

ASSIST *The Pulse*

NSF NANOSYSTEMS ENGINEERING RESEARCH CENTER FOR
ADVANCED SELF-POWERED SYSTEMS OF
INTEGRATED SENSORS AND TECHNOLOGIES

BHANSALI AND TEAM SENSE CORTISOL INNOVATION

ASSIST researchers from FIU push toward a new way to sense Cortisol

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Dr. Shekhar Bhansali and a team of researchers from Florida International University work toward an innovative approach to sensing Cortisol levels.



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The Pulse is the official newsletter of the ASSIST Research Center. Bi-annual issues contain valuable updates on industry research, applications, educational activities, and Center production.



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MESSAGE FROM OUR DIRECTOR



Dr. Veena Misra

It is with great pleasure that we bring you this next edition of the ASSIST newsletter. ASSIST Center's vision of building self-powered, wearable and wireless sensor systems to monitor personal health and personal environment and improve wellness is being realized in all three of its pillars: research, education and innovation. As we move into our third year, we have added strategic leadership in systems driven research by adding Dr. John Lach of UVA as the Center's Chief System Engineer. Under his leadership, we are targeting demonstration of two systems level Testbed prototypes in May of 2015. These include a health and environmental tracker (HET) that provides a high level of functionality by enabling correlation between various sensing modalities and a self-powered and adaptive low power platform (SAP) for continuous and vigilant health monitoring. To meet the specifications of these Testbeds, the Center has further focused its effort on low power electronics, human body harvesting, energy storage and low power sensors. We are also expanding connections with physicians to get their input on future sensing targets while also providing them with prototypes for medical validation. The Center has also added effort on data correlation since this is a critical piece in addressing the health care challenge. This

newsletter provides highlights on several of these areas.

ASSIST is uniquely positioned in that it's looking at both sides of the power problem: increasing the harvested/stored power and decreasing consumed power while at the same time ensuring that these self-powered systems maximize functionality and provide actionable value to the user. In the last few months, key research breakthroughs are emerging from the Center in many of its core areas. As an example, the Cortisol work from Dr. Bhansali's group at FIU illustrates how molecularly imprinted polymers can provide solutions to long term Cortisol monitoring. Scientists from Dr. Bozkurt's systems integration group team are providing Solibands (ASSIST's wearable sensor platforms) to Dr. David Peden (our medical director) for health studies and validation. We are also engaging with our industry partners such as [Device Solutions](#), [Phononic](#) and [Porticos](#) for materials, fabrication and prototyping support for our Testbeds.

Our industry workshop held at FIU, Miami, in October was a huge success and created many opportunities for partnerships between industry and ASSIST center researchers. In addition to the keynote talk given by industry sensors leader Dr. Janusz Bryzek, ASSIST industry members led panel discussions, provided feedback on research directions and engaged with students at poster sessions. The Center continues to grow in its industry membership and also in its sponsored research activity clearly indicating the relevance of our technologies in the industrial space. We also continue to engage with our scientific, medical, military board members for research strategy input and refinement of Center Testbeds. To further the interaction between ASSIST engineers and physicians, ASSIST is co-sponsoring a joint workshop with University of North Carolina called "Engineering Solutions to Health Problems" which will be held on February 27th, 2015 in Research Triangle Park.

Our students are the engine of the Center and as such are involved in many aspects of the Center. In recent months, our students have competed in the national perfect pitch competition in the area of hydration, participated in bimonthly seminar series, won local and national awards for wearable systems, engaged in international internships and are building a robust student community within the Center. To ensure a robust pipeline of excellent students for the Center, we have also sponsored several senior design projects on ASSIST related areas. We are also excited about our newly renovated laboratory and interaction space. Finally, we are very pleased to welcome Roy Charles as ASSIST's diversity director. Under his leadership the Center will implement plans to grow our diversity at the student, staff and faculty levels.

Thanks for all your support and interest in the Center. I hope you enjoy reading this newsletter and I invite you to give us your feedback and thoughts on our technical, educational and industry activities.

Thank you,
Veena Misra
Director ASSIST Center



Tom Snyder

Hello,

As I look back at the past few months, it's amazing how much has progressed in ASSIST. We've welcomed half a dozen new companies to our family since the annual NSF review. Based in large part on industry inputs and guidance, our testbeds have been re-architected, resulting in compelling systems to drive our vision. Research has advanced to the point of new invention disclosures at multiple partner universities and ASSIST faculty members have given key talks at a number of thought-leading conferences and events.

Thanks to all who joined the Industry Workshop at FIU in October. We had great participation and are incorporating your feedback as we evolve the research and educational programs, as well as how we interface with our industry partners.

Since the workshop, the Industry Advisory Board has elected Anita Watkins of Rex Healthcare as Chair of the IAB and Richard Copeland of Tyco Fire and Security as Vice-Chair. We have also recently welcomed [Shanna Rogers](#) to our team to manage our website and online presence, as well as research and information communications to the entire ASSIST community.

As always, we look forward to deeper engagement and I encourage you to become more involved as we move into the new year. One area in particular: our students will soon begin planning for summer internships. We are building a student portal for our website, in part, to connect students and industry in a more direct manner. Please send me your internship opportunities and I'll get them to the student community.

Finally, please mark May 19-20 on your calendars. We look forward to everyone's participation in our critical year 3 review with NSF at NC State University. Until then, happy researching! •

- Tom

Tom Snyder
Industry Liaison

Upcoming NSF Annual Review and Site Visit— May 19-20, 2015 at North Carolina State University

Mark your calendars—ASSIST will be having its third National Science Foundation Annual Review and Site Visit May 19-20, 2015, at North Carolina State University. This event is open to invited guests and all current and prospective ASSIST industry members. This event will be attended by research and education faculty, staff, and students from all our partner universities. This is an important meeting for industry to participate, capture the latest status of ASSIST projects, network with other participants in the Center, and provide valuable feedback to the NSF. We will hold an Industry Advisory Board meeting in conjunction with the event. For more information, contact Tom Snyder at tdsnyder@ncsu.edu. •

ASSIST Shines at 2014 Conferences



Industry Liaison Tom Snyder and graduate researcher Victor Sobral interact with visitors at the ASSIST booth



Graduate researcher Luis Lopez engages with visitors at the ASSIST booth at mHealth Summit 2014

Drawing crowds from many countries across the world, the mHealth Summit 2014 outside of Washington DC hosted a myriad of entities all interested in the same goal: improving the personal healthcare of individuals through mobile connectivity. The mHealth Summit is an international conference that focuses on the exchange of innovations within the mobile and connected health realms between a diverse range of businesses and personnel. With an impressive list of over 230 exhibitors, from start-ups to large scale operations, mHealth's exhibition floor boasted a wide variety of differently focused businesses, associations, universities, and research centers.

ASSIST held true to its customs and attended the DC area conference in December 2014. Represented by Industry Liaison Tom Snyder, Marketing and Communications Director Shanna Rogers, and two graduate researchers – Luis Lopez and Victor Sobral of the University of Virginia – the ASSIST Center displayed the fruits of our research to a plethora of visitors at the booth. In tow with our representatives to the exhibition floor were prototypes of the Ultra-low-power (ULP) System on Chip, thermoelectric harvesting examples and flexible, stretchable silver nanowire electrodes, as well as 2 undergraduate research projects discussed later within this newsletter.

ASSIST representatives captivated audiences at the show, resulting in a large quantity of new and valuable contacts, as well as fresh contact with existing industry members. A substantial amount of

visitors to the booth felt that the research being completed within the ASSIST Center will have a wide range of applications across many different industries, impacting personal health in a way that is more beneficial than ever before.

Along with the mHealth Summit, ASSIST researchers and faculty visited multiple other conferences across the United States including IDTechEX in Santa Clara. Director Veena Misra gave an important talk about wearable sensor systems for long term health and environmental monitoring at TSensors, Munich while Dr. Jess Jur gave a similar speech at the TSensors, Tokyo conference. ASSIST is rapidly gaining access to valuable partners within many different industries, including: medical and fitness devices and equipment, consumer technologies, satellite applications, and cosmetics.

As ASSIST continues to attend and exhibit at conferences across the world, our researchers and staff are increasingly gaining recognition and appreciation as thought leaders in the fields of ultra-low power and wearable devices. Exhibiting at conferences is allowing for the expansion of research and innovations for the Center and its counterparts.

To those who have visited and engaged with the ASSIST Center in and outside of conferences throughout the year 2014, we'd like to graciously thank you for your support and participation. We look forward to seeing you all at conferences throughout 2015. •

ASSIST Center Opens 4th Floor Collaboration Space



Dr. Veena Misra and ASSIST faculty members mingle with students, families and visitors to the 4th floor potluck unveiling



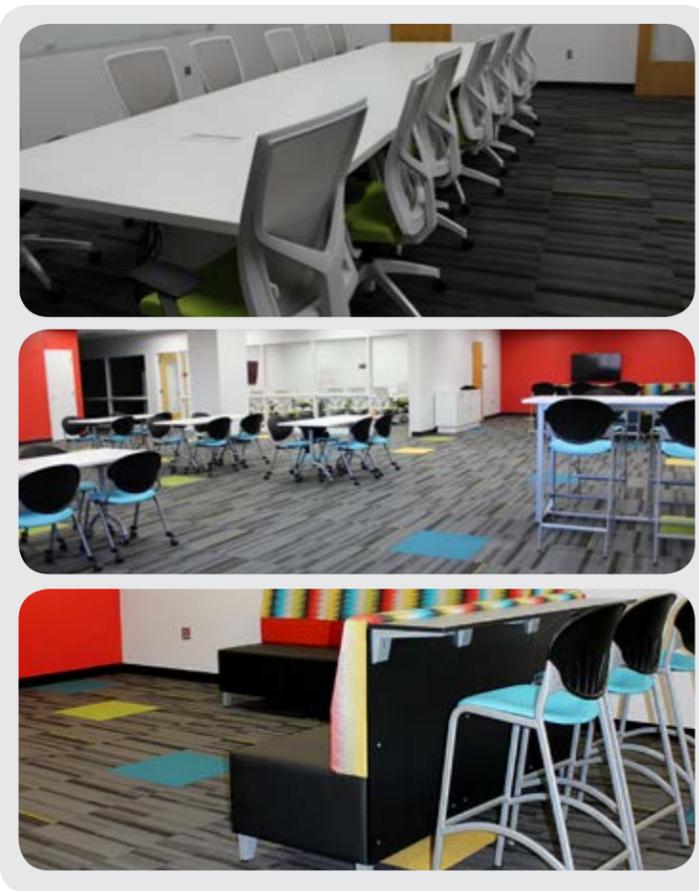
Industry Liaison Tom Snyder and Professor John Muth interact with graduate students in new 4th floor space

An aspiration of the ASSIST Center staff and researchers at North Carolina State University has now come to fruition. In the Monteith Engineering Research Center building on Centennial Campus, where the ASSIST headquarters is currently located, a new office suite will open its doors to all ASSIST related activities in conjunction with the Spring 2015 semester. One of the first events held within the new space was an ASSIST holiday party in December 2014, where researchers, families and friends congregated and participated in an event in which the name for the space was selected.

This renovated 4th floor office suite boasts a large conference room, a medical lab for clinical trials, an engineering lab for improved research efforts, and a slew of comfortable seating arrangements to harbor collaborative efforts. Medical workout equipment will allow for proper testing of each testbed and innovations that come from the Center. The new synergistic space will allow researchers, students, and industry members alike the ability to jointly work on research in a creative, open forum.

Industry Liaison Tom Snyder says that "the new 4th floor space is a setting where new and exciting research opportunities will be unlocked and where industry members and ASSIST researchers will be able to work hand-in-hand toward the betterment of personal healthcare."

With ASSIST gaining recognition and prestige throughout many industries as a thought leading innovation hub, this new space will allow for ongoing engagement and interaction between industry members and researchers in an inviting and relaxed atmosphere. •



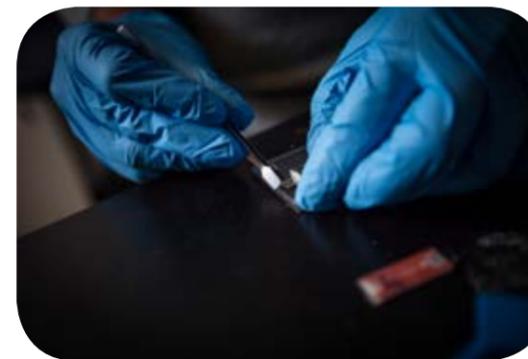
Bhansali and Team Sense Cortisol Innovation

Between the public, private and defense sectors, stress, whether internal or environmental, plays a strong role in personal health. Stress has increasingly become a major concern within the healthcare industry as it has been linked to many chronic illnesses.

Cortisol, in its inactive form, was first discovered by Edward Calvin Kendall and Harold L. Mason in 1939 as a steroid hormone released from the adrenal cortex. In its free form, it plays an important role in the regulation of various physiological processes such as blood pressure, glucose levels and carbohydrate metabolism. It is also instrumental in homeostasis of the cardiovascular, immune, renal, skeletal and endocrine systems.

Cortisol is the key biomarker for individual stress and its detection plays an integral role in the quantification of physiological and psychological stress in the body. Several techniques are available for the detection of Cortisol present in different body fluids. However, most of the established clinical techniques are logistically elaborate and time consuming. This prevents the immediate correlation between the factors causing the imbalances in Cortisol levels and early intervention.

Within the recent past, technologies have been proposed to implement a point of care device that employs optical or electrochemical immunosensors for use in the sensing process, all of which have run into serious roadblocks to commercialization. In light of this, ASSIST Researchers from Florida International University, headed by Dr. Shekhar



Researcher Khalid Pasha works on Cortisol research at Florida International University

Bhansali, are working diligently on a new form of sensing to counteract the shortcomings of current monitoring methodologies.

Bhansali and team are working on an innovative approach to sensing Cortisol levels: Nano-Enabled Molecular Imprinted Polymers. While molecular Sensors have been used previously for sensing in various other markets, this sensing technique has not previously been reported in Cortisol research.

Traditional sensors used for Cortisol detection are single use. Bhansali's team has a unique approach that enables the use of the same sensor multiple times - this process is similar to a puzzle where only a select few pieces fit together. One can bring together different pieces multiple times and only the right ones will fit.

Bhansali and team have been working on interfacing the Nanoparticle embedded sensing electrode with low-power electronics to make a hand held monitor for Cortisol detection as a first step toward a wearable sensor. This device can be used to detect Cortisol levels in patients at the point of care. •

VITALFlo Project Moves Forward After CIMIT Award



Co-Inventor, James Dieffenderfer, displays use of VitalFlo prototype.

VITALFlo, a project which developed out of an NCSU ASSIST sponsored graduate level course, has had exciting success over the year 2014. After being awarded NASA's TechBrief award, VITALFlo has won first place in the CIMIT (Center for Integration of Medicine & Innovative Technology) Student Technology Prize in Primary Healthcare, which awarded \$150,000 toward the project. This competition rewards students and innovators of advanced technologies that show progress in improving aspects of healthcare, including: access to medical care, support patients with chronic disease, or augment the physician-patient relationship.

James Dieffenderfer is quoted saying, "The CIMIT Prize for Primary Healthcare has enabled us to realize our vision for VitalFlo. The increased publicity and supporting funds have allowed us to take some critical steps in advancing this project from a simple prototype towards something that you'd find on the shelf of a store." •



Read the official NC State press release here:
<http://ow.ly/Fq2Zv>

ASSIST Faculty and Students Engage With Children's Museum



8th grader Victor Diaz participating in activities during a visit to Michael Dickey's lab, while ASSIST Director Veena Misra observes.

This fall, ASSIST faculty and graduate students opened their labs and shared their work with local middle school students and their families. Students, parents, and siblings had the opportunity to see a Scanning Electron Microscope in action, learn about nanowires and their fabrication, be amazed by backpack-wearing cockroaches, and use some of the tools and instruments ASSIST engineers use in their daily work.

The reaction to this event was extremely positive. Victor Diaz, an 8th grade student at Carroll Middle School, shared: "I found it really interesting. I especially liked the 3D printer with gallium and the laser cutter experiment, it was cool to use the computer to make physical structures and think about how that can be used in real life. I also

liked using the electron microscope because it was cool to see the textures of apparently smooth macroscopic objects at the microscopic scale, and see how those structures can affect things at the macroscopic level." Even the parents were engaged in learning about ASSIST. Victor's father noted about the field trip that "...it showed the children that there's a value and place for creative thinking far beyond childhood. For me, personally, I most enjoyed seeing in the presenters the qualities and traits that I see in my own child. I hope that it inspired him and opened his eyes to the potential I know he can live up to." Students and families were very appreciative of the faculty and graduate students who opened their labs and donated their weekend time to make the visit a success.

These tours at ASSIST were part of a collaborative grant Marbles Kids Museum (Raleigh, NC) received to create a program to introduce nanoscale science and technology to their audience of children 10 and under. Twenty local middle schoolers were selected through a competitive application process and formed Marbles' inaugural STEM Play Corp. These middle school students love science and enjoy inspiring young scientists. STEM Play Corp participants have taken part in hands-on learning with content experts, and have had the opportunity to visit STEM research facilities around the Triangle, including the ASSIST Center. They work alongside Marbles and ASSIST PreCollege educators to playfully engage younger kids in science play and share their knowledge of nanoscience and nanotechnology. The PreCollege team has been working with the Marbles STEM Play Corps to develop the next generation of scientists and engineers. •

Student Spotlight: NCSU Students Innovate for ASSIST Project

Each year, the ASSIST Research Center partners with NC State University's Electrical and Computer Engineering department to sponsor undergraduate senior design projects. This year's seniors worked in conjunction with Textile Design seniors to bring innovation to the forefront with an ECG Shirt Design that incorporated textile sensors which were comfortably embedded into a shirt and wirelessly linked to a mobile phone, outside of a medical facility.

The team attests that the project, in conjunction with ASSIST, has "given [them] a great opportunity to work hands-on with up-and-coming technologies and collaborate with many talented people." •



Katie Walker, Laura Gonzalez, Kevin Keller, Danny Beckman (from left) work on ECG Shirt Project

Student Leadership Council News



ASSIST students and faculty members participate in SLC's inaugural 5k run/walk/bike

ASSIST Races to Promote Wellness

The SLC hosted the inaugural ASSIST 5k run/walk/bike/any mode of active transportation. ASSIST Student Leadership Council encourages racers of all types to participate in the 5K to promote wellness and increased physical activity. Francisco Suarez was the first to cross the finish with other participants close behind. SLC would like to extend a sincere thank you to everyone who came out and offer congratulations, again, to Francisco! SLC will begin hosting frequent 5ks for ASSIST students, faculty, local industry members, and the public after the academic winter break. Stay tuned for more information.

Undergraduate Outreach

As the ASSIST Research Center has grown, so has the undergraduate population. With such interest in the center, a new

position was opened on the Student Leadership Council: an undergraduate representative. We'd like to extend congratulations to Marc Celestini for taking on this new role! We are looking forward to more undergraduates taking part in ASSIST activities.

The Perfect Pitch

ASSIST hosted a perfect pitch contest to select a finalist to compete at the biennial NSF meeting of all active ERCs. Congratulations to [Amanda Myers](#), [Eric Beppler](#) and [Danhao Ma](#) for first, second and third place, respectively, in our local competition. The ReNUWIt Center took home the national trophy this year but we'll make another strong showing next time! •

Student Spotlight: ASSIST Sponsored Seniors Steal the Show



ECE seniors David Brown, Aaron Martin, Jonathan Howell, and David Le (from left) win first in their category

A dynamic group of graduating seniors, sponsored and mentored by ASSIST member John Muth, captivated their audience with the development and prototyping of a wearable circadian rhythm device. Winning the first place ribbon for their prototype, which has the capabilities to acquire a wide array of data about a user's environment and physiological characteristics, has enabled the team to feel confident in their studies completed at NC State University.

Jonathan Howell expressed "The ASSIST-focused project has added an unquantifiable amount of value to my undergraduate degree. When interviewing with employers, the only topic of discussion is the Circadian Rhythm Measurement System Project..." •

Industry Member Spotlight: Premitec



The fields of research and medicine are making great strides to put into action the notions of advanced prosthetics, which are more commonly known in science fiction movies than real life. Companies are emerging within the new century as life-changing research and development institutes. Rather than continuing to treat symptoms, companies like Premitec are researching and prototyping implantable neuroprosthetic devices that can counteract underlying neurological disorders and ailments.

Premitec is an innovative research and development company creating advanced enabling technologies for life-changing biomedical devices. The company focuses on the components necessary for fully implantable, neural interface systems capable of recording physiologic or external signals, processing this information real-time, and triggering a response or providing sensory feedback. The technology portfolio under development includes high-bandwidth arrays of precision electrodes on formed, ultra-flexible substrates, embedded integrated electronics with high-density through-chip interconnects, engineered conformal barrier coatings for biocompatibility, and incorporated planar spiral coils for inductive power delivery and data telemetry. The nanofabrication process development is central to all of these efforts.

Premitec is located on the Centennial Campus of NC State University. Along with access to ASSIST students and researchers, Premitec has seen considerable benefits from being situated on NCSU's campus. The company has ready access to the university's nanofabrication facilities, which houses a few of the company's own processing tools. Since joining with ASSIST in early 2014, Premitec has been a beneficial research partner. With a

number of projects on the horizon, the union with ASSIST will become more rewarding than ever before.

Prototyping using the more mature aspects of their technology is a service Premitec offers and is one of the areas identified for increased involvement in ASSIST. Leveraging the company's expertise in nanofabrication of intricate, ultra-flexible devices could be advantageous as ASSIST continues the integration of components into system testbeds.

Premitec has secured partnerships with a host of very well-known universities to expand their research and development efforts; these universities including NC State, Duke, Georgia Institute of Technology, and Southern California. In addition to universities, Premitec has formed strategic partnerships with a few companies and research institutes.

To learn more about Premitec, please visit: www.premitec.com, scan the QR Code, or contact Helmut Eckhardt at info@premitec.com or 919-829-5659 •



Prototypes of Premitec's ultra-flexible neural interface devices including embedded electronics and multipolymer

North Carolina State University
Monteith Engineering Research Center
2410 Campus Shore Drive
Campus Box 7564
Raleigh, NC 27695-7564

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assistcenter@ncsu.edu
assist.ncsu.edu
phone: 919.515.1450
fax: 919.515.5055

