VANDERBILT

CTTC

Center for Technology Transfer
& Commercialization

DRIVING INNOVATION FORWARD »

Driving innovations to market.
Promoting collaborations with industry.
Generating revenue that supports future research activities.

Inside:

Practicing What We Preach

MTAShare

The title of this publication – Driving Innovations Forward – aptly describes CTTC's on-campus mission. We are an advocate for researchers to find tangible application for their discoveries to improve the human condition. ***To make easy that which is hard; to make possible that which is impossible***.

Occasionally an opportunity comes along to practice what we preach, to apply creativity and innovation to a problem in our local universe for a better outcome. One such example is the processing of Material Transfer Agreements (MTAs) for University researchers. CTTC processes more than a thousand MTAs annually to facilitate research between academic collaborators. We have experienced a forty percent increase in MTA requests over the past 5 years, and it is a constant struggle to keep up with demand with limited resources. We felt that the only solution was to create an electronic MTA processing system, and so we teamed up with Paul Harris, PhD and his REDCap team to create MTAShare (https://cttc.co/inventors/mtashare).

Through MTAShare, researchers requesting an MTA complete a short REDCap survey and submit it. Then the system interrogates the survey answers, selects the proper MTA from a bank of standardized templates, populates the MTA with information from the survey, aids the reviewer by providing system-generated warnings based on researcher responses to sensitive survey questions, places my signature on the MTA electronically once all warnings are cleared, and requests permission from our office to email the MTA to the other party – which we do with the click of a button. MTAShare has drastically improved our bandwidth for processing MTAs, but has also made us faster and more accurate, and has improved researcher satisfaction – a true win for everybody.

Our system has raised awareness of the benefits of MTA automation at other academic institutions across the country, and we are now working with an external software provider to build a scalable version of MTAShare that will be made available to universities, research institutions and other non-profit organizations across the country, and in fact, across the globe. When this program goes live later this spring and other institutions begin using MTAShare, the processing of Vanderbilt MTAs will become even more efficient, and the system will be able to not only recognize Vanderbilt, but will recognize other institutions as users, and can automate the processing on both ends. The more users of MTAShare, the more automated and efficient the system becomes.

To make this goal a reality, we have had to make some adjustments to the structure and function of MTAShare, to accommodate the differences between our partner's platform and the REDCap platform. The new system, when implemented at Vanderbilt, will function largely the same as the current version of MTAShare, but will have a bit of a different look and feel. It will also have some improved features for researchers, such as the ability to reuse old MTA requests instead of completing an entirely new survey when sending the same materials, or when sending materials to the same recipient institution. We will work through any questions and provide ample training, but the transition will be relatively smooth and the long-term benefits to researchers and administrators alike will be substantive.

We look forward to launching this new and improved MTAShare system on campus by the end of April, and, through our industry partner, to other institutions later in the Spring.

FY18 Snapshot

213
Invention Disclosures

5
New Startup Companies

$17.2M
Licensing Revenue

81
Licenses & Options

273
U.S. Patent Applications Filed

59
U.S. Patents Issued

10YR Snapshot

1744 Inventions
Representing 2,008 Vanderbilt inventors

402 U.S. Patents Issued

717 Licenses
Including 105 exclusive licenses

$109.5M Licensing Revenue

FY09-FY18

Vanderbilt Research

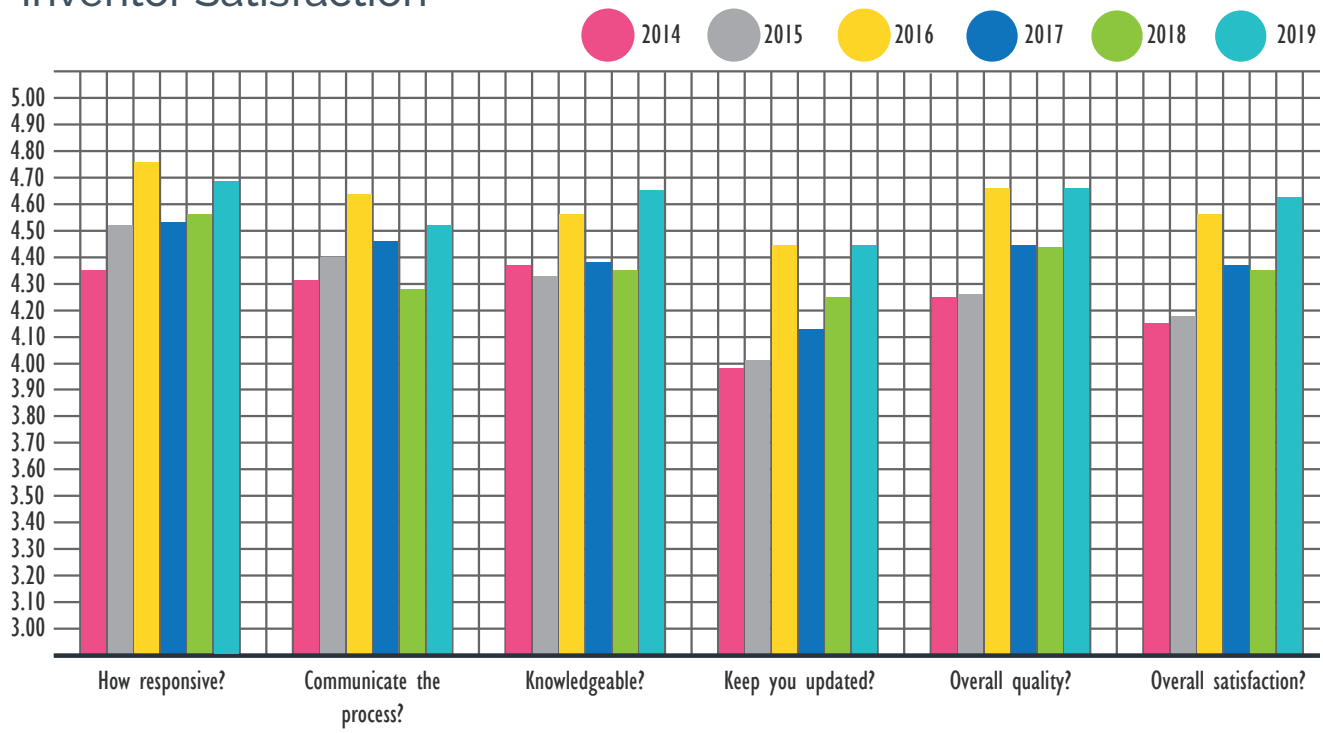
$5.88B
Total Research Expenditures

$4.26B
Federal Research Funding

$287M
Industry Sponsored Research

2009-2018

Inventor Satisfaction



Impactful Transactions

Vanderbilt has been on something of a roll the past several years in terms of closing multiple high-impact transactions – including both license agreements with substantial long term revenue potential and accompanying research funding agreements. Licenses generating the greatest short term revenue involve technologies originating from our portfolio of pharmaceutical innovations, though non-therapeutics make up the majority of our high-impact transactions. Below is a taste of some high-impact transactions completed last year.

Boehringer-Ingelheim

http://www.boehringer-ingelheim.com/

Boehringer-Ingelheim and Vanderbilt University further deepened their successful existing collaboration by expanding its focus in oncology and embarking on a new indication, specifically neuroscience. In addition to developing new chemical therapeutics targeting the cancer causing proteins KRAS and SOS, now the pro-survival protein MCL1 is being pursued. All three programs are being developed in collaboration with Stephen Fesik. The expansion into neuroscience is in collaboration with P. Jeffrey Conn and Craig Lindsley of the Vanderbilt Center for Neuroscience Drug Discovery (VCNDD) and focuses on the development of novel small molecules targeting two distinct G-protein coupled receptors (GPCRs) known to engage in the modulation of brain circuitries that are altered in neuropsychiatric conditions such as schizophrenia.

Cytoveris

https://www.cytoveris.com/

This Farmington, Connecticut-based start-up was venture-financed in 2018. The company's foundational technology for the intraoperative evaluation of tumor margins (e.g., breast cancer) originated from the Vanderbilt Biophotonics Center (https://www.vanderbilt.edu/vbc/) led by Professor Anita Mahadevan-Jansen. Currently the company is developing its MarginAssure™ probe and its TumorMap™ scanner products.

Synchro-Motion

https://www.synchro-motion.com/

This Nashville-based company has been formed for the development and deployment of rehabilitation robotics. Utilizing technology developed during their graduate research results, two students from Michael Goldfarb's Center for Intelligent Mechatronics (http://research.vuse.vanderbilt.edu/cim/) have teamed with him to commercially harden an ankle-knee prosthetic system. The company is pursuing several small business innovation research (SBIR) grants to advance this system. In addition, the company has received preliminary interest in joint development partnerships from several robotics-centric companies.

Industry Engagements

In 2017, "Industry Engagement" was added to the official metrics by which the productivity of our office is measured. In this context, industry engagement is represented by industry research dollars our office helps secure for faculty programs on campus. Since CTTC engages companies on a daily basis to discuss Vanderbilt-created innovations, the opportunity to advertise Vanderbilt's core research capabilities is a natural extension of such interactions. Connecting industry partners to Vanderbilt research capabilities is an important way for CTTC to contribute to the Vanderbilt research enterprise by generating millions of dollars in industry research support annually.

CTTC has reorganized our workflows to take advantage of such opportunities. CTTC helps identify both Project-level collaborations (where an industry partner funds a particular project in a particular researcher's laboratory) and Program-level collaborations (where an industry partner provides financial support for multiple research projects across multiple laboratories, departments and schools over multiple years, generally under the direction of a joint steering committee).

Below are some examples of Program-level research collaborations launched in the last year.

Ancora-Deerfield

Vanderbilt has partnered with Ancora Innovations, a Deerfield Management company, to accelerate the translation of research in Vanderbilt faculty laboratories into clinical therapeutics. The parties hold an annual RFP with the aim of supporting early stage novel therapeutics development to cure life-altering diseases. Through Ancora, Deerfield has committed up to $65 million in initial funding to support promising Vanderbilt translational research. This collaboration has already provided critical development resources for two Vanderbilt programs, and the parties will be searching for new programs that are a good fit with Ancora's funding priorities. See RFP announcement on this page.

Vanderbilt and Ancora Innovations launched their second annual RFP on March 14th. Ancora will fund projects with the aim of discovering novel therapeutics to cure life-altering diseases. The first RFP, initiated spring of 2018, resulted in two funded program that are well on their way in pre-clinical development. Therapeutics programs of all types are eligible for the collaboration, with particular interest in therapeutic antibody programs. More information about the Vanderbilt-Ancora collaboration is available on the CTTC website at:

https://cttc.co/collaboration/vanderbilt-ancora

Bayer

In early FY18, Vanderbilt finalized a collaboration with Bayer AG with a focus on funding and developing new drug candidates for the treatment of kidney disease. The goal of the collaboration is to accelerate the translation of innovative approaches from the laboratory to pre-clinical development toward new investigational drugs addressing the medical need of end stage renal disease. A joint committee selects from proposed projects to enter into the collaboration and throughout the five-year drug discovery project, both parties will contribute personnel and infrastructure to address those important scientific questions. The research hopes to end the long wait for effective therapies for kidney disease.

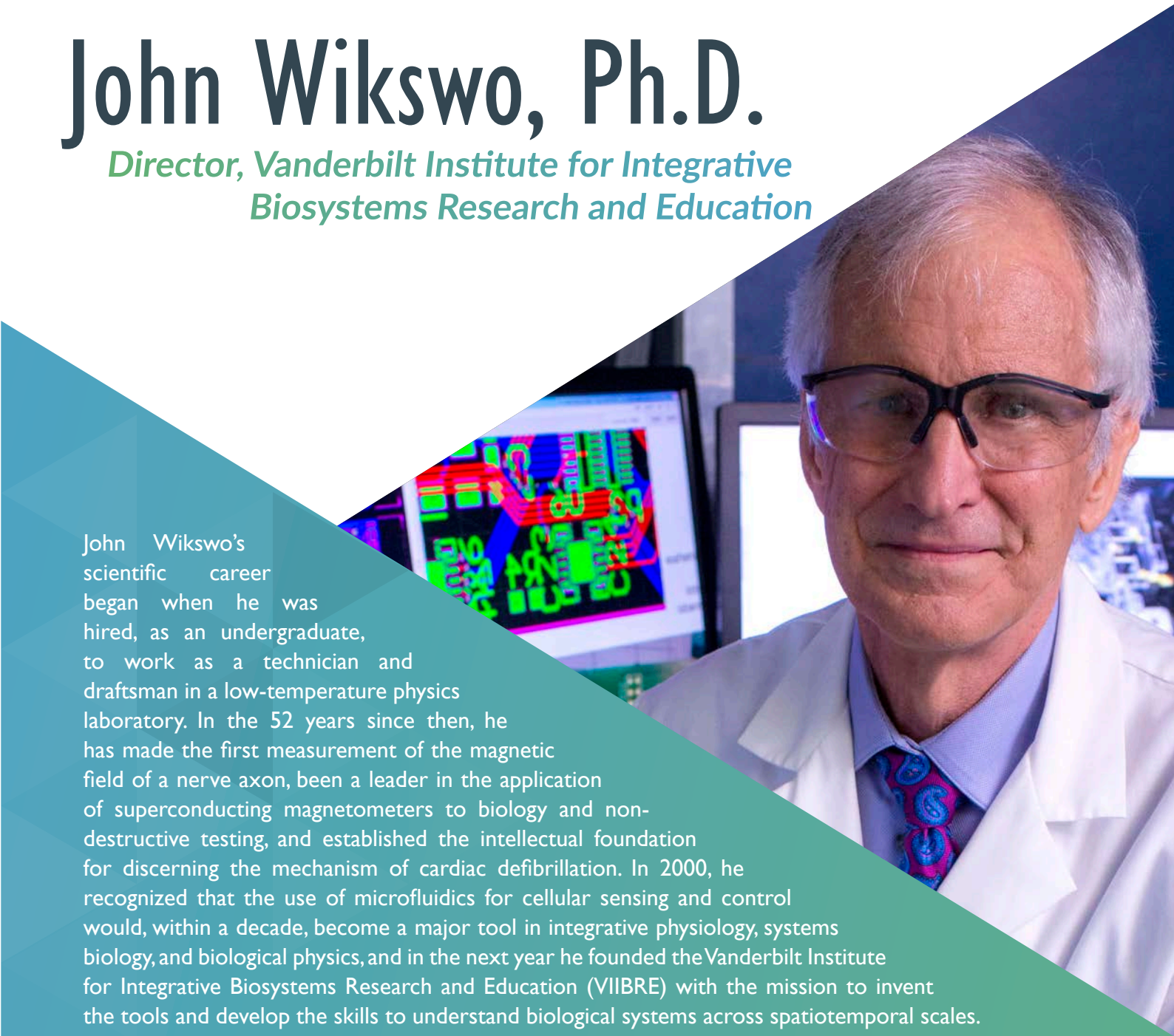
GE Healthcare

GE Healthcare and Vanderbilt have launched a partnership to enable safer and more precise cancer immunotherapies. Immunotherapies use the immune system to recognize and attack cancer cells and can be more effective than traditional treatments, but response rates are often low and side effects can be severe. The parties will team to develop new diagnostic tools to better predict both the efficacy of immunotherapy treatments and their adverse effects for specific patient populations before the therapy is administered. This will enable physicians to better target immunotherapies to the right patients and avoid potentially damaging, ineffective and costly courses of treatments. The parties will also develop AI-powered apps that draw on de-identified patient data to help physicians identify the most suitable treatment for each individual patient. The parties also plan to develop new positron-emission tomography (PET) imaging tracers, which together with the apps, will help physicians to stratify cancer patients for clinical trials.

FEATURED INVENTOR

John Wikswo, Ph.D.

Director, Vanderbilt Institute for Integrative Biosystems Research and Education



John Wikswo's scientific career began when he was hired, as an undergraduate, to work as a technician and draftsman in a low-temperature physics laboratory. In the 52 years since then, he has made the first measurement of the magnetic field of a nerve axon, been a leader in the application of superconducting magnetometers to biology and non-destructive testing, and established the intellectual foundation for discerning the mechanism of cardiac defibrillation. In 2000, he recognized that the use of microfluidics for cellular sensing and control would, within a decade, become a major tool in integrative physiology, systems biology, and biological physics, and in the next year he founded the Vanderbilt Institute for Integrative Biosystems Research and Education (VIIBRE) with the mission to invent the tools and develop the skills to understand biological systems across spatiotemporal scales.

Professor Wikswo has given talks at venues as diverse as meetings on the next generation of helium-temperature cryogenic refrigerators, in silico biology, complexity, parasitic diseases, quantitative systems pharmacology, toxicology, non-destructive testing of aging aircraft, biodefense, mass spectrometry, and cardiac arrhythmias. He holds twenty-eight patents, the first issued in 1976 for a method for measuring externally of the human body magnetic susceptibility changes.

Five of Professor Wikswo's most recently issued patents cover various integrated organ-on-chip systems and applications. He explains his academic titles and professorships in biomedical engineering, physiology, and physics as his being a carpenter, plumber, and electrician, and he is happiest when performing those roles, either using lumber, pipes, and wires at his house, or on a much smaller scale with living tissue in his labs at Vanderbilt.

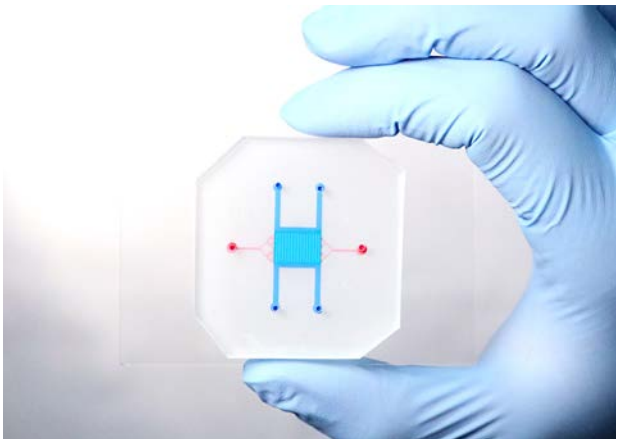
In their neuromagnetism research of the 1980s and 1990s, Professor Wikswo and his group perfected the magnetic measurement of conduction velocity histograms of human peripheral nerves and demonstrated this as an intraoperative tool for peripheral nerve repair. Their experimental and computational studies provided a quantitative understanding of the cellular sources of the magnetoencephalogram (MEG) – work that continues to be cited today.

Professor Wikswo considers his most significant scientific accomplishment to be the first convincing demonstrations of the role of the electrical anisotropy of the cardiac bidomain in both the generation of the cardiac magnetic field, and, more important, the defibrillation of cardiac tissue. His current work, however, which focuses on microfabricated organ-on-chip bioreactors and associated hardware for automated perfusion, control, interrogation, and interconnection of organ chips, may prove to be equally important.

The very idea of an organ on a chip sounds like something out of a science fiction novel: a device roughly the size of a USB flash drive that recreates a millionth of a human organ for scientific study. Thanks to the work of Professor Wikswo and many others in the tissue chips field, this revolutionary concept is being made a reality. It may change how drug development, environmental toxicology, regenerative medicine, and pharmacological and cancer research are performed well into the future.

> *"There is a lot of emphasis on hypothesis-driven science. My hypothesis is that if you invent a new measurement instrument or tool, you will discover or make something that's never been seen before."*
>
> *-- Professor John Wikswo*

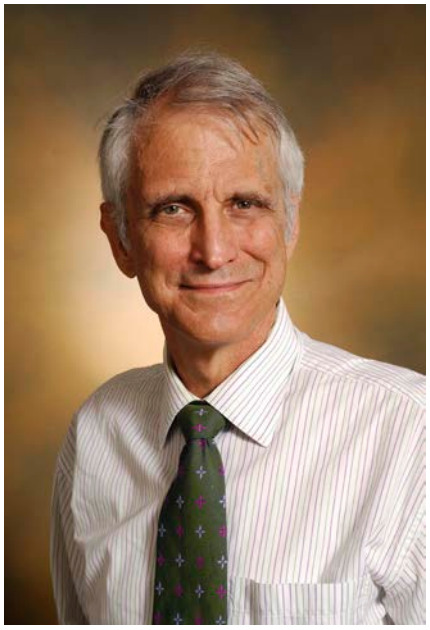
Organs-on-chips are designed to recapitulate the natural physiology and processes of human organs using only a small number of cells maintained in a microbioreactor. The tissue chips themselves incorporate a series of microfluidic channels that are lined with cells. By flowing fluid through the channels, the cells are kept alive and can be made to experience the same tissue microenvironment and even the same types of mechanical forces found in human organs. Connecting several organ chips together enables researchers to mimic systems of multiple organs.



Professor Wikswo and his collaborators are developing tissue chips that create in Vanderbilt laboratories a human blood-brain barrier, gut, liver, mammary gland, and heart muscle to study, among other things, genetic epilepsies, cancer, exposures to toxic environmental chemicals, and opioid use disorder. Couple enough organs and you've created what Wikswo refers to as a "homunculus-on-a-chip." Researchers elsewhere are using the technology to study Alzheimer's disease, Parkinson's disease, diabetes, and various rare genetic disorders.

Professor Wikswo has collaborated on several organ-on-chip projects with researchers at the Cleveland Clinic, the University of Pittsburgh, the University of Washington, Johns Hopkins University, and the Baylor College of Medicine. He is currently leading an NIH-funded effort with colleagues at Vanderbilt University Medical Center (VUMC), the University of Maryland, and Purdue University, and another involving VUMC, the University of Pittsburgh, and the University of Wisconsin. He regularly works with technological and pharmaceutical companies and Federal research labs.

Over the years, Professor Wikswo and his team have developed numerous systems and devices that have pushed the field forward, including novel microfluidic devices and integrated microfluidic measurement chips. One standout innovation is the MultiWell MicroFormulator, which provides precise, continuous, and dynamic control of the formulation, delivery, and removal of cell culture media to each well of a 96-well plate and was awarded an R&D 100 award as one of the most innovative technologies of 2017 (Professor Wikswo's second, the first having been won in 1984 for the Neuromagnetic Current Probe). Licenses to VIIBRE's pump and valve technologies have been issued to KIYATEC, Inc. and CN Bio Innovations, a UK company that develops human organ-on-chip technologies for the pharmaceutical industry. CN Bio has also licensed the MicroFormulator and will soon offer a commercial version, the PharmacoMimix™. The MicroClinical Analyzer patents have been licensed to Agilent.



"I hope that I can amplify the work of my mentors and continue a tradition of discovery and invention."

CN Bio Innovations

https://cn-bio.com/

This Hertfordshire, UK-based company develops human organ-on-chip technologies. The company's products are used by pharmaceutical companies to accelerate drug development. On February 27, 2019, the company announced the development of its PhysioMimix™ benchtop system that will connect human tissues for up to ten organs. The company has licensed technology from the Vanderbilt Institute for Integrative Biosystems Research and Education (VIIBRE) under the direction of Professor John Wikswo.

Several of Wikswo's issued patents and patent applications have undergraduates as co-inventors, bringing us to Professor Wikswo's teaching philosophy, which can be embodied in three quotations: "The mind is not a vessel to be filled but a fire to be kindled" (Plutarch); "You cannot teach a man anything; you can only help him to find it within himself" (Galileo); and "Education is what survives when what you have learned is forgotten" (B.F. Skinner). He loves to build and play with gadgets, help people learn to build things, and figure out and explain how things work – vocations he traces to his childhood.

In addition to teaching countless students since he came to Vanderbilt as an assistant professor in 1977, he has directed twenty-four Ph.D. and twenty-one M.S. degrees and mentored numerous students at both the undergraduate and graduate level, many of whom are continuing to advance science in their own research careers. VIIBRE coordinates its graduate and postdoctoral training with its Systems Biology and Bioengineering Undergraduate Research Experience (SyBBURE), a year-round, multiyear program funded by Gideon Searle, a Vanderbilt alumnus. SyBBURE's goal is to incubate and inspire the next generation of undergraduate innovators through research, design, and community. Since the program began in 2006, SyBBURE has mentored 299 students. SyBBURE students are inventors on eleven patents and patent applications.

"SyBBURE provides students with a demanding yet highly supportive collaborative environment where they are asked questions for which no one knows the answers, and are allowed to make technical mistakes without penalty. The students help run the program and learn from each other – in many ways, SyBBURE is a self-organizing, living system."

See what students have to say about the SyBBURE program and the independence it provides:

"SyBBURE is a community of self-directed undergraduate researchers. More than working in a lab - it is the opportunity to investigate as a full-fledged scientist - come up with your own questions and find your own answers."

--Xavier Ryan, Biomedical Engineering'17

"SyBBURE means diving into discovery and adventure. SyBBURE gives students the opportunity to discover something revolutionary."

--Orlando Hoilett, Biomedical Engineering'14

Entrepreneurship on Campus

Over the past five years or so, there has been a noticeable and building interest among Vanderbilt faculty, staff and students in entrepreneurship on campus. CTTC can claim a small contribution to this movement, but there have been many new programs across campus that support entrepreneurs. The Wond'ry has had a great impact by offering an environment and programs for aspiring entrepreneurs, including their Pre-Launch and Post-Launch programs, and their proctoring of an NSF ICorps Site grant.

Marie Thursby's inter-disciplinary Innovation Realization course has been teaching students how to evaluate and pursue new technology businesses, and the student-run Tech Venture Challenge provides student teams with the opportunity to compete in a technology-based business plan competition. Other programs like the Department of Radiology's Rad-X program and the School of Medicine's Enabling Innovation Initiative (https://my.vanderbilt.edu/ei2/) and its entrepreneurship lecture series inspire entrepreneurship throughout campus.

CTTC contributes to many of the aforementioned initiatives, and has developed processes that enable Vanderbilt researchers to evaluate opportunities to launch a new company (see https://cttc.co/new-ventures/new-ventures-commercialization-process).

We assist with feasibility assessments; customer discover research; identifying entrepreneurs to help run new ventures, advisors, and investors; and we vet new opportunities with our Entrepreneurship Advisory Council of local business expert, entrepreneurs and investors (see https://cttc.co/new-ventures/entrepreneurship-advisory-council). Vanderbilt has also joined a network of other universities to develop a matchmaking tool for connecting Vanderbilt companies looking for entrepreneur-leaders with technology-focused entrepreneurs across the east coast and southeast – more about this program below.

But nothing breeds interest in entrepreneurship on campus like successful Vanderbilt-affiliated start-up companies. We have highlighted several of our more recent new ventures below, and will be setting up a faculty-led entrepreneurship club on campus for existing and aspiring entrepreneurs. CTTC will help set up, but will not lead, this club – so members can talk about us, complain about us (!), share experiences, connect on leads for sources of capital, advisors, laboratory space – anything that supports a stronger entrepreneurial community on campus.

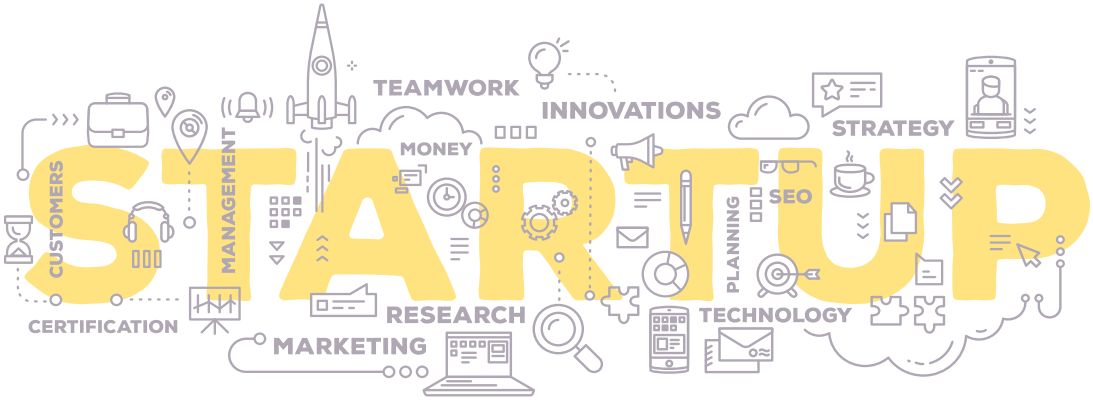
Academic Venture Exchange

For a variety of reasons, including a lack of regional entrepreneurs, faculty are often left to run their own newly formed start-up companies. Some faculty cherish the opportunity, while others would benefit from a talented entrepreneur expending effort every day to make the start-up company more valuable and more successful – something that many scientists cannot do while discharging their responsibilities as researchers and educators at Vanderbilt.

CTTC can serve as a bridge between scientists and regional entrepreneur talent, and we have a network of local entrepreneurs to match with new venture opportunities at Vanderbilt. We can also help aspiring entrepreneurs on campus connect with training and mentorship opportunities, such as the Life Science Tennessee Mentor Network (https://www.lifesciencetn.org/resources/81-2/).

> "SEC XOR is a sophisticated approach to address the very real need of matching expert management talent with technology-based new ventures. This program is another tool in our arsenal for enhancing the prospects for success of Vanderbilt-related startup companies, while also creating new opportunities for regional economic benefits."
>
> -- Alan Bentley, Assistant Vice Chancellor for Tech Transfer

But it is often the case that the optimal entrepreneur for a Vanderbilt start-up company is outside of the region, and CTTC, together with other prominent academic institutions, has developed an online system for seeking out such talent. Through CTTC, Vanderbilt is a member of the SEC-led Executives-on-Roster program in the southeast (spanning from Texas to Florida up to Virginia - http://ow.ly/4M6K30nPIHU), and is a member of the east coast Academic Ventures Exchange (spanning from New England down to the Carolinas). These online networks match experienced entrepreneurs vetted by participating universities with executive needs of companies spinning out of those universities. Anyone interested in this program should contact our office.



VenoStent

VenoStent was co-founded by Vanderbilt Ph.D. graduate, Tim Boire, and is focused on developing an external stent designed to reduce failures at the vein-graft or vein-artery junction of dialysis patients. The external stent technology is based on a series of shape memory polymers that were co-invented by Boire at Vanderbilt and can be made to conform to a specific shape when held at body temperature. Last year, VenoStent was accepted into the prestigious JLabs program in Houston, TX, a life science incubator founded by Johnson & Johnson to help healthcare companies grow and innovate by providing a network of investors and mentors as well as laboratory space. VenoStent has since been awarded an NSF STTR Phase I grant and has received STTR Grant Matching funding from LaunchTN. In November of 2018, VenoStent was recognized as one of the Top 10 Most Promising Companies by the Texas Life Science Forum.

VoluMetrix

Founded by Susan Eagle, Colleen Brophy, Research Fellow Kyle Hocking, and former MD/PhD student Richard Boyer, all from VUMC, and by VU Biomedical Engineering Professor Franz Baudenbacher, VoluMetrix is a prime example of the innovation fostered by close collaboration between VUMC and the VU School of Engineering. VoluMetrix is focused on developing low-cost, non-invasive devices that measure patient fluid status based on venous waveform analysis. This technology can be used, for example, for real-time fluid volume status assessment to help outpatients with congestive heart failure avoid hospital admission for fluid overload. VoluMetrix has successfully raised significant federal funding, having received both an NSF Phase I STTR grant and an NIH Fast Track Phase I/Phase II grant.

The Killer V's

If you have recently launched a new company at Vanderbilt that begins with a "V", you are probably headed for some level of success. We have had a run on V-named faculty start-up companies, and no - in none of them does the "V" stand for Vanderbilt.

VasoPrep

VasoPrep Surgical is a medical device company formed around new technology and tools to treat and prevent vein graft failure (VGF) associated with bypass surgeries. The new technology for treating and processing a vein graft ex vivo during surgery before transplantation to increase preservation and reduce damage to the vein was created by a team of Vanderbilt researchers, Colleen Brophy (Founder), Joyce Cheung-Flynn, Kyle Hocking and Padmini Komalavilas in the Vascular Surgery Department and Susan Eagle in Cardiothoracic Anesthesiology. VasoPrep exclusively licensed the technology from Vanderbilt. Sales of the VasoPrep Surgical Vein Preparation Kit are expected to begin in 2019.

Virtuoso

This Nashville-based Vanderbilt start-up originated from a partnership between Bob Webster's surgical robotics laboratory and the expertise in urologic surgery of Duke Herrell. The company is developing a minimally invasive endoscopic robotic surgery system for a full range of endoscopic applications. Since its inception in 2016, the company has continued to grow and generate interest in the med-tech community (see MedTech Strategist, January 16, 2019).

Startup Spotlight

KARL ZELIK

Karl Zelik, Assistant Professor of Mechanical Engineering, and his team at Vanderbilt University have developed a mechanized "smart" garment aimed at relieving stress on the lower back. The garment is specially designed for people engaged in lifting, leaning and bending activities. This includes a range of activities from moving and sorting boxes in logistics facilities to doctors and nurses who spend significant amounts of time bending and leaning in the operating room and in clinics. The operation of this device is based on careful and thorough scientific measurements of muscle activity, collected in a series of laboratory studies performed by graduate student Erik Lamers.

When the device is activated, it offloads up to 43% of the stress off the wearer's lower back muscles, by redirecting forces through the garment instead of the muscles. When it is deactivated, it loosens so that sitting and other activities not requiring lower back support are not impeded – unlike other competing devices. The device has a low profile allowing it to be worn under clothing. Additionally, this smart garment is simpler, more effective and less expensive than other products currently in the market.

LOW BACK PAIN COSTS PER YEAR

$30B
MEDICAL EXPENSES

$70B
OTHER

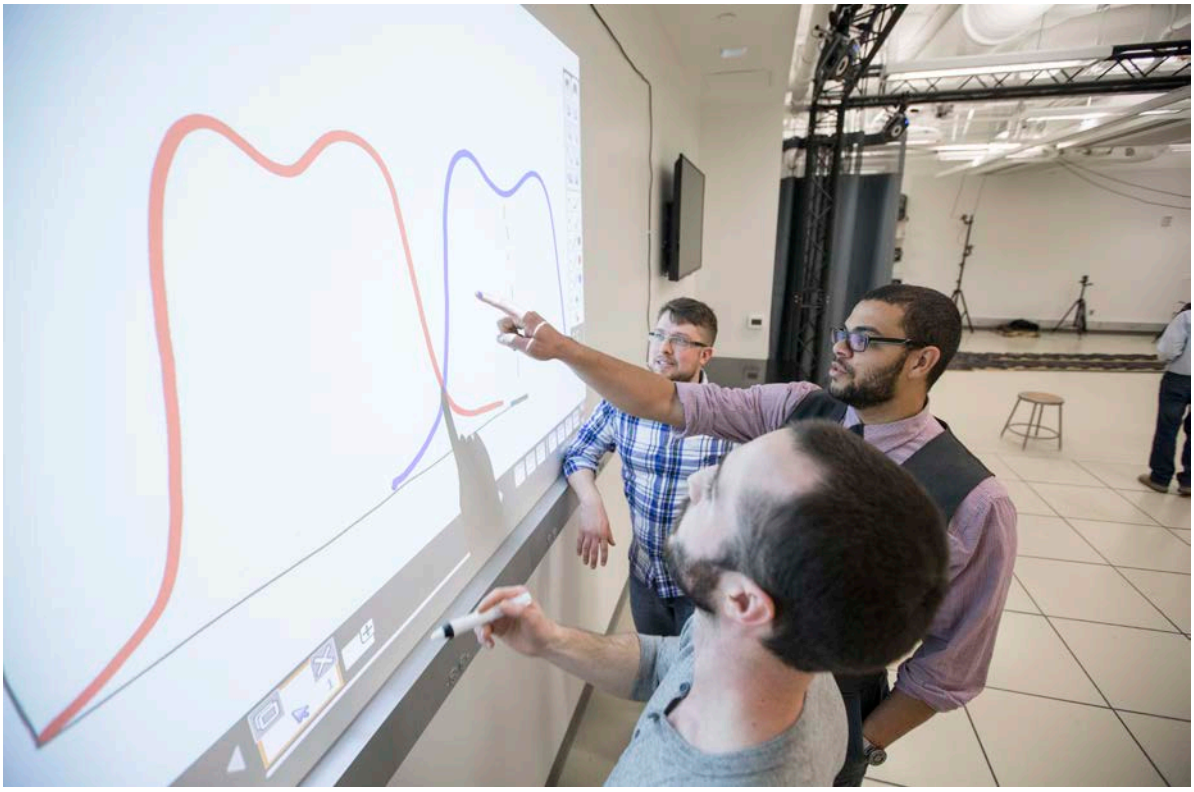
$100B
LOST PRODUCTIVITY

Zelik and one of his graduate students, Matthew Yandell, have formed a startup company called HeroWear LLC. They are actively working with CTTC to further develop the prototypes, draft a business plan for the company, and connect with potential customers and investors. They are also working with a member of the CTTC Entrepreneurship Advisory Council who is assisting them.

The HeroWear device has been demonstrated for several of the largest logistics companies in the world. The reception and interest have been overwhelmingly positive.

80%
LIFETIME INCIDENT OF BACK PAIN

20%
NO BACK PAIN



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