer drug can end the simulation.

The Future

Over the past couple of years, student participation in this project has grown from one graduate student and five senior design students to five graduate students and 21 senior design students. With IcHHo's move into the new ICTAS II facility, dedicated space is now available in which to develop the robot's next generation. A more robust hand, a more capable and smaller upper body, and legs that make walking possible are all planned. With this improved technology, more advanced simulations will be created, and expanded testing will be performed at the Virginia Tech Carilion School of Medicine and Research.

Occupational Safety & Health Research Center

by **Maury Nussbaum** | **Professor, Industrial and Systems Engineering** |
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Our History

The Occupational Safety & Health Research Center (OSHRC) discovers and disseminates innovative ways to separate humans from occupational hazards. Through research, training, and continuing education programs, OSHRC focuses on applications that reduce work-related fatalities, injuries, illnesses, and accidents. OSHRC began in 2010 as an expansion of the Center for Innovation in Construction Safety and Health (CICSH). Established in 2004 with funding from the National Institute for Occupational Safety and Health, CICSH affiliated itself with ICTAS and became the first ICTAS center based on its funded goal to bring an interdisciplinary and collaborative approach to improving health and safety in the construction sector. Today, under the broad OSHRC umbrella, CICSH faculty participate in safety and health research focused on diverse occupational sectors for which they design innovative training methods. This training ultimately reaches workers of different ages, genders, and ethnicities that parallel the demographics of the actual workforce.

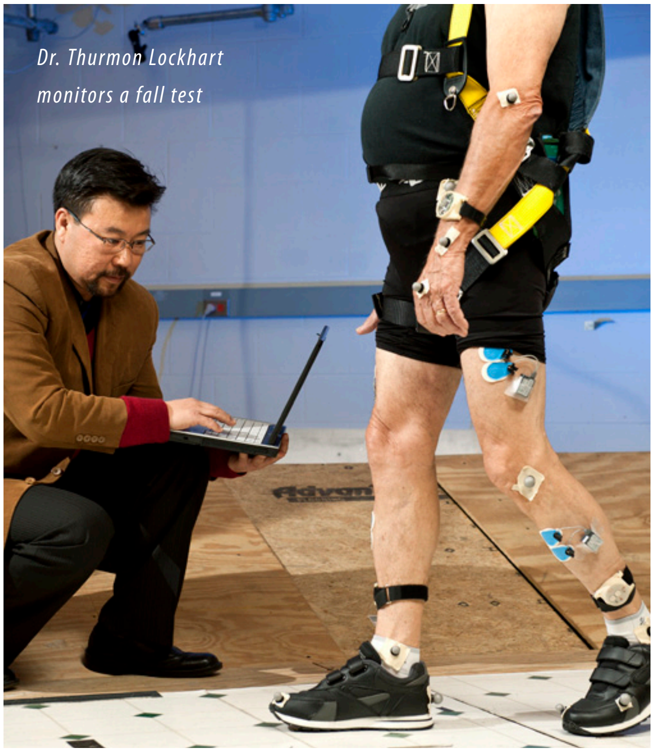
What We Do

True to the ICTAS mission, OSHRC faculty integrate themselves with multiple collaborators from multiple technical disciplines that include industrial hygiene; musculoskeletal disorders; safety, slips, trips, and falls; and work organization. OSHRC researchers have considerable experience across industries where they see similar issues. In turn, OSHRC research has demonstrated that many, if not most, hazards and their respective interventions are nonspecific in terms of industry. For these reasons, OSHRC researchers know that occupational safety and health efficiencies can be realized by benchmarking what works in one industry and by adopting or adapting best practices in a targeted industry. Current primary occupations of emphasis for OSHRC researchers are in the construction, manufacturing, healthcare, mining, and agricultural sectors.

OSHRC field and laboratory research is guided by a hierarchy of safety and health controls for the prevention of risk. OSHRC researchers design, develop, and deliver training and continuing education to decrease the number and severity of injuries, accidents, and fatalities that not only impact workers but their families and friends. To decrease risk, OSHRC puts into practice innovative methods and designs to create an improved safety culture and environment.

Current large-scale OSHRC research projects include:

- A Decision Support System for Ergonomic Construction Design
- Dust-control Usage: Strategic Technology Intervention
- From Finger-pointing to Lifesaving: A Supply Chain Approach to Construction Occupational Safety and Health
- Micro-Processes of Latino Construction Worker Health: Feasibility of Computer Assisted Telephone Survey
- Novel Optical Systems for Real Time Monitoring of Welding Fumes
- 20-Year Trends in Work-Related Injuries and Disorders among Carpenters
- A Fall Protection System for Residential Construction Considering Usability and Worker Attitudes
- Effects of Localized Muscle Fatigue on Risk of Occupational Slips and Falls
- Effects of Obesity and Age on Balance and Fall Risk – Implications for Safety Guidelines



Dr. Thurmon Lockhart monitors a fall test

Practice 2 Research 2 Practice (P2R2P)

OSHRC's interdisciplinary and innovative approach to safety and health has already produced outcomes that have been applied successfully across industry sectors. One such example is slip perturbation training, an award-winning training system that teaches workers in various industries to position their bodies during a fall in such a way that injuries are prevented or mitigated. A 2003 study by Liberty Mutual Research Institute for Safety estimated the direct cost of U.S. annual workplace injuries caused by slips and falls at $6 billion. A modern supply chain perspective dictates that industry sectors are not mutually exclusive. For example, joist buckling transcends forestry and construction. Construction itself is broad: residential, commercial, industrial, heavy, highway, and other industries can benefit from innovations made in construction research and training. Therefore, all OSHRC projects have a P2R2P component.

Sample OSHRC Projects

- Hand-held information devices
- Noise and asphalt exposure control
- Fatigue management
- Slip and fall prevention
- Decision support tool for ergonomic design
- Training and visual aids for Hispanic workers
- Respiratory disease control
- Noise and vibration control of hammer drills
- Falls from joist buckling
- Pervasive computing
- Quantification and solutions to communication and signal detection challenges
- Training needs analysis of single entity and family-owned small businesses

Virginia Tech Researchers Receive Digging into Data Challenge Award

Virginia Tech and the University of Toronto have submitted a winning proposal, "An Epidemiology of Information: Data Mining the 1918 Influenza Pandemic," for the Digging into Data Challenge, an international funding competition promoting innovative humanities and social science research using techniques of large-scale data analysis. One of 14 projects approved for funding by the National Endowment for the Humanities and the Social Sciences and by the Humanities Research Council of Canada, this 2-year funding opportunity seeks to harness the power of data mining techniques with the interpretive analytics of the humanities and social sciences to understand how newspapers shaped public opinion and represented authoritative knowledge during the deadly pandemic that struck the United States in 1918. Research methods developed through this project will reveal new insights into understanding the spread of information and the flow of disease in other societies facing the threat of pandemics. Faculty researchers and graduate students will apply the latest in computational techniques to learn how information about a pandemic spreads. Their hope is that this information will teach valuable lessons for disease control today.

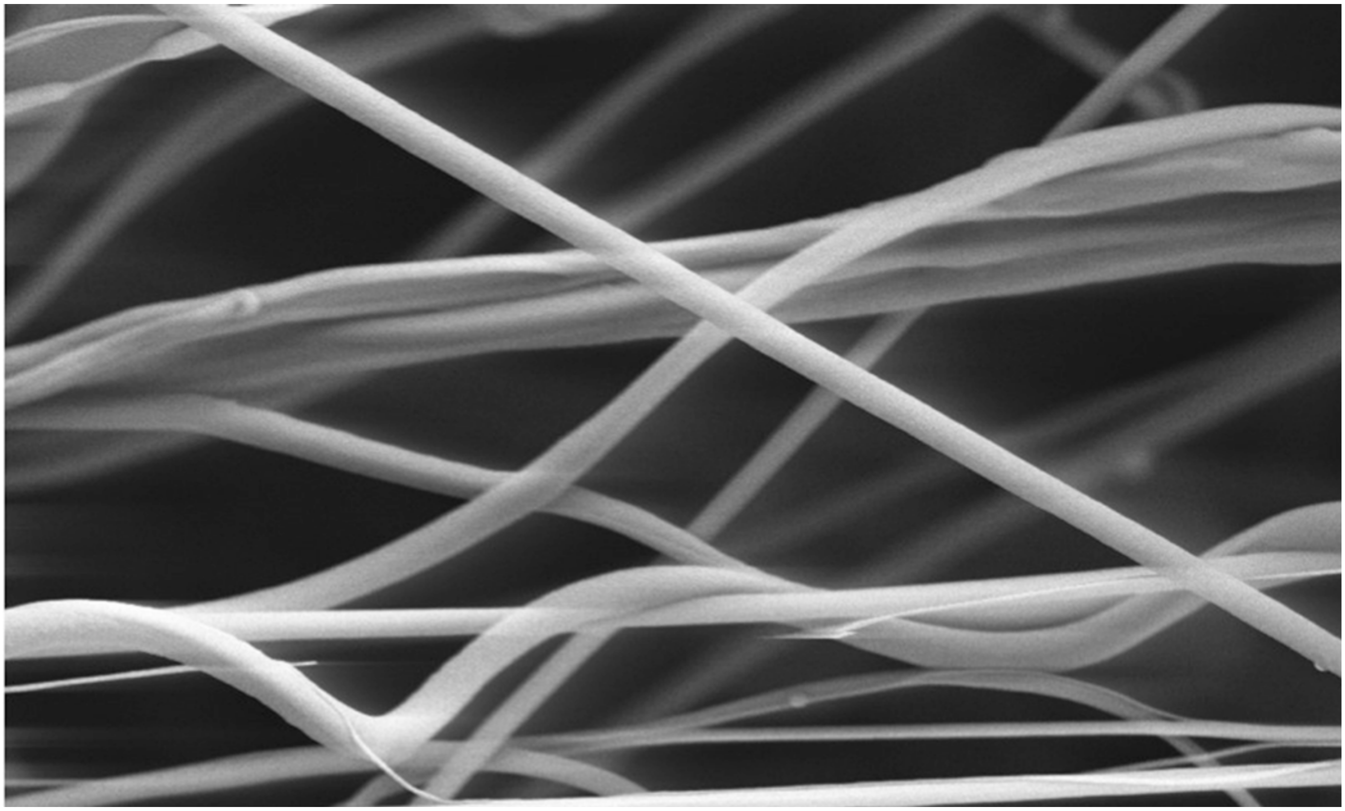
Principal investigators from Virginia Tech are Tom Ewing, professor of history and associate dean in the College of Liberal Arts and Human Sciences; Bernice L. Hausman, professor of English in the College of Liberal Arts and Human Sciences with a secondary appointment as professor at the Virginia Tech Carilion School of Medicine; Bruce Pencek, associate professor and college librarian for the social sciences in the University Libraries; and Naren Ramakrishnan, professor and associate head for graduate studies in computer science in the College of Engineering, and director of the ICTAS-supported Discovery Analytics Center. This project will make use of digitized newspapers, including the more than 100 titles for 1918 available from the Chronicling America website at the United States Library of Congress and the Peel's Prairie Provinces collection at the University of Alberta.

Virginia Tech and the University of Toronto will split the $250,000 in external funding provided by this opportunity.

ICTAS Research Group Pursues NanoFibers Technologies

Dr. Roop Mahajan, ICTAS Director, and Dr. Eugene Joseph, ICTAS Research Professor, have developed a solvent-free manufacturing process that combines layer multiplying technology with melt blowing to create nonwoven fiber webs. The resulting webs have hundreds to over a thousand layers within each microfiber with a 1- to 10-micron diameter. This approach results in nanofibers obtained by delamination of the layers which is achieved by using orientation, sonication, hydroentangling, or aqueous extraction of one of the web components. This technology can significantly increase the surface area in the produced webs, a key factor in using them for applications involving filtration, drug delivery, sensors, and scaffolds for tissue engineering.

Compared with current available technologies for fiber production, this manufacturing technology is unique: first, two polymers with different properties can be selected and combined in this process to nanolayer fiber webs with unique properties that affect density, elongation, dimensional stability, heat conductivity, absorbency, and strength, and second, with a given polymer pair, the number of layer multipliers can be changed to obtain a different layer thickness for each fiber. Thus this technology platform can be used to tailor fiber web performance for specific applications depending on the two polymers used and the number of layer multipliers selected. This type of process flexibility is not present in existing processes. With this technology, customers can develop their own fiber web products once a set of required properties has been established. Mahajan and Joseph, along with the ICTAS-supported Center for Innovation-based Manufacturing and its director, Dr. Jaime Camelio, are investigating potential commercial products that can take advantage of this technology. The most logical first application would be air and water filtration. The type of nonwoven webs that can be created can significantly increase surface areas and hence improve filtration performance. The ability to tailor the mechanical properties of the fibers gives a competitive advantage.



Humboldt Kolleg

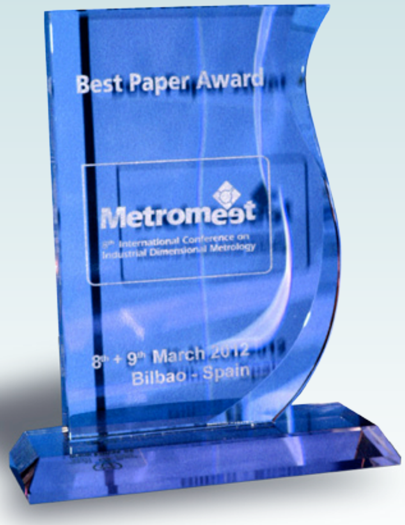
The ICTAS-organized Humboldt Kolleg was held in Arlington, Virginia, on February 24 and 25. Bruce Alberts, past president of the National Academy of Sciences and editor-in-chief of *Science* magazine, was the Kolleg's keynote speaker. Sponsored by the Alexander von Humboldt Foundation, the theme for this year's Humboldt Kolleg was "Collaboration and Networks in the 21st Century."

Kolleg participants exchanged ideas, presented findings, provided networking opportunities, and created a framework in which to analyze the emerging trends in collaboration and networks that are impacting present and future research. Global leaders from academia and the private sector participated in the 2-day Kolleg. Their focus was on three themes: global problems and technologies, new networking tools and generational expectations, and global networking for science.

"The Kolleg was an excellent forum for leaders in science, technology, and policy to engage with each other," said Tom Campbell, Associate Director for Outreach and a Research Associate Professor at ICTAS. Doctoral students from any university were encouraged to submit poster abstracts for consideration in a poster session. Students whose posters were accepted received partial travel funds for the conference.

The Alexander von Humboldt Foundation provides support to postdoctoral scientists and scholars of all nationalities and disciplines for long-term research projects. Humboldt Kollegs are initiatives of Humboldt alumni associations and are designed to strengthen regional and interdisciplinary networking of past recipients of Humboldt fellowships.

Tom Campbell Wins Best Paper Award



Tom Campbell, ICTAS Associate Director for Outreach and Research Associate Professor, won Best Paper Award at Metromeet 2012 for his presentation "Metrology for Additive Manufacturing Opportunities in a Rapidly Emerging Technology." In making the award, the Technical Committee noted the high quality of Dr. Campbell's presentation and its real applicability.

METROMEET is a unique event and the most important conference in the sector of industrial dimensional metrology. This year, it took place in the beautiful city of Bilbao, Spain, at the award-winning Conference Centre Euskalduna. Speakers contributed information about the latest technology and progress made in the sector, debated metrology and its development in a fast-changing industry, and presented the latest news about new digital and optical developments and the European and international norms.

ICTAS Doctoral Scholar Poster Session

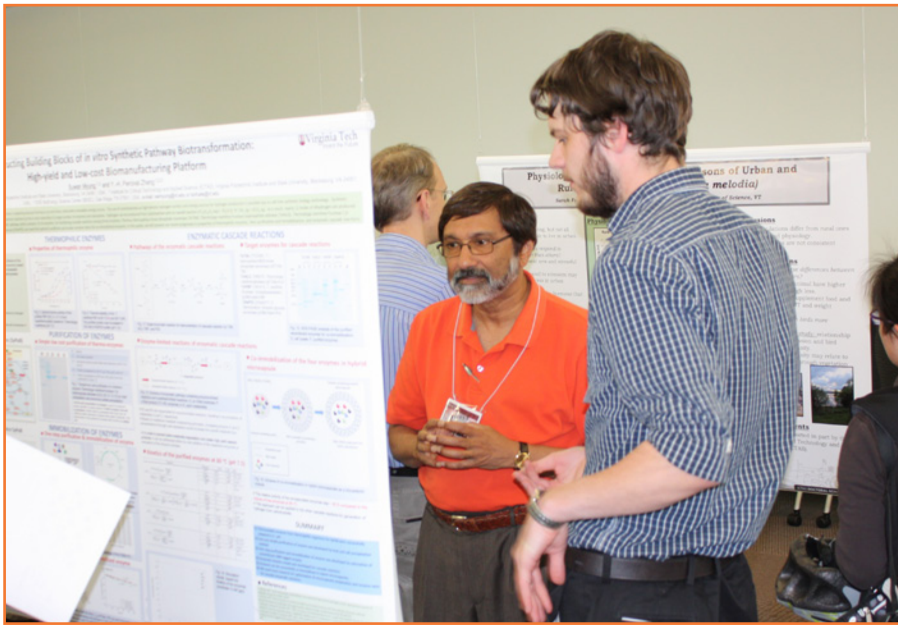
On April 10, 2012, ICTAS hosted its yearly poster session for the institute's doctoral scholars. The event gives doctoral scholars an opportunity to not only showcase their research but to discuss it with others in an informal but scholarly environment. The informal nature of this event is created by the relationship between the poster presenter and the audience who is not seated but stands and walks through the exhibit area which typically is a hallway. A poster presenter usually stands next to his or her poster and engages with passers-by in a one-on-one discussion. Posters prepared for this event are well-designed representations of student research efforts and not simply journal papers pasted onto poster board. Posters must not be overloaded with text. Individual sections of a well-designed poster–typically title, subject, purpose, and results–orient readers and can be read quickly to allow the audience to move timely from one poster to another.

The ICTAS Doctoral Scholars Program was established in 2007 to honor exceptional Ph.D. applicants with a Graduate Research Assistantship. This program is a cooperative effort supported and coordinated primarily by ICTAS, with significant contributions from participating departments, colleges, and the graduate school.

Scholar Bill Vogt (left) presents to fellow scholars Daniel Vanden Berge and Rachel Umbel.

Dr. Robert Moore (right), ICTAS Associate Director for Research and Scholarship, examines a poster as scholars Matthew MacInnis and James Dale discuss the session. Moore is head of scholarship at ICTAS, and the doctoral scholar program falls under his purview.

Scholar Kyle Ashley (center) presents his poster and answers questions about his research.



Dr. Eugene Joseph (left), ICTAS Research Professor, listens to the presentation of doctoral scholar Daniel Youngstrom.

ICTAS Director Roop Mahajan (right), discusses the work of doctoral scholar Youssef Bichiou (left).

ICTAS-Funded Seed Awards 2012

ICTAS is pleased to announce that it will award financial support to 20 Virginia Tech faculty research teams. The 20 awards total $1,260,000 and will be available to recipients beginning July 1, 2012.

The 2012 ICTAS Request for Proposals (RFP) program solicited submissions from the Virginia Tech academic research community in response to two funding opportunities: (1) Junior Faculty Collaborative (JFC) proposals and (2) Transformative Science and Technology Seed (TSTS) proposals. The JFC opportunity encourages and supports collaborative research relationships between junior and senior faculty members on topics that align with the eight ICTAS research thrusts: Nanoscale Science and Engineering, Nano-Bio Interface, Sustainable Energy, Renewable Materials, Sustainable Water, Cognition and Communication, National Security, and Emerging Technologies. The TSTS opportunity supports interdisciplinary high-risk/high-impact research efforts capable of transforming a field of science and technology and thereby promotes significant growth for the university and ICTAS.

ICTAS received 145 white papers in response to the FY 2012 RFP announcement of December 2011. Following a preliminary review, 45 of the submissions were invited to submit a full proposal. These full proposals were then reviewed by 5 expert panels composed of Virginia Tech faculty from a wide range of academic disciplines who followed a National Science Foundation style review process. This review resulted in the recommendations for funding 16 JFC projects and 4 TSTS projects.

In assessing the applicants, Bob Moore, Associate Director for Research, ICTAS, said: "This year's RFP program stimulated a remarkable response in submissions from the faculty at Virginia Tech. I am particularly pleased to have had the opportunity to support the emerging success of many of our talented junior faculty. We look forward to great success from the seeds planted through this program."

The proposals selected for award follow (by category and in alphabetical order by title):

Junior Faculty Collaborative Proposals (JFC)

A Coupled Biochemical/Biophysical System to Remediate Diffuse Nitrate in Shallow Groundwater

Principal Investigators:	Dr. Mark S. Reiter (Crop and Soil Environmental Sciences) and Dr. Zachary M. Easton (Biological Systems Engineering)
Co-Principal Investigators:	Dr. Wade E. Thomason (Crop and Soil Environmental Sciences) and Dr. Brian L. Benham (Biological Systems Engineering)
ICTAS Thrust Area:	Sustainable Water

A Multi-Disciplinary Approach for Co-Design of the Cyber and Physical Components of Autonomous Miniature Air Vehicles

Principal Investigator:	Dr. Mazen Farhood (Aerospace and Ocean Engineering)
Co-Principal Investigator:	Dr. Sandeep Shukla (Electrical and Computer Engineering)
ICTAS Thrust Area:	National Security

A New Approach to Low-Power Design of Radios for Wireless Devices

Principal Investigator:	Dr. Kwang-Jin Koh (Electrical and Computer Engineering)
Co-Principle Investigator:	Dr. Dong S. Ha (Electrical and Computer Engineering)
ICTAS Thrust Area:	Cognition and Communication

A Novel Fiberoptic Microneedle Device for Therapeutic Cancer Vaccine Delivery

Principal Investigator:	Dr. Chris Rylander (Mechanical Engineering)
Co-Principal Investigator:	Dr. Elankumaran Subbiah (Veterinary Medicine)
ICTAS Thrust Area:	Nano-Bio Interface

Biodiscerned© Flight Kinematics for Articulated Flapping Systems

Principal Investigator:	Dr. Javid Bayandor (Mechanical Engineering)
Co-Principal Investigator:	Dr. Andrew Kurdila (Mechanical Engineering)
ICTAS Thrust Area:	Emerging Technologies

Carbon Footprint Monitoring of Earthmoving Construction Operations using Networks of Existing Cameras and Inventories of Greenhouse Gas Emissions

Principal Investigator:	Dr. Mani Golparvar-Fard (Civil and Environmental Engineering)
Co-Principal Investigator:	Dr. Linsey C. Marr (Civil and Environmental Engineering)
ICTAS Thrust Area:	Emerging Technologies

Co-verification of Critical Cyber-Physical Systems: A Formal Approach

Principal Investigator:	Dr. Chao Wang (Electrical and Computer Engineering)
Co-Principal Investigator:	Dr. Michael S. Hsiao (Electrical and Computer Engineering)
ICTAS Thrust Area:	Emerging Technologies

Design of Multiscale Heterostructures with Enhanced Energy Harvesting

Principal Investigator:	Dr. Marwan Al-Haik (Engineering Science and Mechanics)
Co-Principal Investigator:	Dr. Donald J. Leo (Mechanical Engineering)
ICTAS Thrust Area:	Nanoscale Science and Engineering

Electrocatalytic Flow-Through Metal Organic Framework Membranes for Sustainable Fuel Generation from a CO_2 Feedstock

Principal Investigators:	Dr. Amanda Morris (Chemistry) and Dr. Eva Marand (Chemical Engineering)
ICTAS Thrust Area:	Sustainable Energy

Magneto-optical Studies of Carbonaceous Nanostructures for Quantum Information and Other Applications

Principal Investigator:	Dr. Hans Robinson (Physics)
Co-Principal Investigator:	Dr. Giti Khodaparast (Physics)
ICTAS Thrust Area:	Nanoscale Science and Engineering

Model-Guided Metabolic Engineering of Plants

Principal Investigator:	Dr. Ryan Senger (Biological Systems Engineering)
Co-Principal Investigator:	Dr. Glenda Gillaspy (Biochemistry)
ICTAS Thrust Area:	Renewable Materials

Modular Biotemplates for Assembly and Patterning of Bio-inspired, Nanostructured Materials

Principal Investigator:	Dr. Tijana Grove (Chemistry)
Co-Principal Investigator:	Dr. Robert Moore (Chemistry)
ICTAS Thrust Area:	Nano-Bio Interface

Next Generation Data-to-Decision Systems for Disaster Response

Principal Investigators:	Dr. Christian Wernz (Industrial and Systems Engineering) and Dr. Naren Ramakrishnan (Computer Science)
ICTAS Thrust Area:	National Security

Sustainable Plant-microbial Interactomes to Feed an Impoverished World: Exploiting Gene Diversity for Fe and Zn Accumulation in Tubers of Potato and Its Interaction with Helper Microbes

Principal Investigator:	Dr. Mark A. Williams (Horticulture)
Co-Principal Investigator:	Dr. Richard Vellieux (Horticulture)
ICTAS Thrust Area:	Emerging Technologies

Tissue Scaffold Fabrication via Micro-Stereolithography

Principal Investigator:	Dr. Chris Williams (Mechanical Engineering)
Co-Principal Investigator:	Dr. Timothy E. Long (Chemistry)
ICTAS Thrust Area:	Nano-Bio Interface

Using the Generalized Langevin Equation Formalism to Reconstruct Dynamic Equations from Time Series Data

Principal Investigators:	Dr. Jianhua Xing (Biological Sciences) and Dr. Michel Pleimling (Physics)
ICTAS Thrust Area:	Emerging Technologies

Transformative Science and Technology Seed (TSTS)

A New Approach to Lightweight Armor Applications: Metal-Ceramic Composite Castings

Principal Investigator:	Dr. Alan P. Druschitz (Materials Science and Engineering)
Co-Principal Investigators:	Dr. Christopher B. Williams (Mechanical Engineering) and Dr. Romesh C. Batra (Engineering Science and Mechanics)
ICTAS Thrust Area:	National Security

Artificial Hair Cells as the Basis for New Methods of Treating Hearing Loss and Balance Disorders

Principal Investigator:	Dr. Donald J. Leo (Mechanical Engineering)
Co-Principal Investigators:	Dr. John W. Grant (Biomedical Engineering), Dr. Rolf Mueller (Mechanical Engineering), and Dr. Pablo Tarazaga (Mechanical Engineering)
ICTAS Thrust Area:	Emerging Technologies

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Please send comments and address corrections to Melissa Wade, *mwade05@vt.edu.*

Melissa Wade, editor | Alex Parrish, graphic designer

ICTAS-Funded Seed Awards 2012 (continued)

StREAM Lab Examination of Critical Watershed Processes Governing Dissemination of Agricultural Sources of Antibiotic Resistance

Principal Investigator:	Dr. Amy Pruden-Bagchi (Civil and Environmental Engineering)
Co-Principal Investigators:	Dr. W. Cully Hession (Biological Systems Engineering), Dr. Leigh Anne Krometis (Biological Systems Engineering), Dr. Kang Xia (Crop and Soil Environmental Sciences), and Dr. Katherine F. Knowlton (Dairy Science)
ICTAS Thrust Area:	Sustainable Water

Physicochemical Effects of Temperature and Water Chemistry on Streambank Erosion

Principal Investigator:	Dr. Theresa Wynn-Thompson (Biological Systems Engineering)
Co-Principal Investigator:	Dr. Matthew Eick (Crop and Soil Environmental Sciences)
ICTAS Thrust Area:	Sustainable Water


Troy Henderson

Henderson Heads $3 Million SPAWAR Project

Virginia Tech has been awarded a $3 million cooperative agreement with Space and Naval Warfare System Center Pacific (SPAWARPAC) in San Diego, California. Principal investigator for the award is Troy Henderson, Assistant Professor in Virginia Tech's Aerospace and Ocean Engineering Department. The ICTAS Center for Naval Systems (CNavS) will manage the relationship between SPAWARPAC and Virginia Tech. Over 24 faculty members participated in the proposal's development. This award calls for research in command, control, communications, computers, intelligence, surveillance, and reconnaissance. Under this task order award, individual faculty members or teams of faculty members will be tasked to conduct individual research projects. Dr. Henderson and his team kicked off the award with a visit to SPAWARPAC early in 2012.