



\$30.2 MILLION

NSF Funding at Vanderbilt in FY 2019

19

Active NSF CAREER Awards in FY 2019

7

New NSF CAREER Awards in FY 2019

Catalyzing cyber-physical research across the nation

Vanderbilt University researchers are leaders in cyber-physical systems research, extending the use of the internet to create a deeply connected world where humans, their machines, and the physical environment interact seamlessly, continuously, and without mistakes and breakdowns that could lead to safety issues.

Vanderbilt's Institute for Software Integrated Systems is managing the Cyber-Physical Systems Virtual Organization for the National Science Foundation, linking together all of the organizations working on the topic, archiving and disseminating documents produced by research, and offering collaboration and experimental platforms for thousands of CPS researchers. Since 2015, the institute has received over \$9 million in grants from NSF to develop and test the incorporation of social norms, policies, and values into these new generations of systems.

NSF I-Corps Program at Vanderbilt

The I-Corps program prepares scientists and engineers to extend their focus beyond the university and accelerates the economic and societal benefits of NSF-funded research projects that are ready to move toward commercialization. To date, the Vanderbilt I-Corps site has supported more than 115 teams of researchers in identifying product opportunities for their ideas; 46 percent of the teams have been led by women. Participants have worked on a wide range of projects, including a virtual reality tool to treat addiction, a blockchain-enabled fintech product that allows refugees to safely access their money when fleeing persecution, and an advanced cybersecurity



A Vanderbilt Ph.D. student studies a stalagmite in Mawmluh Cave in India to find a connection between rainfall amounts and climactic conditions in the region. (Vanderbilt University)

solution that protects against ransomware attacks. The participants have won at SXSW, been accepted into Techstars (a program that provides entrepreneurs with financial, human, and intellectual capital to fuel the success of their businesses), hired their first employees, and licensed their technologies to strategic partners.

Since 2017, more than 15 teams of Vanderbilt students and faculty have been accepted into the National I-Corps program, each receiving a \$50,000 grant to explore the commercial potential of their research. These grantees gain skills in entrepreneurship through training in customer discovery and product market fit with guidance from established entrepreneurs. Six of the teams have already gone on to receive significant additional funding from grants and venture capital.

Recent CAREER Awards at Vanderbilt

NSF's Faculty Early Career Development (CAREER) Program offers the foundation's most prestigious awards in support of early-career faculty who exemplify the role of teacher-scholars through outstanding research, excellent education, and the integration of education and research within the context of their organizations.

- An assistant professor of mechanical engineering received a CAREER award to study how lithium-ion batteries for vehicles and for renewable electricity grid storage could improve domestic energy security. The professor will conduct fundamental research on advanced solid-state hybrid electrolytes that show potential for greater energy density while remaining safe to use. This will help assess the performance gaps in cost and battery life, which ultimately limit their use.

- An assistant professor of chemistry received a CAREER award to better understand how the molecules in human breast milk promote or suppress the growth of specific gut bacteria in infants. The gut microbiome helps us digest food and fight pathogens. The project also integrates an outreach program to teach carbohydrate science to children at the Martha O'Bryan Center, an anti-poverty, non-profit organization in Nashville, Tennessee.
- An assistant professor of chemical and biomolecular engineering received a CAREER award to investigate if the stiffness of the molecular network that provides structural and biochemical support to surrounding cells, also known as the extracellular matrix, is one of the causes of dysfunction of the blood-brain barrier. The blood-brain barrier may be compromised in various brain diseases, but the reason for this change is often unclear. These results will provide key insights into fundamental processes related to the progression of changes in brain vascular physiology due to aging or disease.

Negative stereotypes, racial disparities, and non-academic career paths for STEM students

NSF has supported the work of an associate professor of education, diversity, and STEM at Vanderbilt Peabody College of education and human development as she researches racial and gender disparities in the STEM workforce.

She studied the collegiate experiences and academic and career decisions of 61 black, Latinx, and Asian advanced undergraduate STEM college students from six U.S. postsecondary institutions. She found that high-achieving black students are working to defy stereotypes of intellectual inferiority, while Asian students are trying to uphold the “model minority” stereotype about their intellectual superiority.

She also examined factors that dissuade engineering and computing doctoral students in the U.S. from pursuing a career in the professoriate. Respondents were critical of institutional norms that lead to stress related to grant writing, publishing, and promotion as junior faculty.

Another initiative is surveying and interviewing black, Latinx, and indigenous Americans with engineering Ph.D.'s who are not directly using their engineering skillset after switching from an engineering job into a non-engineering job or transitioning into a leadership or administrative position. The team will then develop and examine a measure called “equity ethic,” which manifests in engineers and computer scientists as having intentions or taking steps to use one's engineering-specific skills and positions to address equity concerns.

Stalagmite holds key to predicting droughts, floods for India

With support from an NSF graduate research fellowship, a team of Vanderbilt earth scientists returned to an unusual cave in India to unlock secrets about climate change that could have far-reaching implications for agriculture. They studied the last 50 years of growth of a stalagmite from Mawmluh Cave in the northeastern Indian state of Meghalaya, an area that experiences so much summer monsoon rainfall that it is credited as the rainiest place on Earth, and found an unexpected connection between winter (dry season) rainfall amounts in northeast India and climatic conditions in the Pacific Ocean. Winter rainfall following weak monsoon years can alleviate water stress for farmers in India. This distant link between land and ocean records could aid in predicting dry season rainfall amounts in northeast India.



A photo of the stalagmite in the Mawmluh Cave in Northeast India before it was collected. (Vanderbilt University)





NSF and Vanderbilt expand STEM education opportunities

Training for graduate students in STEM

Eighteen Vanderbilt graduate students won NSF graduate research fellowships in 2019, bringing the total number of fellows at Vanderbilt to 65. The fellowships provide three years of support and are aimed at aiding individuals who have demonstrated notable potential early in their research careers and increasing the diversity of the science and engineering workforce.

Tennessee State University and Vanderbilt are partnering to lead an expansion of the Tennessee Louis Stokes Alliance for Minority Participation (TLSAMP), an NSF-funded collaborative effort by 10 Tennessee colleges and universities to improve the retention of underrepresented minority students in STEM fields statewide. The goals of TLSAMP are to significantly increase the number of underrepresented minority students matriculating into and completing high-quality degree programs in STEM disciplines and to increase the numbers of minority STEM graduates that are highly qualified and prepared to enroll in graduate programs.

A \$3 million grant from NSF will establish a first-of-its-kind graduate traineeship program at Vanderbilt called Neurodiversity Inspired Science and Engineering which will train a new generation of engineers and scientists to develop AI-based technology and tools to train, connect, and support people with autism spectrum disorders in finding jobs and succeeding in the workforce.

Research Experience for Undergraduates

Vanderbilt Institute for Nanoscale Science and Engineering has hosted an NSF-funded Research Experience for Undergraduates site program on campus since 2011. VINSE REU attracts undergraduates from across the country to Vanderbilt and provides valuable supplementary enrichment and social activities to the participating students. In its nine years of operation,



A team of Vanderbilt researchers work an interactive prototype that prepares applicants with ASD for job interviews. (Vanderbilt University)

VINSE REU has provided opportunities to 101 students who have gone on to win national awards, including 17 NSF graduate research fellowships.

INCLUDES Programs

Vanderbilt received one of NSF's inaugural INCLUDES (Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science) awards. That award supported a pilot program to find innovative ways to improve the success of students with disabilities in STEM disciplines.

Additionally, a Peabody College researcher is among an alliance of researchers funded through INCLUDES who have been tasked with forging pathways to STEM careers for people who are, or were, incarcerated. The project's mission is to make educational programming for STEM careers and college study commonplace, accessible, and rigorous in U.S. prisons and reentry programs.

Training for teachers

Researchers at Vanderbilt Peabody College, in partnership with Fisk University, will establish a second Robert Noyce Teacher Scholarship Program. Noyce scholarships, funded by NSF, are designed to recruit and prepare high-quality STEM teachers for high-need school districts.

