Annual Report

2014
2015

THE UNIVERSITY OF MEMPHIS

FedEx Institute of Technology

Professor Jasbir Dhaliwal, PhD.

The FedEx Institute of Technology has had a dramatic impact on the breadth and depth of interdisciplinary research and innovation across the university since its inception.

This report captures some of these successes from the past year. The next stage of its growth is now starting and we plan to build on the successes of the past to have a greater impact on our students, faculty, industry partners and community stakeholders. The interdisciplinary journey that started many years ago will be strengthened with the creation of truly inter-disciplinary research innovation clusters. These clusters will bring together not just individual faculty from different areas but also diverse research centers and disciplinary colleges to collaborate on new technology innovation areas that can impact our larger world. Areas of focus include cyber security testing, bio-logistics, analytics and data science, smart biomaterials, and healthcare.

As the front door to the university's research infrastructure and capabilities, the FedEx Institute of Technology has a unique role to play in attracting technology companies, organizations and innovators to the Mid-South. For example, the Institute is launching an Innovation in Action series to introduce emerging technologies to our region. Both internal and external partners will be involved in developing novel applications of these emerging technologies. A renewed focus on basic and applied research in areas of common interest and benefit can help the university quicken the flow in its innovation pipelines as it replenishes both its innovation core and intellectual property banks. The focus will be on speedy application and execution just as much as on intellectual property protection.

The Institute will also be capitalizing on the university's strengths in graduate programs to boost its intellectual environment and research culture. Nearly one thousand doctoral and close to three thousand masters students in 115 different graduate programs on campus will be invited to participate in interdisciplinary discourse and technology innovation at the FedEx Institute of Technology. This is also an open call for industry partners and community organizations to join these conversations by articulating their problems and needs so that these can be the focus of technology innova-tion and resolution.

Please enjoy the innovation successes described in this annual report and come visit us to connect and collaborate at this exciting time of renewal and revitalization!

Sincerely,
Professor Jasbir Dhaliwal, PhD.
UofM Chief Innovation Officer
and Executive Director of the
FedEx Institute of Technology

Stay informed.
Follow us on:

FedEx Institute of Technology
The University of Memphis
365 Innovation Drive
Memphis, TN 38152
memphis.edu/fedex

Editor
Cathy Carrigan

Research Innovation Clusters

In the coming months, the FedEx Institute of Technology will be launching Research Innovation Clusters which will focus on the university's critical areas of strength. Individual researchers, collaborative research groups and existing research centers across campus are contributing to this effort.

With the support of the FedEx Institute, members of the clusters will work together to apply for external research funding, seek external research partners, undertake common research projects, create training and certification programs for the community, organize seminars and workshops, and develop internship and research opportunities for students.

Three research clusters are currently in development. The Cluster to Advance Security & Testing (CAST) comprises a consortium of experts in cyber security testing to provide proactive leadership and cohesion to the region's responses to this constantly shifting challenge. CAST works on various certification, research, and curricular projects that open new avenues for leading-edge cyber security testing and ideation.

The Biomaterials Research Innovation Cluster will bring together researchers from several disciplines to develop materials that will give healthcare providers novel tools and treatments to address unmet medical needs. Localized drug delivery and bioprinting are two proposed areas of focus.

The Biologistics Research Innovation Cluster will bring the university's bioengineering, freight transportation, and bioinformatics groups together. Our region is uniquely positioned to take full advantage of the research capabilities of this group.

Dr. Santosh Kumar

MD2K
Center of Excellence for
Mobile Sensor
Data-to-Knowledge

Mobile Sensor Data-to-Knowledge (MD2K) Center of Excellence

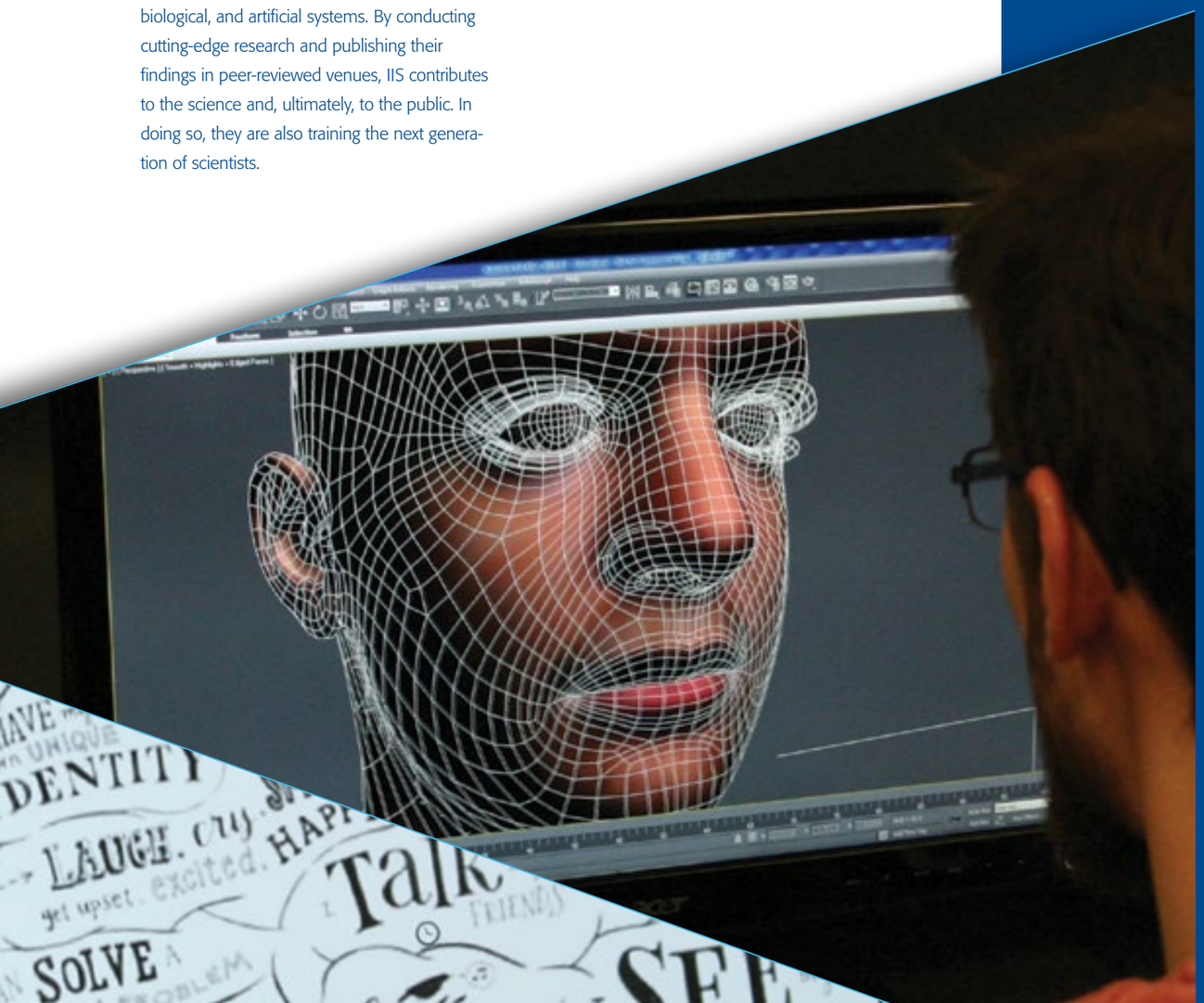
MD2K is one of 11 national Big Data Centers of Excellence awarded by the National Institutes of Health as part of its Big Data-to-Knowledge initiative. The MD2K Center brings together the top brains in computer science, engineering, medicine, behavioral science, and statistics, drawn from 12 universities and the non-profit Open mHealth. The MD2K Team is developing innovative tools to make it easier to gather, analyze and interpret health data generated by mobile and wearable sensors. The goal of the big data solutions being developed by MD2K is to reliably quantify physical, biological, behavioral, social, and environmental factors that contribute to health and disease risk.

The research conducted by MD2K is expected to improve the health of individuals through early detection of adverse health events and by facilitating prevention through just-in-time adaptive interventions. The MD2K team is directly targeting two complex health conditions with high mortality risk—reducing hospital readmission in congestive heart failure (CHF) patients and preventing relapse in abstinent smokers. The approach and product of MD2K will be also applicable to other complex diseases, such as asthma, substance abuse and obesity. The Center will make the MD2K tools, software, and training materials widely available and organize workshops and seminars to encourage their use by researchers and clinicians. The MD2K Center is led by University of Memphis computer scientist Santosh Kumar and is housed in the FedEx Institute.

Institute for Intelligent Systems

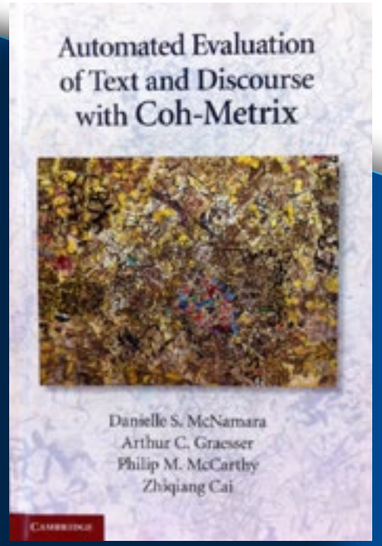
The Institute for Intelligent Systems (IIS), which is housed at the FedEx Institute, is a research center officially recognized by the Tennessee Board of Regents (TBR). Since its inception in 1985, the IIS has dedicated itself to advancing the state of knowledge and capabilities of intelligent systems, including psychological, biological, and artificial systems. By conducting cutting-edge research and publishing their findings in peer-reviewed venues, IIS contributes to the science and, ultimately, to the public. In doing so, they are also training the next generation of scientists.

This past academic year, IIS made significant progress toward their objectives. IIS has grown to 38 members from a diverse 16 departments. These researchers were awarded $2.7 million in new grants and produced 226 publications as journal articles, conference proceedings, book chapters, and books.



Coh-Metrix

The study of how humans use and respond to language has provided powerful insights into how we think, behave and even how we engage each other. However, traditional methods for analyzing text (e.g., word length and average words per sentence) don't deliver the sophisticated analysis needed to gain deeper insights and provide useful information. As the amount of text of all types (from formal to tweets and blog posts) has expanded exponentially with the growth of the internet, there is a clear business opportunity in mining this information to identify trends and sort comments based on sentiment analysis. Also, the ability to proactively analyze text written for specific needs and audiences would reduce the time required to deliver completed text while also increasing confidence in the quality of the final product. Coh-Metrix, an automated text analysis tool that was created in the Institute for Intelligent Systems at the University of Memphis FedEx Institute of Technology was developed to meet this need. Coh-Metrix has transformed into arguably the most comprehensive computational linguistics tool available to the public. The measures provided by Coh-Metrix reflect an advanced multilevel theoretical view of language, communication, and comprehension. Coh-Metrix extends beyond shallow level word counts to conduct a deeper level discourse analysis employing sophisticated natural language processing techniques, e.g. syntactic parsing and cohesion computation. Coh-Metrix has garnered significant attention across multiple fields and academic communities. Just in the last year, Coh-Metrix has been used to analyze and explore captured Iraqi and terrorist records at the Department of Defense, predict psychological functioning in PTSD populations, differences in fraudulent and genuine communication for deception detection, customer perceptions of Yelp and Amazon product reviews, students' cognitive and social processes during interactions in emerging



educational environments (intelligent tutoring systems, MOOCs and collaborative interactions). The increasing number of requests has stimulated a project, funded by the FedEx Institute of Technology and University of Memphis, focused on scaling up Coh-Metrix. This project will transform Coh-Metrix to a robust web-scalable platform that will allow for the analysis of large volumes of text in near-real time. This will make possible a number of strategically valuable research capabilities, and open up commercial opportunities.

SENSORIUM

Sensorium was established in 2010 by researchers in biomedical engineering, chemistry and electrical engineering. The goal was to invent novel technologies to improve our ability to detect clinically and environmentally important chemicals. The group's current work, aided by the addition of family medicine physician and electrochemist Dr. Bradford Pendley, involves the design and testing of a novel instrument that would give ER doctors advance warning of septic shock in trauma patients. The device under development would detect, in near-real time, the presence of molecular markers known to indicate the onset of shock. Septic shock is a leading cause of death in trauma patients. Because it is both very hard to control after onset and challenging to predict which patients will be affected, having a simple devise that provides clinicians with a clear signal that shock is eminent, will likely save lives and reduce cost of trauma care. This device is undergoing early tests. The university will protect the proprietary aspects of this new technology and will make it available to industry under exclusive license terms.

Center for Translational Informatics

The mission of the Center for Translational Informatics (CTI) is to provide expertise and resources to develop innovative informatics methods and approaches, to transform scientific data into knowledge, and to translate that knowledge into clinical research and practice, community resources and public health initiatives.

Currently, the CTI is involved in over 13 interdisciplinary projects including genomics, bioinformatics, molecular and physiological modeling, social network analysis, biomedical/health informatics, and community resource development. To date, CTI activities have resulted in 13 peer-reviewed scientific publications by its 11 UofM faculty collaborators. CTI external collaborators represent local companies and non-profit institutions.

In addition to supporting several currently funded projects, the following Center-driven activities have resulted in over $1.3M (direct costs) in new external grants: 1) FITKids Project—funded by TN Blue Cross Blue Shield Foundation; 2) System Dynamic Modeling of Child Growth and Cognitive Development—funded by the Bill & Melinda Gates Foundation; 3) Bioinformatics Certificate Program— Funded by the US Dept. of Labor through the Memphis BioWorks Foundation.

.

Dr. Erno Lindner

Dr. Edward Chaum

Propofol Measuring Technology

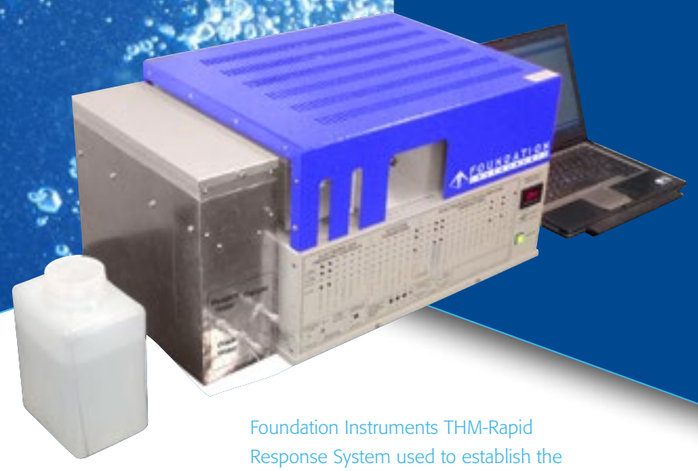
The general anesthetic and sedating agent propofol is the most widely used intravenous anesthetic in the world. It has been safely delivered by semi-automated pumps worldwide for over two decades using the method of target-controlled infusion anesthesia (TCIA) to target the drug level in patients. However, TCIA has not yet been approved by the FDA due to safety concerns about potential overdose. A novel technology invented jointly by Dr. Erno Lindner of UofM and Dr. Edward Chaum of UT Health Science Center will provide clinicians with a tool to accurately measure propofol levels in blood, in real time. This novel, patent-pending biosensor is under exclusive license by a Memphis-based startup called Infusense.

The original impetus for developing this technology was the need to provide army medics with a safer way to deliver propofol to wounded soldiers during transport from battlefields to medical facilities. A grant from the Army to Drs. Lindner and Chaum of $1.47M and a $100,000 grant from the Tennessee Technology Development Corp. provided key early funding for further development of this important tool.

With a market in the U.S. that consists of 130M surgical procedures per year, most of which include the use of propofol, there is also a compelling opportunity to improve outcomes for civilian patients and an attractive market opportunity for Memphis-based Infusense.

Foundation Instruments

Foundation Instruments, Inc. continues to grow with more utilities adopting their technology. The company is completing their $150,000 National Science Foundation Small Business Innovation Research (NSF-SBIR) Phase 1 grant and entering the competition for a Phase 2 award. The grant was awarded to develop a new device for measuring the concentrations of federally-regulated, carcinogenic chemicals produced during water disinfection at municipal water treatment plants. Currently, their flagship product has been adopted by plants in Tennessee, Arkansas and North Carolina in addition to its use by a major environmental engineering firm in the US. Plants from Minnesota to California are currently considering adoption and the coming year is looking very positive in terms of sales and potential investments. Foundation Instruments is a high-tech start-up company spun out from the University of Memphis. The company was founded by Gary Emmert, Wei Wu-Emmert and Paul Simone. Foundation Instruments received early support from the FedEx Institute of Technology.



Foundation Instruments THM-Rapid Response System used to establish the program for automated online monitoring of individual and total THM concentrations.

New Biology Fellow

Seunggwan Shin has joined the lab of Duane McKenna as a postdoctoral fellow in the Department of Biological Sciences. He was previously a visiting research scholar at North Carolina State University, and has an M.S. in Agricultural Biotechnology from Seoul National University in South Korea. He joined the McKenna lab to assist with the 1,000 Insect Transcriptome Evolution (1KITE) Beetle Project, the Insect 5,000 Genomes (i5k) Asian Longhorned Beetle Genome Project, and other insect comparative genomics and phylogenomics efforts in the McKenna lab, mostly involving beetle-plant interactions. The FedEx Institute has provided partial funding for Shin's position.

Seunggwan Shin

SupportScape, LLC

Supportscape offers Geographic Information Systems consulting and support to local government agencies. The LLC began as an internship project: an interdisciplinary initiative with funding from the FedEx Institute of Technology; consultation with the Center for Partnerships in GIS; resource availability through the Crews Center for Entrepreneurship; and course credit offered through Fogelman College of Business, all on the University of Memphis campus. The internship began with in-depth market research conducted through interviews with local GIS professionals, as well as contacts with Ecuador and the Philippines, to examine industry problems and scalable business concepts related to the fast-growing field of GIS. Business development and financial modeling yielded a viable business model based on high-touch customer service and expert assistance for over-worked, under-staffed local government offices with GIS capabilities. The company will offer packages, which include project assistance along with data migration and management, web development or data collection.

Office of Technology Transfer

The Office of Technology Transfer (OTT) continues to work closely with UofM faculty researchers to identify commercially-valuable inventions being developed in their laboratories. Since OTT opened in 2008, we have received 110 invention disclosures, filed 145 U.S. provisional, utility and foreign patent applications, received 22 issued U.S. patents, and signed 12 licenses and exclusive options.

New Inventions of Note

Adaptive Selection Strategies for Multi-Factor Authentication

Dipankar Dasgupta, Abhijit Nag and Arunava Roy

Multi-Factor Authentication (MFA) is the current trend to genuinely identify authorized users through the active authentication process using passwords, biometrics, cognitive behavior and others. As new authentication modalities are becoming available, they broaden the options for security researchers to devise more secure solutions to continuously authenticate users of online systems. This invention focuses on describing a framework for continuous authentication where authentication factors are selected adaptively by sensing the users' operating environment (the devices, communication media, and surrounding conditions).

Asad Nawaz

The Office of Technology Transfer sponsored a Lunch and Learn for UofM faculty and grad students in April. The guest speaker was Asad Nawaz, a Supervisory Patent Examiner in the U.S. Patent and Trademark Office. He spoke about differences in copyrights, trademarks and patents, and reviewed the patent application process.

Biodegradable Micelle as Efficient Gene Delivery System

Tomoko Fujiwara and Daniel Abebe

Gene therapy holds significant promise for treating human disease. This novel method to safely package and deliver therapeutic genes can be used for targeted applications that should extend the range of diseases treatable by gene therapy. Also, this non-viral, polymer-based gene delivery systems will potentially have a lower toxicity than other similar systems currently in trials.

Mitigation of Adverse Effects of GIC on Transformer by Fuzzy Controlled Variable Resistor

M. Hasan Ali

Geomagnetically induced currents (GIC) are the waves of energy from solar flares that disrupt the power grid and communications networks. Conventional approaches to mitigate the GIC are expensive and have no sophisticated control mechanism. Employing a mathematical and software tool called fuzzy logic, this invention will give power distribution equipment manufacturers a way to make transformers resilient to GIC.

Sensor-level Modular and Fully-Reconfigurable EEG and Other Body-Worn Sensor System

Bashir Morshed, Ruhi Mahajan

This breakthrough technology is the first to allow fully modular and rapidly reconfigurable sensor networks to reduce cost and increase patient-centric care options. Sensor modes that this technology will support include EEG, ECG, pulse oximetry and temperature.

Compositions and Methods for Enhancing Healing and Regeneration of Bone and Soft Tissue

Gary Bowlin and Isaac Rodriguez

This invention provides dentists and oral surgeons with a degradable membrane that supports guided tissue regeneration (GTR) and enhanced epithelialization while reducing or preventing bacterial infections after oral surgeries. Being resorbable over 6-12 weeks is a significant improvement over non-resorbable membranes or rapidly resorbable membranes: they don't have to be removed in a secondary surgery but they last long enough to provide the barrier function needed for full healing.

Patterned Carbon Nanotube Array for Dry Physiological Sensor
Bashir Morshed, Sergi Consul-Pacareu and Md. Nazmus Sahadat

Continuous sensing of medically-relevant signals from the human body requires conductive electrical sensing. Examples of such physiological data are EEG (electroencephalography), ECG or EKG (electrocardiography), EMG (Electromyography), and GSR (Galvanic Skin Response). Traditional sensors to obtain such physiological signals are wet (saline solution) or gel interface-based with an electrode material. These traditional interfacing of wet or gel only work for a short duration, as the performance of the sensors deteriorates with time, primarily due to evaporation. This invention relates to a novel dry electrode that uses patterned vertically aligned carbon nanotube sensor. The prototyped pvCNT sensors can maintain good conductivity through rough skin and thin hairs, do not degrade over time, and are able to capture signals with low noise.

Issued Patents

8,993,540 **Compositions and Methods for Delivering an Agent to a Wound**
Joel Bumgardner, Warren Haggard, Scott Noel

8,969,590 **Novel Autotaxin Inhibitors**
Abby Parrill and Daniel Baker

8,969,093 **Novel Calibration Method and Device for Remote Location Testing Instruments**
Gary Emmert and Paul Simone

8,780,345 **Spatially-Selective Disks, Submillimeter Imaging Devices, Methods of Submillimeter Imaging, Profiling Scanners, Spectrometry Devices, and Methods of Spectrometry**
Eddie Jacobs and Orges Furxhi

A Tennessee Board of Regents University. An Equal Opportunity/Affirmative Action Institution. Publication number UOM109-FY1516/1M1C