

PURDUE UNIVERSITY

Discovery Park

MID-YEAR REVIEW | 2018-2019



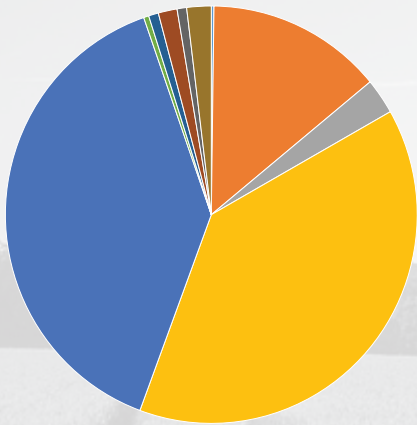
15 YEARS OF **GIANT LEAPS**
PURDUE UNIVERSITY

Big Idea Challenge

This initiative continued as a means to spark additional interdisciplinary research on global challenges in health, global conflict and security, and sustainability.

AWARDS BY SPONSOR

CTSI	\$38K
DoE	\$2.5M
NIFA.....	\$.5M
NSF.....	\$7M
ONR	\$7M
PHS-NIH-Fogarty Intl. Center.....	\$73K
Purdue-Mellon	\$140K
Sandia National Lab.....	\$267K
Science Applications Intl.	\$136K
UNSA	\$347K
Total.....	\$18.1M



- ◆ CTSI
- ◆ DoE
- ◆ ONR
- ◆ UNSA
- ◆ Science Applications International
- ◆ NIFA
- ◆ NSF
- ◆ Purdue-Mellon
- ◆ Sandia National Lab
- ◆ PHS-NIH-Fogarty International Center

Dear Friends,

Another extraordinary year is well underway at Discovery Park as we celebrate Purdue University's 150th Anniversary year. At this mid-year point, it is clear that we are making "Giant Leaps" in impacting global health, global sustainability and global security.

As Purdue University's hub and open laboratory for interdisciplinary collaboration, Discovery Park researchers continue to strengthen our strong reputation and further advance our prominence nationally and beyond. As proof of this tremendous interdisciplinary research activity, Discovery Park is again on pace to exceed last year's record sponsored research funding. Overall sponsored research funding has so far generated \$330.7 million at Purdue University with Discovery Park funding contributing \$115.4 million of that total.

This upward trend of sponsored research funding can be attributed to many things: strengthened federal and industrial interest in emerging research areas such as quantum information science, artificial intelligence, trusted microelectronics, and autonomous systems; growing national and international partnerships focused on pressing global sustainability issues; and renewed financial support for creating proactive, patient-oriented, wellness-focused healthcare delivery systems. Discovery Park is proving that it is uniquely equipped, due primarily to the dedication of its faculty and staff, to help find solutions for all of these grand challenges. As a result, our worldwide recognition and reputation continue to enjoy exponential growth.

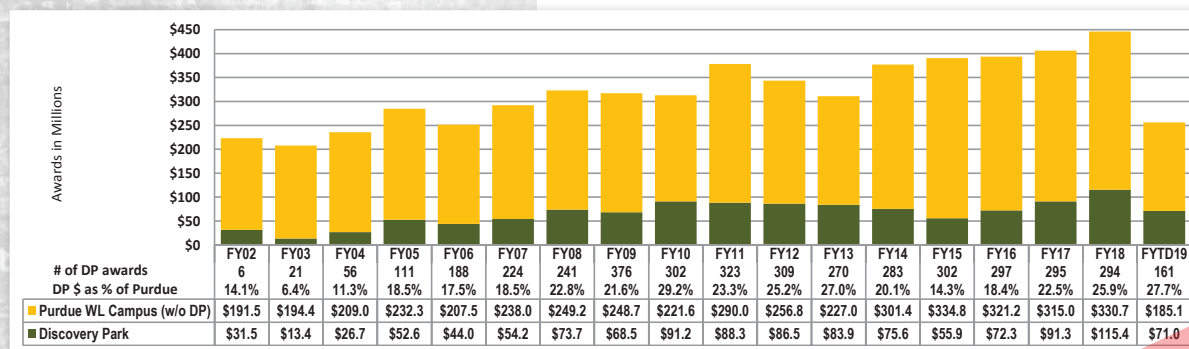
Throughout Purdue's "sesquicentennial" year, I wish you a very happy and successful 2019. I invite you to learn more about our mission by visiting Discovery Park and the mission of all of our research centers and institutes. Lastly, I encourage you to follow Discovery Park on Facebook, Twitter, Instagram and LinkedIn to receive the latest updates.

Cheers!



Tomás

Discovery Park and Purdue West Lafayette Campus Awards



Purdue WL Campus	
225.7	Dec of FY18
256.1	Dec of FY19
13.5%	% change

Discovery Park	
51.8	Dec of FY18
71.0	Dec of FY19
37.1%	% change

↑ 37.1%

Discovery Park centers and institutes focused on the Impacting Global Sustainability Strategic Theme bring specialized research in the areas of food security, environment, climate change and alkane energy resources.

Center for Global Food Security (CGFS)

Center for the Environment (C4E)

Purdue Climate Change Research Center (PCCRC)

Center for Innovative and Strategic Transformation of Alkane Resources (CISTAR)

Joint Transportation Research Program (JTRP)

GLOBAL SUSTAINABILITY



PURDUE CENTER FOR GLOBAL FOOD SECURITY

PURPOSE

The Purdue Center for Global Food Security (PCGFS) helps to ensure that we have enough food, feed and fuel for the 21st century and beyond.

GOALS

- Provide Global Leadership
- Create Global Public Good
- Build Human and Institutional Capacity
- Strengthen and Grow Partnerships
- Develop Entrepreneurial Capacity

Colloquium Organized

- A high-level colloquium has been organized for April 10-11, 2019 to gather global experts engaged in combating world hunger to discuss actions for addressing food insecurity. A signature conference is planned for September 2019, most likely in New York City, with the participation of global leaders from the UN and world governments.

Building Capacity

- The Center for Global Food Security is building the capacity of two universities to conduct research and build graduate programs, one in Ethiopia and the other in Peru. In Ethiopia, Purdue is Haramaya University’s primary partner for the World Bank-funded African Center of Excellence (ACE) in Climate Smart Agriculture and Biodiversity.

UNSA

- As part of the NEXUS program, the CGFS is helping the National University of San Agustin (UNSA) in Arequipa, Peru to establish a Center for Food Security.

Scale Up Conference

- The CGFS was a primary partner in organizing and holding the first ever Scale Up Conference for Innovations in Agriculture which took place on September 25-27 (also part of the 150 Years of Giant Leaps). The Scale Up conference attracted more than 250 specialists from academia, industry, NGOs and government agencies.

\$70M Grant

- A \$70m grant from USAID for translational research in developing countries has been co-sponsored with the Global Engineering Program.

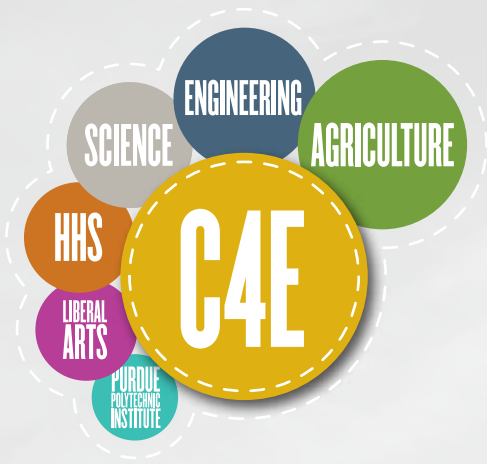


Scale Up conference organizers and participants – Loeb Playhouse



Gary Burniske discussing research on food processing at the National University of Central Peru

CENTER FOR THE ENVIRONMENT



VISION

To support efforts to address three overlapping aspects of the environmental challenges facing the world today:

- challenges to ecosystem functioning
- environmental challenges to community health and well-being
- environmental decision-making and behavior

Arequipa Nexus Institute Active Projects

- Equitable Co-existence of Agriculture, Mining, and Regional Development in Arequipa: Realities, Barriers, and Opportunities
- Net Zero Energy Building - Pilot Project
- A Framework for Sustainable Water Management in the Arequipa Region
- Elevating the Peruvian Grape and Wine Industry into a Global Competitor through Advancements in Sustainable Agriculture
- Arequipa Region Soil Vulnerability, Impairment, and Health Assessment
- A Framework for Sustainable Water Management in the Arequipa Region
- A Purdue-UNSA Initiative to Establish a Center on Food Security in Peru - Pilot Project
- Robotic Water Quality Monitoring and Distribution Systems
- Elevating the Peruvian Grape and Wine Industry into a Global Competitor through Advancements in Sustainable Agriculture
- Arequipa Region Soil Vulnerability, Impairment, and Health Assessment
- A Framework for Sustainable Water Management in the Arequipa Region
- Integrated Sensing Systems for Detection of Heavy Metal Contamination Across Food-Water-Environment Nexus in Arequipa

BUILDING SUSTAINABLE COMMUNITIES

HALF THE WORLD'S POPULATION lives within 40 miles of an ocean, and three-quarters of all large cities are located on a coast. As many as **13 MILLION PEOPLE** may live in **VULNERABLE REGIONS** along the U.S. coastline by 2100 if sea levels continue to rise.

Nearly **\$60 TRILLION** is needed to build and update **TRANSPORTATION INFRASTRUCTURE GLOBALLY.**



BUILDINGS account for **20%** of global energy consumption.

The World Bank notes that in Latin America, **INDIGENOUS PEOPLES** face **POVERTY RATES** that are on average twice as high as for the rest of the population.

Most of the world doesn't see **CLIMATE CHANGE** as a distant threat. A global median of **79%** say climate change is **ALREADY HARMING PEOPLE AROUND THE WORLD** or believe it will do so in the next few years.

Discovery Park

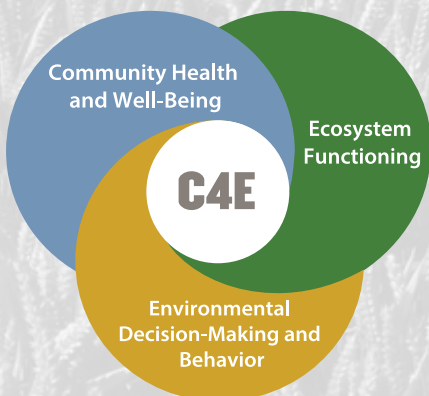
Compiled using reports from Pew Charitable Trusts, the World Bank, Rockefeller Foundation, Energy Information Administration, and the United Nations Environment Programme.

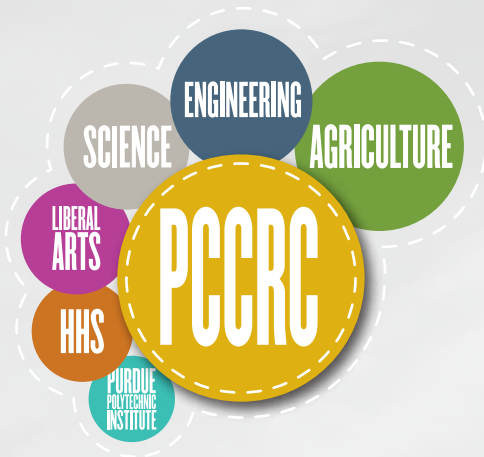
Research Study Abroad Experience in Peru

Develop a deep understanding of renewable energy as well as other potential sources of energy for Peru. Integrate wind energy and solar systems with water nexus, storage, irrigation or other areas (e.g., agriculture), economics and policy. Evaluate the history of Incas Empire in terms of engineering, energy and sustainability.



New C4E Director | Timothy Filley, professor of geochemistry and soil science in the Department of Earth, Atmospheric, and Planetary Sciences and the Department of Agronomy, has been named as the new director of Discovery Park's Center for the Environment. His appointment began November 11.





PURDUE CLIMATE CHANGE RESEARCH CENTER

Indiana Climate Change Impacts Assessment

The center released three new reports detailing the impacts of climate change on Indiana’s agriculture, aquatic ecosystems, and tourism sectors. Each report outlined key findings, provided downloadable graphics, and addressed knowledge gaps. All the reports are available at www.indianacclimate.org.

ABOUT

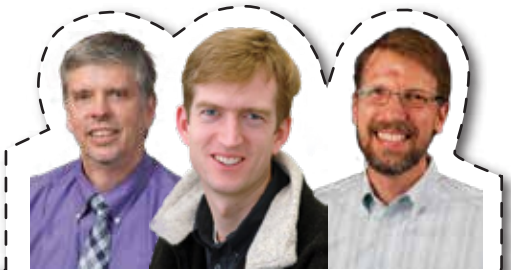
The Purdue Climate Change Research Center (PCCRC) works to increase scientific and public understanding of the causes and consequences of climate change through interdisciplinary research and effective education and outreach. The PCCRC provides science-based, non-partisan, and collaborative analysis to support real-world decision making from the local to the global scales. A hub for people who want to work across disciplines on issues related to Earth’s changing climate, the PCCRC serves to connect researchers, support collaborative projects, and share findings and expertise with stakeholders.

Reconnect with Purdue

The center launched a new program bringing together academic faculty and Purdue alumni to inform and inspire conversations around important topics related to climate change. The first event was held on December 12, 2018 in Washington DC. Designated a 150th Ideas Festival special event and co-hosted with the Purdue Alumni Association, the gathering brought together more than 50 alumni to hear from a panel of experts on the social, political, and scientific aspects of climate change.

Seed Grants

The center issued four seed grants to support research exploring the complex chemistry occurring in the air above forests; investigating how water moves between large lakes and the atmosphere; testing the use of reflected signals for remote sensing of biomass; and using nitrogen isotopes to study past climate change.



Honors

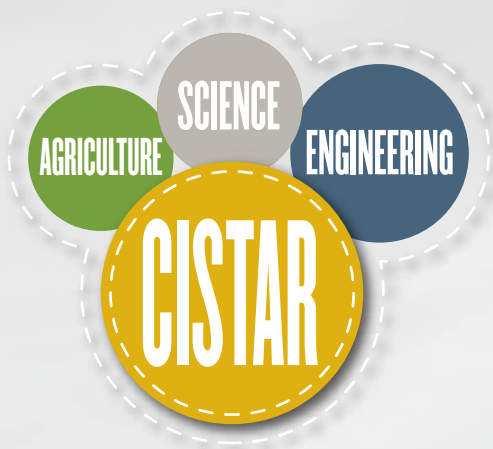
- Professor Marc Caffee named a 2018 American Geophysical Union Fellow
- Professor Jeff Dukes named a 2018 Ecological Sciences of America Fellow
- Professor Leigh Raymond received a 2018 Fulbright Fellowship



WHAT WILL CLIMATE CHANGE MEAN IN INDIANA?

Since the beginning of the 19th century, Indiana's average temperature has risen more than 7° and total annual precipitation has also increased every decade. What does this mean for Indiana's future? The Purdue Climate Change Research Center, in collaboration with Purdue's Center for Global Change Science, has released a new report detailing the impacts of climate change on Indiana's agriculture, aquatic ecosystems, and tourism sectors. The report is available at www.indianacclimate.org.

PCCRC
PURDUE UNIVERSITY
Discovery Park



CENTER FOR INNOVATIVE AND STRATEGIC TRANSFORMATION OF ALKANE RESOURCES

Notables

- \$3.75M released by NSF for Year Two funding
- 19 industrial consortium members
- Professor Raj Gounder received DOE research grant and Alfred P. Sloan Research Fellowship

VISION

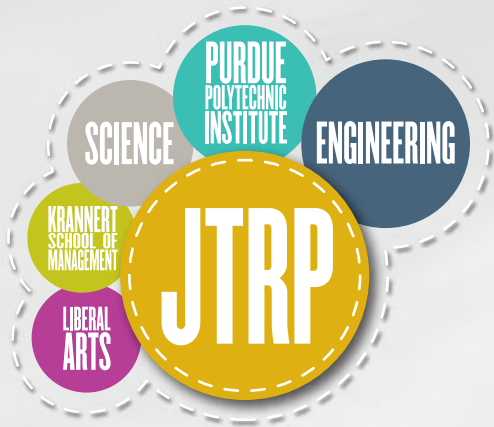
To create a transformative engineered system to convert light hydrocarbons from shale resources to chemicals and transportation fuels in smaller, modular, local, and highly networked processing plants.

RESEARCH

The CISTAR team will develop innovative process designs for economic production of chemicals and transportation fuels from shale gas hydrocarbons. Researchers also will explore novel approaches for converting methane to chemical intermediates, which can then be used as a feedstock for conversion to liquid fuels.

New materials and fundamental understanding will be transferred from initial, proof of concept lab-scale experiments to full-size pilot scale operations with economic evaluations using systems-level lifecycle and environmental impact analysis to guide research and scale these innovative processes to field demonstrations with industrial partners.





JOINT TRANSPORTATION RESEARCH PROGRAM

Ford X/Jelly

Ford X, a division of Ford Motor Company, initiated an e-scooter pilot program at Purdue in collaboration with JTRP during the fall of 2018:

- Operational shared dockless e-scooter service
- Answer key questions on design and operation
- Provided Ford with information needed to scale up initiatives to meet demands

PURPOSE

Facilitating collaboration between the Indiana Department of Transportation, higher education institutions and industry to implement innovations that result in continuous improvement in the planning, design, construction, operation, management and economic efficiency of the Indiana transportation infrastructure.

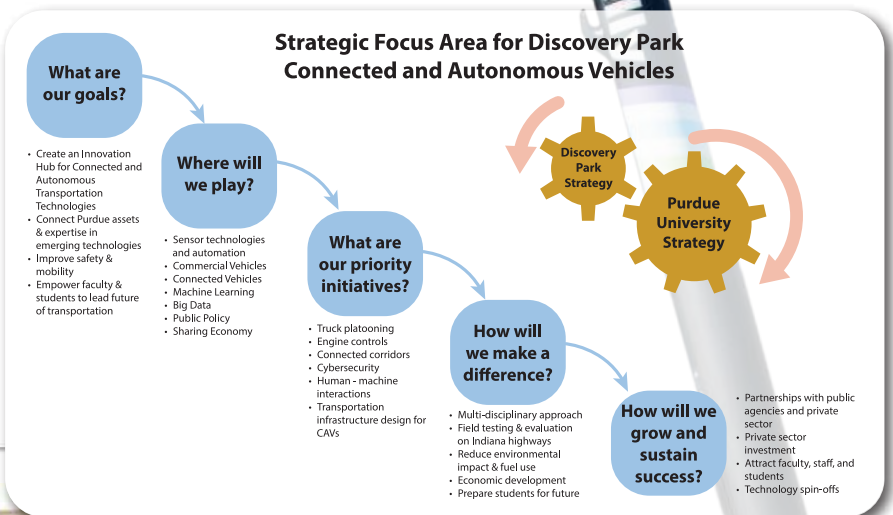
AREAS OF INTEREST

- Future-Proofing Transportation Infrastructure
- State of Indiana DOT Collaboration
- V2I Technology Development on Indiana Highways

“Enhanced Traffic Signal Performance Measures” was approved by the Transportation Pooled Study Program

PI: Darcy Bullock

CATV Initiative



Prof. Bullock with FordX scooter team prior to Jelly deployment on campus

Discovery Park centers and institutes focused on the Impacting Global Health Strategic Theme bring specialized research in the areas of immunology, inflammation and infectious disease, neuroscience, drug discovery, and healthcare engineering.

**Regenstrief Center
for Healthcare
Engineering
(RCHE)**

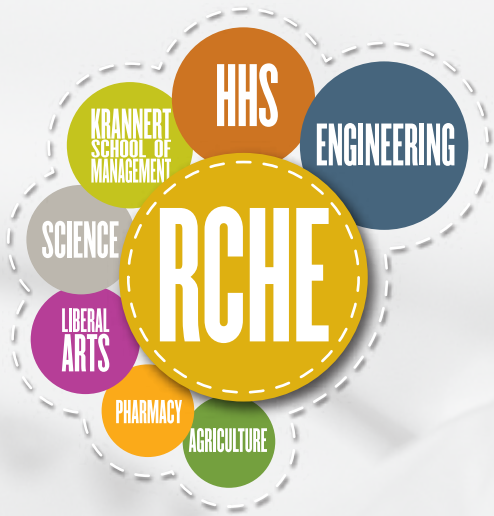
**Purdue Institute of
Inflammation,
Immunology and
Infectious Disease
(PI4D)**

**Purdue Institute for
Integrative
Neuroscience
(PIIN)**

**Purdue Institute for
Drug Discovery
(PIDD)**

**Women's Global Health
(WGH)**

GLOBAL HEALTH



REGENSTRIEF CENTER FOR HEALTHCARE ENGINEERING

Regenstrief Center is Renewed

The Regenstrief Foundation recently renewed its financial support for Purdue's Regenstrief Center for Healthcare Engineering.

- \$10 million commitment
- Supports RCHE from 2019 to 2024

RCHE/PHA Awarded a \$12M Grant from Centers for Medicare and Medicaid Services through the Indiana FSSA

Funding will help support research in two areas, including pilot implementation for each area in two Indiana communities:

- A health information technology-enabled community-wide approach to opioid treatment
- Cost effective quality care for long term care Medicaid patients

Launch of PHA Direct

- Purdue Healthcare Advisors (PHA) launched PHA Direct, an online platform for instruction, coaching, and community building
- Includes a new community of practice that provides for ongoing professional collaboration and direct access to Purdue experts and kCards, a micro-learning approach that supports the mastery of soft skills

Medical Device Informatics (REMEDI)

In an effort to improve patient safety, the Regenstrief National Center for Medical Device Informatics (REMEDI) is receiving medical device data from over 400 hospitals across 32 states. In 2019 it launched a subscription-based model.

MISSION/VISION

Mission: Pursue a proactive, patient-centered, and wellness-focused healthcare delivery system by conducting impactful research that leverages collaborative partnerships.

Vision: Be a leading research institution that generates evidence for the effectiveness and successful adaptation of interventions and policies to improve the quality, accessibility, equity, and affordability of healthcare delivery.

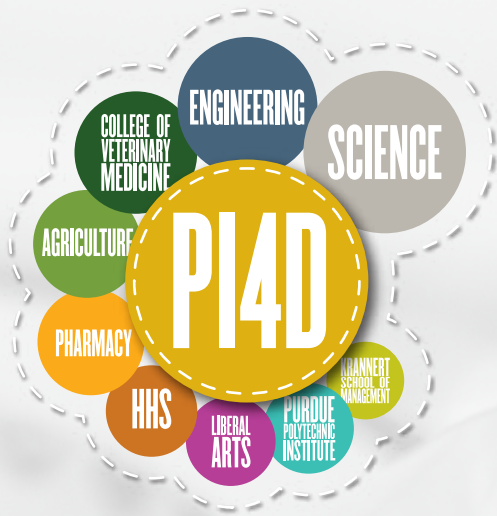
STRATEGIC AREAS

- Health Analytics — developing data science-based approaches to personalized care
- Care/Capacity Management — a systems approach to matching health resources to need
- Rural/Global Health — improving access to care for vulnerable populations



Associate Director Yih and PhD student Dawei Wang trains a group of Ugandan doctors, nurses, professors, and research assistants in using a new maternal health supply system.





PURDUE INSTITUTE OF INFLAMMATION, IMMUNOLOGY AND INFECTIOUS DISEASE

Program Areas

The institute is structured around four program areas:

- Imaging and Diagnostics
- Immunology and Inflammation
- Infectious Diseases
- Control and Intervention

Vision

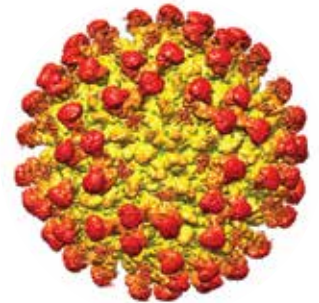
- To leverage the significant diversity of life sciences, physical sciences and engineering on campus to invent and integrate basic immunologic advances, new diagnostics, probe basic biological and inflammatory processes, and to develop and commercialize novel intervention methods to control an array of chronic inflammatory conditions, cancer and infectious diseases.

Mission

- To provide the foundation for collaborative research across a broad spectrum of disciplines at Purdue that leads to increased funding in the life sciences and national and international recognition.

Conquering Zika

Since the original determination of the structure of the Zika virus by PI4D Director Richard Kuhn and his long-time colleague Michael Rossmann (PI4D), three additional structures from the Kuhn-Rossmann groups, revealing more atomic details of the virus and its assembly intermediates, have been published. One of them, identifying the binding sites of disease combating antibodies on the viral surface, defines therapeutic target sites, which will greatly inform the development of anti-Zika vaccines.



Purdue Lecture Hall Series

PI4D initiated a program, Purdue Lecture Hall Series, for local high school students that quickly expanded to include all three new life science institutes. In these monthly programs that are rotated through different lecture halls at Purdue, life sciences graduate students explain their thesis projects and relay their enthusiasm for science.

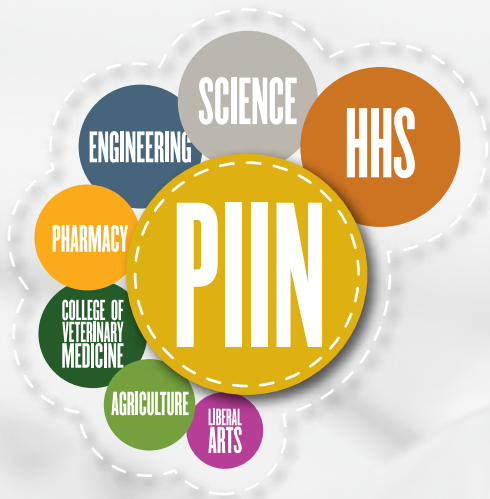
New State-of-the-art Facilities

Last summer, the Purdue Institute of Inflammation, Immunology and Infectious Disease (PI4D) moved into new, state-of-the-art facilities on the fourth floor of the Hall for Discovery and Learning Research (HDLR). Funded in part by the university through its five-year, \$250 million life sciences initiative, the floor houses administrative offices and laboratories for PI4D as well as the new Molecular Evolution, Protein Engineering and Production (MEPEP) Facility, which provides protein discovery, engineering and design for Purdue researchers and partner institutions and organizations.



New route to fight infection, disease | New research has revealed how a single protein interferes with the immune system when exposed to the bacterium that causes Legionnaires' disease, findings that could have broad implications for development of medicines to fight disease and infection.

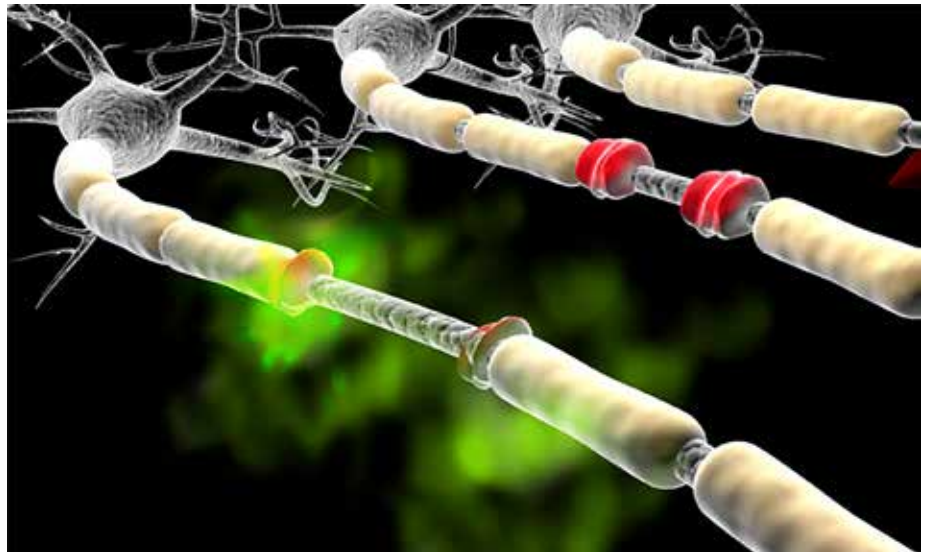
Zhao-Qing Luo, professor of biological sciences and member of the Purdue Institute for Inflammation, Immunology and Infectious Disease, led the research. "We have revealed an intricate mechanism of how a protein from the potentially deadly pathogen *Legionella pneumophila* turns off the major immune regulatory protein NF- κ B, which controls numerous important cellular processes. This is important because it reveals a highly effective and specific way to turn off an immune response."



PURDUE INSTITUTE FOR INTEGRATIVE NEUROSCIENCE

Possible Biomarker for Multiple Sclerosis Identified

A biomarker for multiple sclerosis that could be an early warning for the disease has shown promise in both human and animal testing. Researchers at Purdue University and the Indiana University School of Medicine found that acrolein, a molecule previously suspected as a metabolic waste product that accumulates in people with certain neurological disorders such as multiple sclerosis and Parkinson's disease, could possibly be used to help diagnose MS.



Program Areas

The Purdue Institute for Integrative Neuroscience is structured around these four program areas:

- Development, Genetics and Neuropharmacology
- Neurotrauma and Neuropathology
- Aging and Neurodegeneration
- Neuroengineering

Centers and Focus Areas

Many PIIN faculty are members of and/or interact with the following affiliated centers, whose research complements the institute's program areas.

- The Purdue Autism Cluster
- Center for Implantable Devices
- Center for Research of Brain, Behavior, and NeuroRehabilitation (CEREBBRAL)
- Hearing Sciences at Purdue



Ruth L. Kirschstein National Research Service Award Institutional Research Training Grant

Awarded from the NIH, the training grant will support graduate training for students at the interface of technology and auditory neuroscience and involves faculty from the colleges of science, health and human sciences, and engineering.

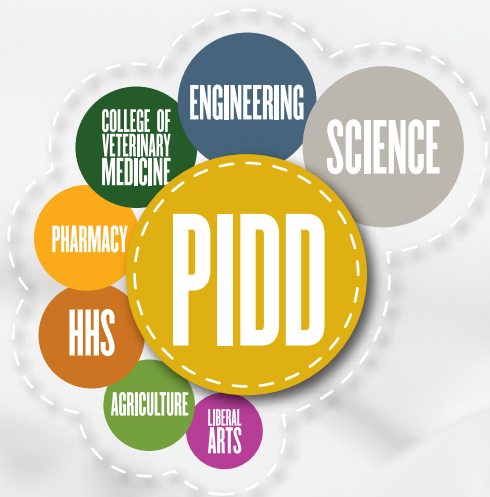
New State-of-the-art Facilities

In summer 2018, Purdue University reopened the newly renovated third and fourth floors of the Hall for Discovery and Learning Research (HDLR) as part of its five-year, \$250 million life sciences initiative. Along with the creation of four new life sciences institutes, including the Purdue Institute for Integrative Neuroscience (PIIN), the university's investment supports the purchase of advanced instrumentation and the development of shared research facilities in buildings such as HDLR along and the Bindley Bioscience Center, which now houses a neuroscience cell engineering core operated by PIIN.

Showalter Scholars

Two PIIN faculty members were designated Showalter Faculty Scholars for 2018 to pursue innovative research.

- R. Claudio Aguilar, associate professor of biological sciences
- Edward Bartlett, associate professor of biological sciences and biomedical engineering



PURDUE INSTITUTE FOR DRUG DISCOVERY

Purdue Drugs and Diagnostic Agents Entering Clinical Trials

The PIDD vision from its inception was to couple Purdue's internationally recognized strength in synthetic organic chemistry and biochemistry with basic biological research to produce new agents for disease diagnosis and treatment. In 2018, the 23rd Purdue-discovered chemical agent entered human clinical trials. Currently, 16 Purdue entities are in active clinical trials and the pipeline remains vibrant. The next milestone will be to obtain FDA approval for one or more of these entities.

Purdue's Drug Discovery Pipeline

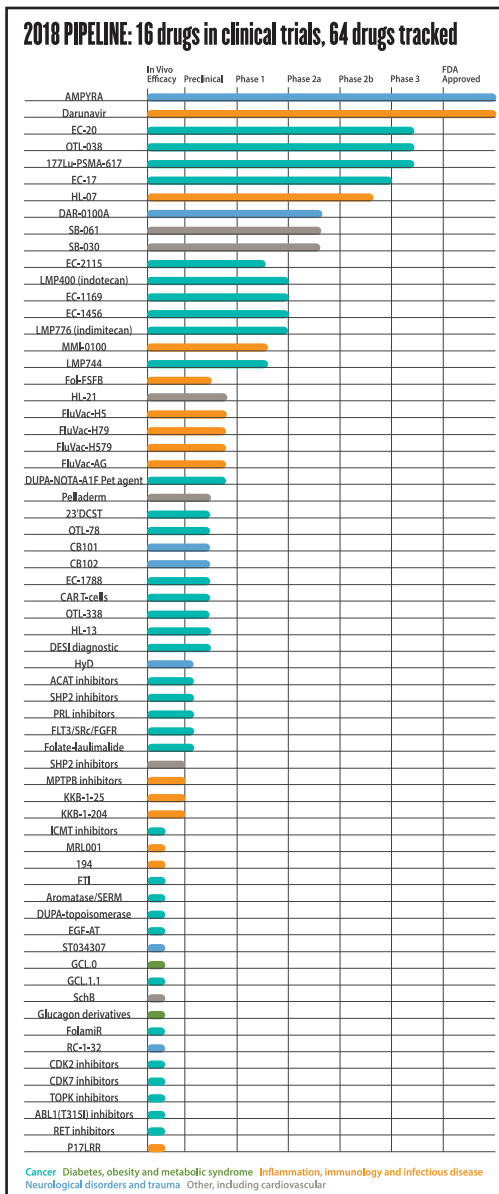
Over the last five years, members of the Purdue Institute for Drug Discovery have increased the number of drugs in clinical trials as well as the number of drugs that are actively being tracked by the institute. Twelve new faculty core to the mission of PIDD were added during this period.

Mission Statement

- To create an innovative research environment that will stimulate the discovery, synthesis, testing and clinical translation of new drugs for the diagnosis and therapy of human diseases.

About

- The Purdue Institute for Drug Discovery accelerates the translation of basic research into life-changing treatments
- The institute has more than 100 researchers representing more than 16 countries around the world, and disciplines ranging from biomedical engineering to medicinal chemistry to fluorescence-guided surgery
- The research spans from the nano level to high resolution protein structures
- Faculty members develop and promote innovative drug candidates for cancer, neurological disorder/trauma, immunology/inflammatory/infectious diseases, diabetes/obesity/metabolic diseases



23
PURDUE-DISCOVERED DRUGS
HAVE ENTERED CLINICAL TRIALS

Endocyte Inc.

In 2018, Endocyte Inc. (Nasdaq: ECYT) became the first Purdue startup to reach \$1.5 billion in value. Late that year, the biopharmaceutical company inked a \$2.1 billion acquisition deal with Swiss pharmaceutical giant Novartis AG, becoming the ninth Purdue University startup to be bought by a major national or international company. Located in Purdue Research Park, the company has licensed several technologies developed at Purdue, most based on research led by Philip Low, the Purdue University Presidential Scholar in Drug Discovery and the Ralph C. Corley Distinguished Professor of Chemistry. Low's work in the Purdue Institute for Drug Discovery focuses on creating small molecules, such as folate, that attach to chemotherapy or radioactive isotopes to provide direct-targeted treatment to diseased cells.



WOMEN'S GLOBAL HEALTH INSTITUTE

Partnerships

- Formed new partnerships with Purdue Institute of Inflammation, Immunology and Infectious Disease (PI4D) and Center for Research on Brain, Behavior, and NeuroRehabilitation (CEREBBRAL); Recruited three more external advisory council members: one in US, two international

Grants

- Issued a call out of Women's Health Pilot Grant and selected two grants to move forward for funding; Applications to center grants, such as Specialized Centers of Research Excellence (SCORE) on Sex Differences (U54 NIH) and two U01 NIH

Symposia

- Organized and hosted Women's Health Research Symposia: "Gut to Brain," Prevention of Chronic Disease," and The Eighth Annual International Breast Cancer Prevention Symposium: Technology, Engineering & Data Science

MISSION/VISION

Mission | The WGHI coordinates, promotes, and leverages research and training at Purdue University in engineering and technology, as well as biology, natural and social sciences. General areas of interests are in bone health, women's cancers, neurodegenerative disorders, and wellness.

Vision | The WGHI improves the health and quality of life of women worldwide through research, entrepreneurship, and training future investigators. The Institute drives a new research paradigm in seeking proactive approaches for prevention and early detection of non-communicable diseases, rather than the classic medical model focusing on treatment. We aspire to implement the model of the WGHI nationally and globally in the future.

Goals

- Develop strategies for improving women's health around world
- Build infrastructure to fund and conduct research that applies new technologies to diagnosing and evaluating interventions for optimizing health and preventing disease
- Initiate training programs across disciplines for careers in women's health research
- Facilitate commercialization of health-associated products and technologies



The Women's Health Research Symposium



Discovery Park centers and institutes focused on the Impacting Global Security Strategic Theme bring specialized research in quantum science and engineering, artificial intelligence and defense innovation.

Institute for Global Security and Defense Innovation (i-GSDI)

Center for Education and Research in Information Assurance and Security (CERIAS)

GLOBAL SECURITY



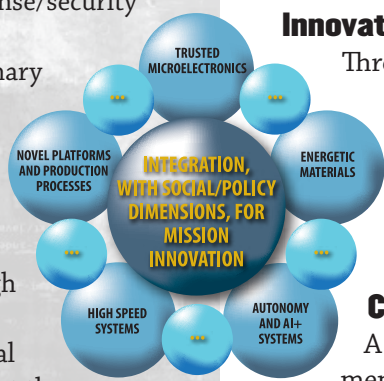
INSTITUTE FOR GLOBAL SECURITY AND DEFENSE INNOVATION

ABOUT

I-GSDI significantly impacts Purdue's national prominence, improves our visibility and access to defense/security related opportunities, and converges our interdisciplinary resources into addressing the needs of our nation. I-GSDI's focused, responsive, and agile efforts provide Purdue a valuable entry point for high level engagements with governmental and industrial organizations, key entities at the state and federal level.

MISSION

The Institute will converge Purdue's interdisciplinary resources to bring timely, responsive and transformative solutions to the most pressing security and defense challenges facing the nation and the world.



AI+ Grants

To stimulate rapid innovation for defense and security, i-GSDI awarded internal grants to nine innovative Purdue researchers who drove research on four AI+ projects:

- Autonomous Exploration and Localization of Targets for Aerial Drones
- Intelligent Biomorphic Robots with Adversarial Machine Learning Capacity
- An AI-based Hybrid Pilot Drowsiness Detection System
- Automatic Target Recognition for Weapon Seeker Target Acquisition or Re-acquisition from Unmanned Aerial Vehicles (UAVs)

Innovation Leads

Three Purdue faculty members have accepted appointments as "Innovation Leads" for i-GSDI. Peter Bermel in Trusted Microelectronics, Nathan Hartman in Digital Transformation, and Jonathan Poggie in Hypersonics have agreed to lead on strategy, partnership building, and capability awareness in their respective fields.

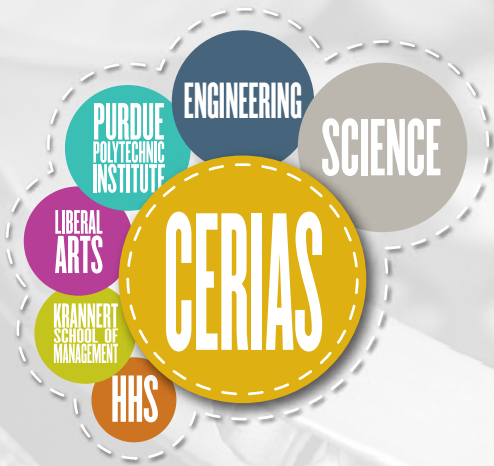
Consortium

A pack of strong government and industry players came together as members of i-GSDI's first Consortium Meeting in October 2018.

- CONSORTIUM MEMBERS:** Lockheed Martin Corp. • McKinney Associates • Mercury Systems • Crane Army Ammunition Activity (CAAA) • Indiana Innovation Institute (IN3) • Naval Air Systems Command (NAVAIR) • Naval Surface Warfare Center (NSWC) Crane Division • Purdue Research Foundation • Sandia National Labs Strategic Alliance • U.S. Army Research Laboratory (ARL)

i-GSDI government and industry consortium members collaborate with Purdue innovators at the first i-GSDI Consortium Meeting in October 2018.





MISSION

CERIAS advances the knowledge and practice of cyber/cyber-physical security, assurance, resiliency, privacy, and trusted electronics, through discovery, education and engagement.

GOALS

- Empower faculty and research staff from diverse disciplines to address cyber/cyber-physical problems, formulate research and education solutions, and secure funding and support
- Strengthen meaningful partnerships with Discovery Park and its affiliated centers
- Establish and advance the scientific rigor of the field
- Discover, develop, and transfer technologies, methods, and information that enhance practice in the field
- Engage industry, government, and other academic institutions as awareness, education, and research partners



Center for Education and Research
in Information Assurance and Security

CERIAS researchers Xiangyu Zhang (CS), Dongyan Xu (CS), Mathias Payer (CS), Byoungyoung Lee and Rohit Bhatia (CS) are working to increase security for IoT devices

CENTER FOR EDUCATION AND RESEARCH IN INFORMATION ASSURANCE AND SECURITY

Northrop Grumman

- Northrop Grumman introduced a new research consortium for fund AI/ML research. CERIAS, who has a long relationship managing the Northrop Grumman Cybersecurity Research Consortium (NGCRC) program, lead Purdue's involvement that lead to \$400,000+ of unrestricted funding support for new machine learning research with CERIAS affiliated faculty at Purdue.



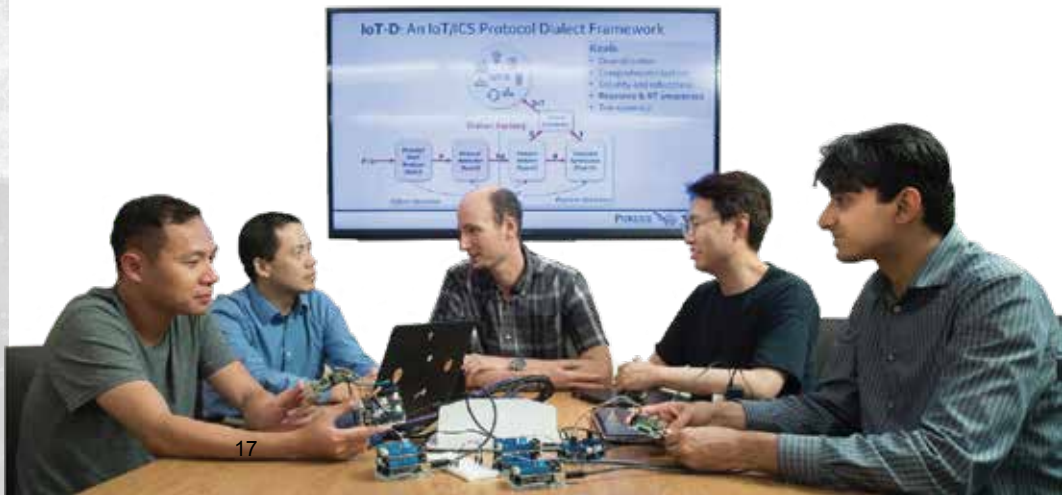
David Ebert (ECE) | Named Interim Director of CERIAS, effective November 1, 2018.

Research Awards

- CERIAS faculty teams received \$722,502 through the (NGCRC) and \$435,000 unrestricted (REALM) funding from Northrop Grumman
- Matias Payer (CS) | CORE: Medium: Collaborative: Threat-Aware Defense: Evaluating Threats for Continuous Improvement, \$1,199,849.18 (Payer was project PI, \$399,849.18 will remain at Purdue, with remainder going to his co-PIs at other universities), NSF SaTC
 - Justin Yang (CIT) | Supporting Controlled Unclassified Information with a Campus Awareness and Risk Management Framework, \$598,373.00, NSF OAC
 - Dongyan Xu (PI), Xiangyu Zhang, Mathias Payer, Byoungyoung Lee (CS, all) | IoT-D: Towards Internets of Dialect-Speaking Things, \$6M Office of Naval Research



Eugene Spafford (CS) | 2018 Information Security Executive (ISE) Luminary Leadership Award



Discovery Park centers and institutes focused on the Impacting Global Security Strategic Theme bring specialized research in quantum science and engineering, artificial intelligence and defense innovation.

Bindley Bioscience Center (BBC)

Birck Nanotechnology Center (BNC)

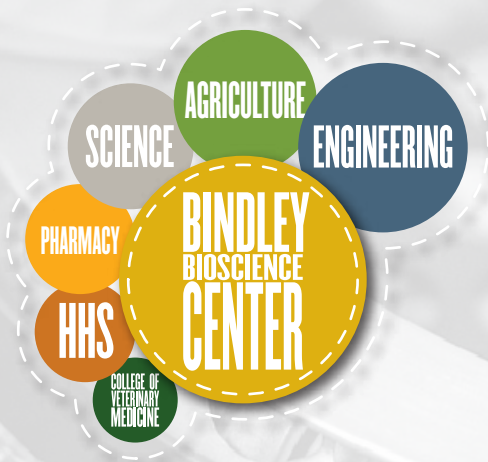
Burton D. Morgan Center for Entrepreneurship (BMCE)

Network for Computational Nanotechnology (NCN)

Purdue Center for the Science of Information (PCSOI)

Purdue Policy Research Institute (PPRI)

CROSS-CUTTING CENTERS AND INSTITUTES



BINDLEY BIOSCIENCE CENTER

Indiana Metabolomics Collaborative

- In conjunction with the Indiana University School of Medicine, Bindley is launching the Indiana Metabolomics Collaborative. This distributed core laboratory will leverage existing resources at both Purdue and IU to create a unique and comprehensive set of metabolic profiling capabilities to serve the needs of scientists across the state.

Instrumentation Proposal

- Bindley submitted a major instrumentation proposal to the NIH for a new high definition mass spectrometry imaging system. In addition to standard mass spectrometry sources, the system includes a small molecule DESI source, a technology invented at Purdue by Dr. Graham Cooks. This instrument will bring unique capabilities to Bindley and to Purdue, enabling research across the life sciences, including cancer biomarker discovery, cellular signaling, and drug discovery.

VISION

To integrate interdisciplinary life sciences research with engineering to create unique opportunities to solve global challenges in the life sciences

ABOUT

The Bindley Bioscience Center (BBC) is a multidisciplinary research facility where life sciences and engineering researchers collaborate to explore new technologies and scientific knowledge that impact the broad boundaries of plant, animal and human diseases.



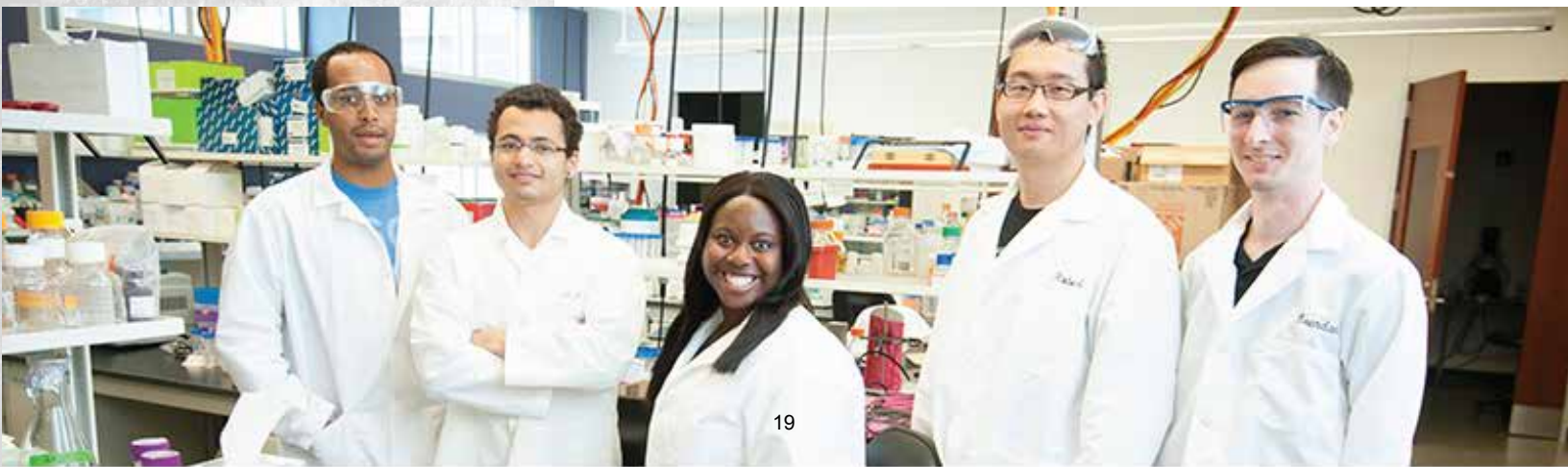
New Bindley Director | In the spring of 2019, Bindley will welcome a new director. Dr. Ramaswamy Subramanian (“Rams”). Rams currently serves as a senior professor and founding Dean of the Institute for Stem Cell Biology and Regenerative Medicine in Bangalore, India.

Core facilities

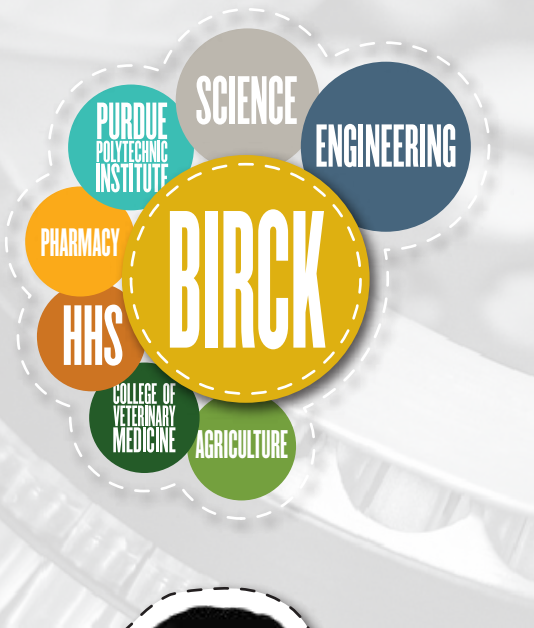
- Biophysical Analysis Lab
- Bioscience Imaging Facility
- Computational Life Sciences and Informatics
- Purdue Translational Pharmacology
- Flow Cytometry and Cell Separation Facility
- Purdue Proteomics Facility
- Metabolite Profiling Facility

Affiliated facilities

- Enhanced Oil Recovery Facility
- Transgenic Mouse Facility
- Purdue MRI Facility
- Neuroscience Cell Engineering Core



BIRCK NANOTECHNOLOGY CENTER



ASSURE Program

- Purdue University, Indiana University, Notre Dame and the Indiana Innovation Institute (IN3)
- Two-year program to make sure that security and reliability of trusted microelectronics are baked in, and not an afterthought
- Indiana Innovation Institute (IN3) has awarded Purdue a \$2.3 million contract to help develop the ASSURE program (Achieving Scientifically Secured User Reassurance in Electronics)
- Led by Peter Bermel, associate professor of electrical and computer engineering

The specific goals of ASSURE are:

- Address vulnerabilities in military electronics
- Create a national research center of excellence in trusted and reliable military electronics
- Establish partnerships that will drive research, workforce training, and economic development in Indiana



NEW QUANTUM CENTER

Yong P. Chen | Professor of physics and of electrical and computer engineering and associate director of the Birck Nanotechnology Center has been named director of the **Purdue Quantum Science and Engineering Institute (PQSEI)**. The Institute will be headquartered in Birck, which also houses various research programs ranging from nano/quantum photonics to nanoelectronics and spintronics.

The new Quantum Science and Engineering Institute was formed to coordinate and incentivize university-wide activities and establish a new resource for faculty and students working on and interested in the pivotal field, which may lead to an array of advanced technologies and products.

The New Double-Aberration Corrected Transmission Electron Microscope



WHIN (Wabash Heartland Innovation Network)

A regional approach to utilize the Internet of Things (IoT) to transform the regional into a global epicenter for next generation manufacturing and digital agriculture.

- Develop manufacturing and agriculture testbeds
- Develop low cost and scalable sensors
- Demonstrate and educate IoT to the region
- Focus on sensor applications and adoption
- Enabling real-time analytics for manufacturers and farmers
- Invest in innovative place-making projects that increase education, vitality, and prosperity



BURTON D. MORGAN CENTER FOR ENTREPRENEURSHIP

ABOUT

The Burton D. Morgan Center for Entrepreneurship (BDMCE) fosters and stimulates the understanding and application of entrepreneurship with faculty and students across the Purdue campus and with stakeholders throughout Indiana and the world.

Boilermakers by the Bay

- Co-sponsored with Krannert and the College of Engineering
- Engage Silicon Valley alumni
- Nine Purdue startup companies featured
- Tour new Facebook campus
- Meet with three different venture capital firms
- Closing dinner hosted by Foundation Capital Founder and Purdue Alumnus Bill Elmore

New Student Competitions

The Center for Entrepreneurship had a busy fall working to put together three new student competitions:

- Final Four Pitch Competition
- BlueSky Pitch Competition
- Crossing State Street Competition

Local Outreach

As a new part of our annual business model competition, this year we extended an invitation to local high school students. 33 students from Jefferson High school and Central Catholic participated. Students learned about the business model canvas and applied these principles to their own ideas and pitched what they learned to a panel of judges. The winner of the competition was given a special invitation to compete against the college students during the January preliminary round.

Purdue startup founders getting a tour of the Facebook campus



Riley Gibb from Purdue Ventures moderates a VC panel during the BlueSky pitch competition.



Purdue startups ready to pitch their ideas to Venture Capitalists in Silicon Valley



ENGINEERING

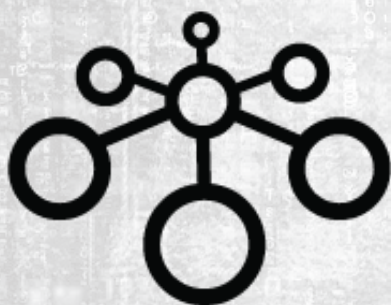
NCN

ABOUT

The National Science Foundation (NSF) is funding a team at Purdue University for the operation and advancement of nanoHUB.org, a national nanotechnology infrastructure.

The NCN cyber platform supports a virtual society that shares simulation software, data, and other innovative content that provides engineers and scientists with the fundamental knowledge required to advance nanoscience into nanotechnology.

Annually, more than 1.5 million visitors participate in nanoHUB. nanoHUB provides a library of over 500 simulation tools, free from the limitations of running software locally. More than 17,000 people annually use simulation tools on nanoHUB in the scientific computing cloud.



ncn
nanoHUB

NETWORK FOR COMPUTATIONAL NANOTECHNOLOGY

nanoHUB

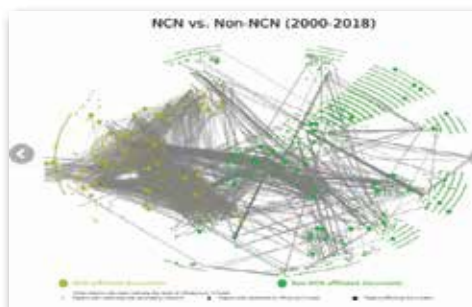
- In the 12 months through November 2018, the nanoHUB science gateway operated by NCN has been accessed by nearly 1.5 million unique visitors, including more than 17,000 simulation users who ran over 1 million simulations. nanoHUB hosts over 6000 resources for education and research, including over 500 simulation tools. To date, nanoHUB has been cited over 2000 times in the scholarly literature.

NCN URE

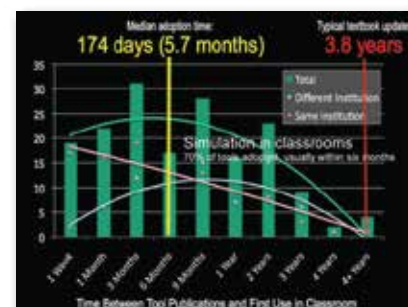
- Each summer, NCN engages students from within and outside Purdue in an Undergraduate Research Experience (URE) program. In the summer of 2018, the NCN URE program worked with 21 students, including eight students from community colleges in a cutting-edge program to engage students who might typically not have opportunity and mentorship to participate in a URE program.

NSF Awards

- In September 2018, the nanoHUB project was renewed for five years under NSF Award 1227110 for the Network for Computational Nanotechnology Cyber Platform. Principal investigators include Gerhard Klimeck, Krishna Madhavan, Alejandro Strachan, Lynn Zentner, and Michael Zentner. The project will continue innovations to meet the needs of a growing community in nanotechnology and adjacent fields. Separate awards at the University of Illinois and Indiana University support teams developing content in nano manufacturing and nanobio applications. Together, the three projects comprise the Network for Computational Nanotechnology.



The National Science Foundation has recently reconfigured the Network for Computational Nanotechnology to continue to address challenges and serve the growing nanotechnology community. The newly reconfigured NCN consists of a cyber node responsible for the support and development of the nanoHUB infrastructure, as well as two content nodes with research and educational directives in the areas of nano-manufacturing (nanoMFG) and nano-bio (Engineered nanoBIO).





CENTER FOR THE SCIENCE OF INFORMATION

New Algorithm for Identifying Cells

- Center Researchers Ananth Grama (Purdue CS Professor), David Gleich (Purdue CS Associate Professor), Shahin Mohammadi (postdoc), and Vikram Ravindra (grad student), have developed a new algorithm for identifying cells, allowing them to discover new subtypes of melanoma cancer

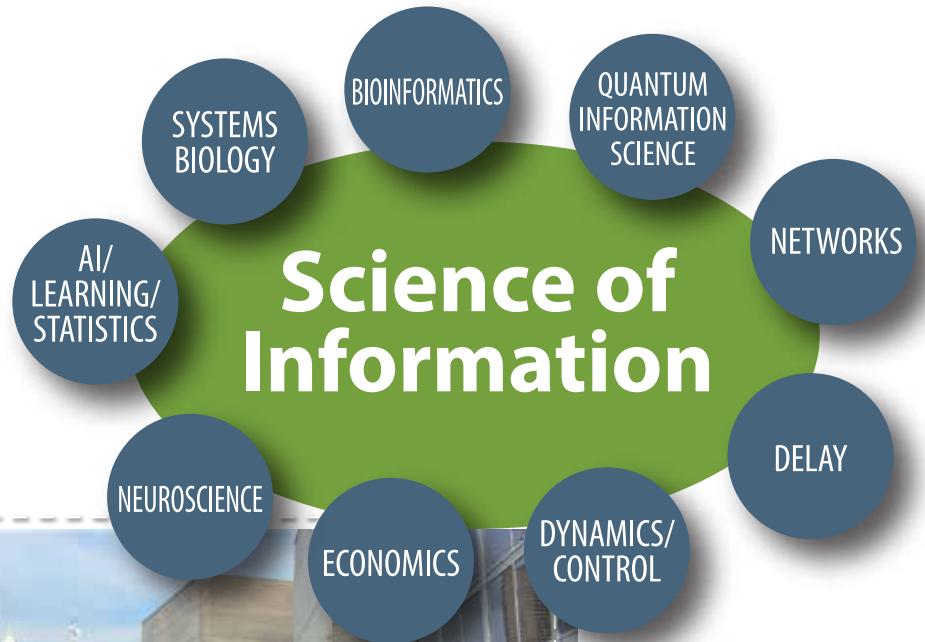
Bits and Biology

- The Center for Science of Information hosted a research workshop in New York City with partners from Princeton and CUNY as co-hosts — “Bits and Biology” addressed how the mathematical structure of information theory teaches about the mechanisms at work in living systems.

MISSION

At the Center for Science of Information, our mission is to advance science and technology through a new quantitative understanding of the representation, communication, and processing of information in biological, physical, social, and engineered systems. We aim to do this through the following goals:

- Integrative research
- Education, human resources, and diversity
- Knowledge transfer
- Leadership and management
- Ethics



Graduate student participants attending the Center for Science of Information’s (CSOI) 2018 NSF Science and Technology Center Professional Development Workshop pause for a photo. The workshop, developed and hosted by CSOI, was held for a fourth consecutive year in Indianapolis.

PURDUE POLICY RESEARCH INSTITUTE



PURPOSE

PPRI is a research community led by faculty but including also staff, post-doctoral students, graduate and undergraduate students.

- Generate policy research
- Create and participate in interdisciplinary grant activities

AREAS OF INTEREST

- Drones, Automated vehicles, aviation
- Artificial Intelligence and big data
- NetZero energy, food energy, and water systems; disasters, sustainability, and resilience
- Women's movements and social and economic rights

CATV: Ethics & Policy Workshops

- Robust discussions and subsequent reports
- Further collaboration with JTRP, CCAT, and other faculty on campus to seek funding on CATV projects where there is synergy

Global Challenge Projects

- Supported by funds from the Mellon Foundation
- Multidisciplinary teams working on global challenge projects connect their work with stakeholders on the national and international stage
- Professor Thomas Hertel and team engaged federal government, industry, and agricultural association leaders and representatives for feedback on their model for sustainable agriculture at the Press Club in Washington, DC
- Professor Manjana Milkoreit and team traveled to Bonn for the United Nations' climate change negotiations
 - Shared their 'game' which helps decision makers understand global temperature goals to avoid climate tipping points

Purdue Peace Project (PPP)

PPRI has welcomed the Purdue Peace Project (PPP) into Discovery Park with the aim of incorporating a variety of disciplines and building on its impressive reach. The Peace Project's first initiative under the umbrella of PPRI is the launch of the Peacebuilding Big Idea Challenge, co-sponsored by the Alliance for Peacebuilding. The \$10,000 prize is funded by PPP funder, Milt Lauenstein and encourages the development of novel, ambitious, and potentially impactful ideas on peacebuilding, particularly in areas plagued with armed conflict.

Steven Schladover, one of the pioneers in autonomous transportation research, kicked off PPRI's CATV Ethics + Policy Workshop series in October 2018.





PURDUE UNIVERSITY
Discovery Park

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