RAY W. HERRICK LABORATORIES
ANNUAL REPORT

2020

HOME OF THE CENTER FOR HIGH PERFORMANCE BUILDINGS

PURDUE UNIVERSITY | Ray W. Herrick Laboratories

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THE RAY W. HERRICK LABORATORIES

MESSAGE FROM THE DIRECTOR

Jeffrey F. Rhoads

Members of the Ray W. Herrick Laboratories Community,

When I assumed the role as Director of the Ray W. Herrick Laboratories in October 2019, I was very mindful of both the opportunities and challenges that lay ahead. My predecessor, colleague, and friend Professor Patricia Davies, had done an awesome job reinforcing Herrick's firm foundation. She had set a clear trajectory for growth through hard work and decisive action, including helping guide, with faculty and staff colleagues, the construction of our newest building in 2013-14. The opportunity that these actions, and faculty growth, afforded was clear. Running counter-current to this opportunity, however, was clear uncertainty and unease related to the nation's growing social divide and unrest, which so starkly contrasted Herrick's emphasis on inclusivity and alarmed our community, and the emergence of the COVID-19 global pandemic. The combination of these challenges and opportunities made 2020 a year like no other in recent memory.

It is perhaps easiest to begin by articulating the role of the current pandemic on the Herrick community. On March 19th, we became the first laboratory on campus to shut down, and we continued to operate with all research functions off-site until May 8th. Through the hard work of the Herrick staff, and my fortuitous selection to Purdue's COVID Task Force focused on research-related matters, we were able to position ourselves as the first laboratory to re-open on campus, with research related to national security (defense- and health-related studies) beginning on campus May 8th and the remainder of on-site research activities beginning June 10th. Throughout this process, you all can take great pride in the fact that Herrick was able to lead the way. Our faculty, staff, and students helped identify best working practices and in many ways we established ourselves as the campus standard for safe research operations. Though even one infection is troubling due to the severity of this virus, I'm happy to report that as of the end of 2020 only a handful amongst our community were confirmed to have the virus (all have returned to work healthy), and, to date, our strict protocols on mask usage, social distancing, and cleaning have led to no known viral spread within our facilities.

Less easy to articulate is the short-term and lasting impact that the global pandemic, as well as social divide and unrest, have had on the mental health of our students, faculty, and staff. As I am sure you can each appreciate, it was, and continues to be, highly stressful to balance the need to develop new ways to teach, learn, and conduct research at a distance with the need to provide tangible support to those in our community who have been marginalized or impacted by systemic racism, which once again was brought into national focus in 2020. While these challenges are not unique to Herrick, we take our small role in the solution seriously. This has led us to work with University partners to bring more visibility to key issues within the Laboratory and across campus, to start meaningful dialogue, and, with key partners, to help craft new programs that will launch in 2021 focused on strengthening and diversifying our community. Though these are only small, first steps in the right direction, early anecdotes stemming from our actions to date are truly heartening and a refreshing reminder of the power of the Herrick community.

Despite the aforementioned challenges, stopping my note at this juncture would leave a truly incomplete picture, for the strength, creativity, and wisdom embedded within the Ray W. Herrick Laboratories didn't just ensure that we survived 2020, it ensured that we thrived!

In 2020, we welcomed three new faculty, Professors Rebecca Ciez, Tian Li, and Davide Ziviani, to our team, and in doing so not only strengthened our core areas of expertise, but expanded our scope into closely related areas of emerging importance. You can read more about Rebecca, Tian, and Davide later in this document and will hopefully get to meet them, as well as our new Managing Director, Maralee Hayworth, in person later in 2021!

In addition, most, if not all, of our traditional productivity metrics improved. Research expenditures markedly increased (~38%) between FY19 and FY20, our student population continued to grow, and the number of new Herrick alumna and alumni entering the global workforce increased.

Our students and faculty also continued to shine on the technical stage. Though I cannot highlight everyone in this constrained format, I was excited to see Professor Neera Jain continue to work with her colleagues to conduct pioneering research in human-aware and adaptive automation, and to share her technical perspective with the world as a frequent contributor to Forbes. Likewise, it is fantastic to see a bright path ahead for Herrick with early career recognitions by the National Science Foundation (NSF) and Defense Advanced Research Projects Agency (DARPA) for Professors Andres Arrieta and Fabio Semperlotti, respectively. And one cannot fail to mention that Professor Stuart Bolton became the latest recipient of the Per Bruel Gold Medal for Noise Control and Acoustics from ASME, becoming at least the fourth Herrick-related recipient of this distinct honor that highlights those at the very pinnacle of the acoustics and noise control discipline.

The other notable accomplishments of 2020 stem from the growth of our four full or partially resident research centers. The Center for High Performance Buildings, under the leadership of Professor Jim Braun and Davide Ziviani, remains a successful model of industry/university collaboration in a research area that was thrust into the global spotlight in 2020 as we were all stuck at home. Likewise, the National Aeronautics and Space Administration (NASA)-funded Resilient Extraterrestrial Habitat Institute (RETHi) continues to set the course for high performance buildings on other celestial bodies. August 2020 proved to be one of the best months to date at Herrick with the NSF announcing that one of its newest Engineering Research Centers, focused on the Internet of Things for Precision Agriculture (IoT4Ag), would be partially based at Purdue and led by Herrick faculty member David Cappelleri, and with the United States Army announcing that we had formally established a large-scale cooperative agreement related to energetic materials (propellants, explosives, and pyrotechnics). The latter effort, which I am leading, spans our sister laboratory, the Maurice J. Zucrow Laboratories, and Herrick, and is slated to be one of the largest research efforts in Purdue history to date.

As we look ahead, I am confident that 2021 will present no fewer opportunities, or challenges, than 2020. Society is fundamentally rethinking buildings, transportation, space exploration, the energy sector, climate change, materials and manufacturing, national security, and the human-machine interface, and Herrick faculty and students have so much to contribute to the global discussion. With this in mind, we will continue to explore avenues for physical, human capital, and intellectual growth in the year ahead to accommodate our expanding research and education endeavors; we will continue to explore new avenues for impact on industry, government, and society writ large, and we will continue to explore new opportunities to engage with each of you as we once again remember that society and humanity represent very complex dynamical systems to navigate.

I look forward to chatting soon, hopefully in person!

Regards,

Jeff Rhoads

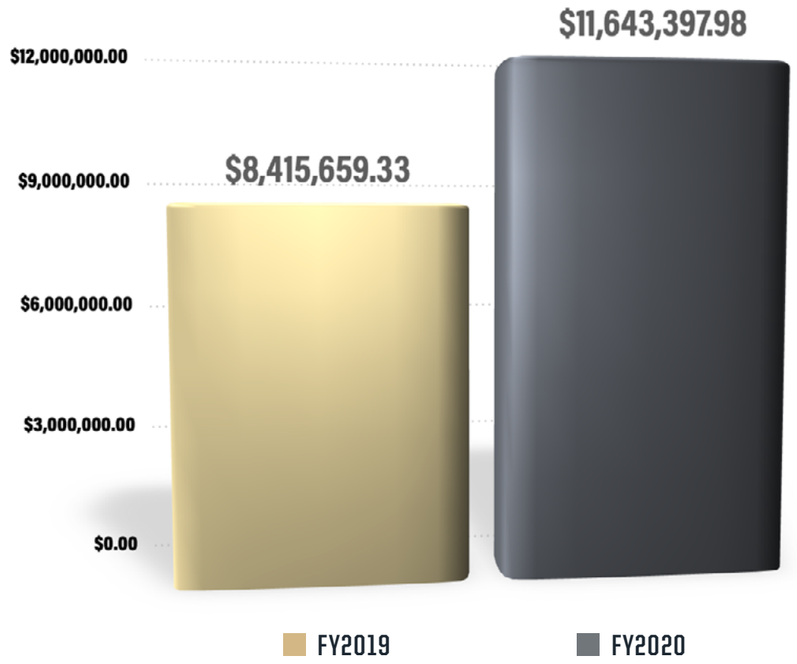
RESEARCH - FISCAL YEAR	FY2019	FY2020
Research Expenditures	$8,199,045	$11,643,398
Proposals Submitted	$37,010,359	$40,522,937
Number of Sponsors	65	67
STUDENTS		
Graduate Student Researchers	127	133
MS	39	49
Ph.D.	88	84
Student Breakdown		
Research Assistants	-	54
Fellowships	-	18
Teaching Assistants	-	12
Undergraduate Student Researchers	13	28
Post-Doctoral Researchers	6	3
STUDENTS GRADUATED		
MS	17	15
Ph.D.	14	16
VISITING RESEARCHERS		
Visiting Research Assistants	17	7
EDUCATION AND OUTREACH		
Conferences/Workshops Held	5	0*
CHPB Members Meetings	2	2**
Conferences Planned in the Next 2 Years	5	5
Short Courses Held	0	0*

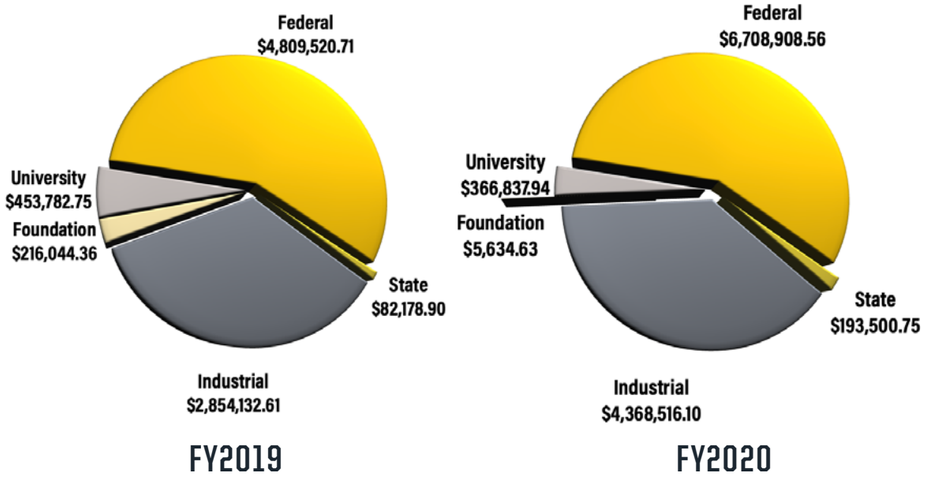
* - Due to COVID-19, many conferences and workshops were canceled or postponed.

** - Meetings Held Virtually

FY2019 - FY2020 RESEARCH EXPENDITURES

Shown below is the distribution of research expenditures for FY2019 and FY2020.





SELECT STUDENT SUCCESS STORIES

STUDENT SUCCESSES

Recent graduates of Herrick have gone on to successful beginnings in a wide variety of areas within Industry and Academia. For example, Kumar Akash (Ph.D., '20) is now employed with the Honda Research Institute, Karan Gohil (MSME, '20) is now employed at Qualcomm, Allison Murray (Ph.D., '19) has joined the faculty at Marquette University, and Xinye Zhang (Ph.D., '20) is now employed with Honeywell. These are just a handful of many of our recent graduates that have started their exciting careers as Herrick Alums in 2020.


AKASH

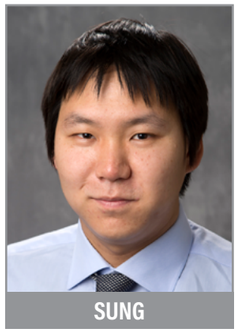

GOHIL


MURRAY


ZHANG

STUDENT HIGHLIGHTS

Over the past year, several students have been recognized with awards for their efforts. Weonchan Sung received the Leo Beranek Student Medal, which is awarded for Excellence in the Study of Noise Control from the Institute of Noise Control Engineering. Tony Xue was the recipient of the Outstanding Research Award from Purdue University and is now employed as a Senior Engineer at Seagate Technologies. We are very proud of all of the outstanding work being conducted by our students and recent graduates.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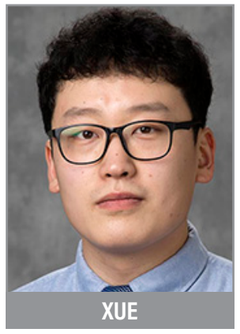
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HERRICK RESOURCE COMMITTEE

The Herrick Laboratories Student Resource Committee is a student-run committee that provides Herrick students, faculty, and staff with opportunities for personal and professional growth. They organize picnics, seminars, fundraisers, IAC Student Events, and perform community outreach. The resource committee is also newly chartered as an Official Purdue Student Organization.

SELECT FACULTY SUCCESS STORIES

FACULTY PROMOTIONS AND HONORS

Over the course of the last year, two Herrick faculty members have received promotions. Marcial Gonzalez was promoted to Associate Professor and Panagiota Karava to the Jack and Kay Hockema Professor in Civil Engineering. In addition, several faculty have been recognized for their outstanding efforts. For example, Andres Arrieta was awarded an NSF CAREER Award; Stuart Bolton was recognized as the Per Bruel Gold Winner by ASME; Jeff Rhoads was awarded the prestigious Murphy Award for Outstanding Undergraduate Teaching; and Fabio Semprlotti was awarded the DARPA Young Faculty Award.


GONZALEZ


KARAVA


ARRIETA


BOLTON


RHOADS


SEMPERLOTTI

PURDUE ENERGETICS RESEARCH CENTER

In August, Purdue and the Army Research Laboratory forged a cooperative agreement focused on the development of new energetic materials, manufacturing processes, and modeling and diagnostic tools. The 3-year, $24.7M project is one of the largest research contracts in Purdue history, and will be completed primarily at the Maurice J. Zucrow and Ray W. Herrick Laboratories.

CENTER FOR HIGH PERFORMANCE BUILDINGS

A cornerstone of Herrick, the Center for High Performance Buildings remains dedicated to partnering with industry in the development, demonstration, evaluation, and deployment of new technologies and analysis tools for high performance buildings. In 2020, CHPB had 15 corporate members who are collaboratively engaged on 10 distinct projects.

CHPB CENTER FOR HIGH PERFORMANCE BUILDINGS AT PURDUE

RESILIENT EXTRA-TERRESTRIAL HABITAT INSTITUTE

RETHi's mission is to develop the technologies needed to establish Resilient Extra-Terrestrial Habitats. The initiative is tackling the issue in three research thrusts: System Resilience, Situational Awareness, and Robotic Maintenance. The team is led by Shirley Dyke and encompasses researchers from Purdue, UCONN, Harvard, UTSA, and NASA.

INTERNET OF THINGS 4 PRECISION AGRICULTURE

Herrick Professor David Cappelleri will Co-PI a new five-year, $26 million grant from the National Science Foundation with the Engineering Research Center for the Internet of Things for Precision Agriculture (IoT4Ag). This project was created to develop advanced agricultural technologies to address food, energy and water security challenges.

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2021 HERRICK EDUCATION AND OUTREACH

Due to the COVID-19 Pandemic, scheduled events for 2020 were either canceled or postponed.

MARCH 29 - APRIL 2	SAPEM: **S**ymposium on the **A**coustics of **P**oro-**E**lastic **M**aterials
MAY 24 - 28	Twenty-fifth International Compressor Engineering Conference Eighteenth International Refrigeration and Air Conditioning Conference Sixth International High Performance Buildings Conference
AUGUST	Purdue Energetic Materials Summit
NOVEMBER 11-12	Annual Colloquium on International Engineering Education

2020ne Purdue Conferences

Compressor Engineering | Refrigeration and Air Conditioning | High Performance Buildings

SAPEM 2021 6TH TRIENNIAL

SYMPOSIUM ON THE ACOUSTICS OF PORO-ELASTIC MATERIALS

'21 PEMS

PURDUE ENERGETIC MATERIALS SUMMIT

PURDUE UNIVERSITY | Ray W. Herrick Laboratories

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