

APL Achievement Awards and Prizes: The Lab's Top Inventions, Discoveries, and Accomplishments in 2019 and 2020

APL Staff Writers

ABSTRACT

Every year, the Johns Hopkins University Applied Physics Laboratory (APL) honors the accomplishments of its staff members with an awards program. At its inception more than three decades ago, the program recognized staff members' exceptional contributions to the scientific community via publication. Today's program continues to recognize outstanding publications but has grown to include awards and prizes celebrating extraordinary achievements in both sponsored programs and internal research and development, efforts that exemplify APL's focus on transformative innovations, and, most recently, significant contributions that promote a positive, diverse, and inclusive culture at the Laboratory. In 2020, the program underwent yet another change as the Lab pivoted from the formal in-person ceremony on APL's campus in Laurel, Maryland, to a safe and fun virtual format during the COVID-19 pandemic. This article details the awards presented for achievements in 2019 and 2020.

INTRODUCTION

Despite the many disruptions related to COVID-19, APL staff members continued to find innovative solutions to the nation's most pressing challenges. And although the annual ceremonies celebrating these achievements looked a little different, the APL Achievement Awards program recognized a record number of staff members and accomplishments in 2019 and 2020. During the 2020 ceremony honoring 2019 achievements, Jerry Krill, APL's assistant director for science and technology, noted that APL staff members "are dedicated to making critical contributions and, to quote our centennial vision, 'exemplifying what it means to be a trusted research and development laboratory.'" He echoed this sentiment during the 2021 ceremony recognizing 2020

accomplishments, remarking, "In a year as challenging as the one we've had, it was incredibly inspiring to see the quantity and quality of nominated projects and staff. We were able to recognize some incredible work, including many of the critical contributions our staff members have made to the pandemic fight, both for our nation and for our community."

The 2020 APL Achievement Awards ceremony was held on Tuesday, September 8, via ZoomGov. In addition to celebrating the innovative technical contributions staff members made in 2019, the ceremony highlighted the Lab's creativity in developing an interactive format that staff members could enjoy safely from their homes. In all, 485 APL staff members were nominated in 114

entries, resulting in 28 awards and 129 staff members recognized for winning entries.

Held virtually for the second consecutive year, the annual APL Achievement Awards ceremony on April 27, 2021, included honors for outstanding publications, notable projects, and individuals and teams who accomplished incredible things in 2020. The 2021 ceremony also included a new award—called Light the FUSE—to recognize staff members who have made significant contributions to promote a positive, diverse, and inclusive culture at APL. The program exceeded the prior year's numbers, with 724 staff members included in 134 nominations. A record 32 awards were presented, with 184 staff members recognized as winners during the ceremony.

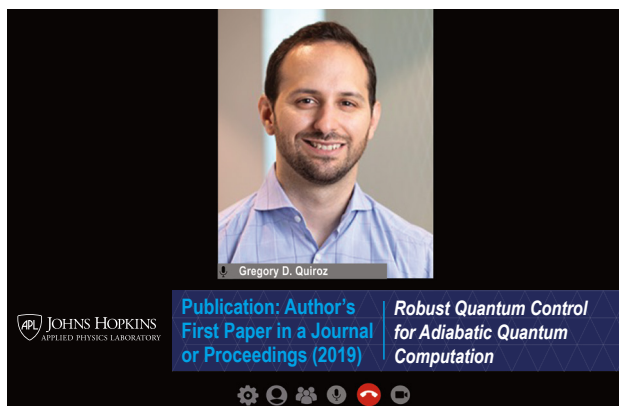
Only APL contributors are named since the awards program is open to only current APL staff members. The winners and projects represent just a portion of the game-changing impact APL staff members demonstrated in 2019 and 2020.

PUBLICATION AWARDS

Administered by the editorial board of the *Johns Hopkins APL Technical Digest*, the publication awards program aims to inspire and recognize scholarship through publication in the professional literature. Awards were first presented in 1986, and the nomination and selection process has remained unchanged from that time: Departments and sectors may submit up to two nominations in each category. Judges consider the nominated works' significance and clarity, giving considerably greater weight to the significance of the work in advancing science, engineering, or the mission of the Laboratory.

Author's First Paper in a Journal or Proceedings

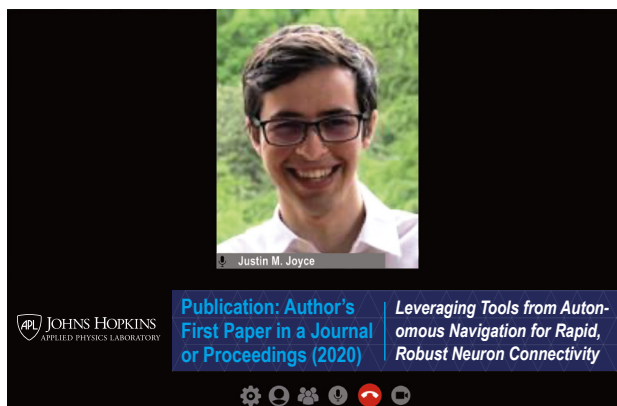
The award for an author's first paper published in a journal or proceedings in 2019 went to Gregory D. Quiroz for "Robust Quantum Control for Adiabatic Quantum Computation" published in *Physical Review*



A.¹ This paper describes a novel method for mitigating noise produced by the system environment interactions in quantum computing hardware. This method, which substantially improves the computational accuracy of a particular quantum computing paradigm, is scalable and implementable on both currently available and future quantum computing hardware.

Two awards were presented for an author's first paper published in a journal or proceedings in 2020. The first award recognized Matthew W. Logan for "Reversible Atmospheric Water Harvesting Using Metal-Organic Frameworks" published in *Scientific Reports* by Nature Research.² This paper describes a novel approach for studying the harvesting of clean water from humid air in metal-organic frameworks (MOFs). A parametric study of nine hydrolytically stable MOFs with diverse structures revealed the kinetics of water sequestration in MOFs as well as their overall uptake capacity.

The second award recognized Justin M. Joyce for "Leveraging Tools from Autonomous Navigation for Rapid, Robust Neuron Connectivity" published in *Medical Image Computing and Computer Assisted Intervention – MICCAI 2020*.³ This paper describes how tools from autonomous navigation of robot swarms were applied to design and develop a computer vision system to explore large-scale neuroscience data sets to efficiently create 3-D brain maps for health and artificial intelligence applications.



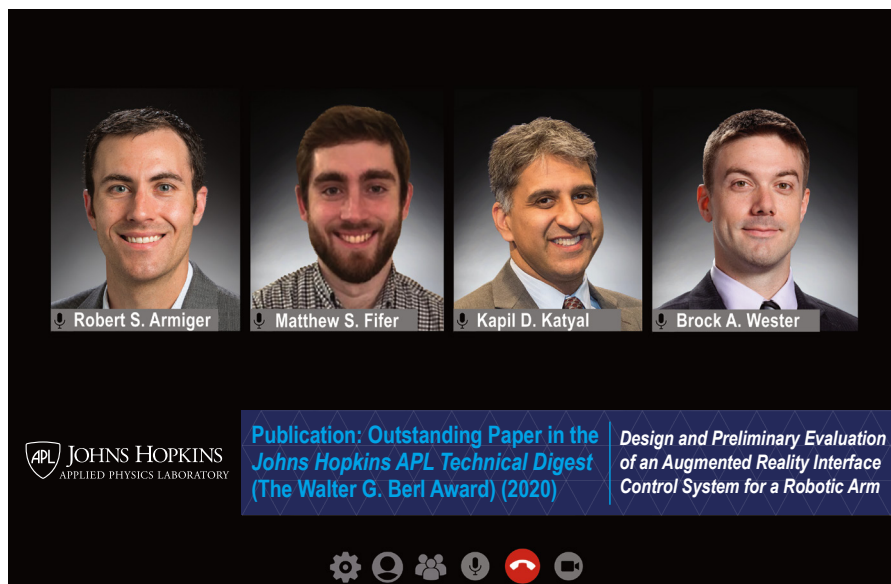
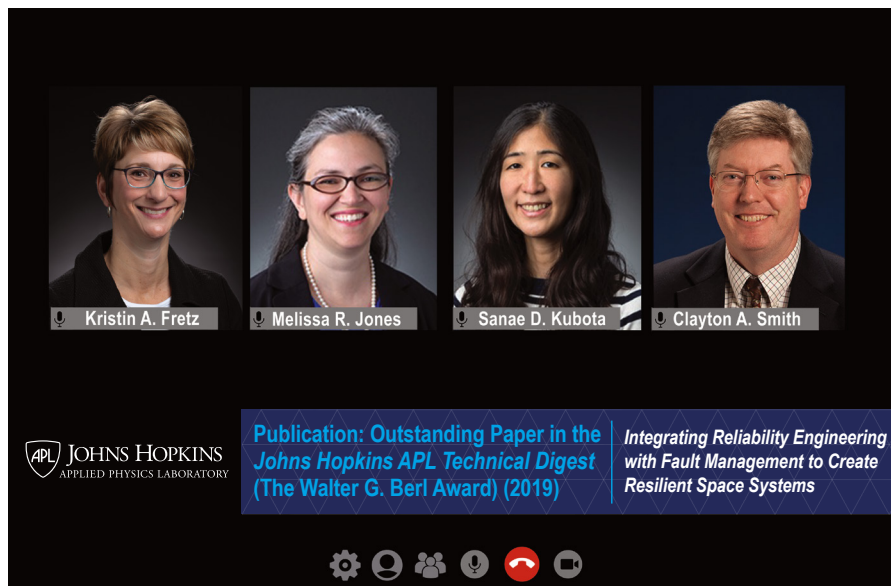
Outstanding Paper in the *Johns Hopkins APL Technical Digest* (The Walter G. Berl Award)

Named for Walter Berl, editor-in-chief of the *Digest* when the publication awards program was created and who oversaw the program for many years, this award recognizes excellence in APL's own journal, the *Johns Hopkins APL Technical Digest*.

The 2019 award went to Kristin A. Fretz, Melissa R. Jones, Sanae D. Kubota, and Clayton A. Smith for "Integrating Reliability Engineering with Fault Management to Create Resilient Space Systems."⁴ This article describes how failure modes and effects analysis (FMEA) was applied to the Parker Solar Probe mission, the NASA/APL mission to touch the Sun. FMEA is a useful process for any design campaign. However, by expanding

the breadth and scope of the FMEA for fault management, the team created a new product to increase the confidence that all potential failure modes were captured, making the Parker Solar Probe mission more resilient.

The award for outstanding *Digest* paper published in 2020 recognized Robert S. Armiger, Matthew S. Fifer, Kapil D. Katyal, and Brock A. Wester for "Design and Preliminary Evaluation of an Augmented Reality Interface Control System for a Robotic Arm."⁵ This article presents the design and evaluation of an augmented reality system for controlling intelligent assistive robotics informed by computer vision. Paralyzed patients with Duchenne muscular dystrophy used eye-tracking to provide low-level directional and supervisory commands, such as selecting a target object to grab, to the robot.



Outstanding Research Paper in an Externally Refereed Publication

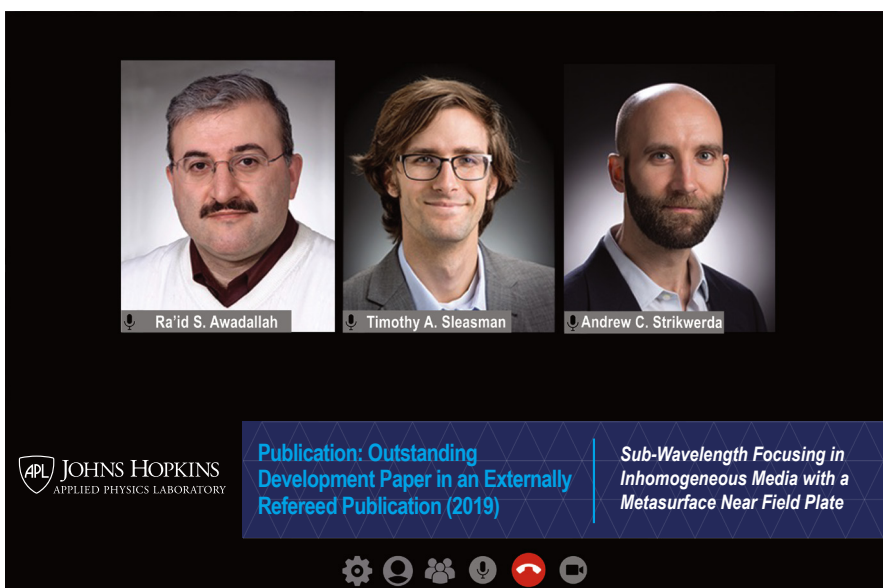
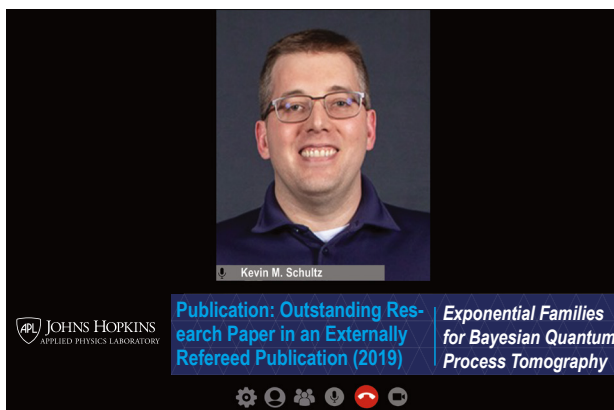
The award for outstanding research paper published in an externally refereed publication in 2019 went to Kevin M. Schultz for the *Physical Review A* article “Exponential Families for Bayesian Quantum Process Tomography.”⁶ This article describes the development of novel statistical models and Bayesian estimation techniques for the characterization of quantum systems, including quantum computers. These techniques reduce the number of measurements required to characterize a high-fidelity quantum operation and have the potential for substantial impact in the development of future characterization protocols.

The award for outstanding research paper published in an externally refereed publication in 2020 went to Adam W. Freeman, Konstantinos Gerasopoulos, Christopher M. Hoffman Jr., Spencer A. Langevin, Matthew W. Logan, and Douglas B. Trigg for the article “UV-Cured Eutectic Gel Polymer Electrolytes for Safe and Robust Li-Ion Batteries” published in the *Journal of Materials Chemistry A*.⁷ This work demonstrates the integration of a safe and nonflammable deep eutectic solvent (DES) into an acrylic polymer host, resulting in a gel polymer electrolyte with improved physical and chemical robustness compared with standalone DES and enabling excellent battery cycle capabilities, even when assembled under ambient conditions.

Outstanding Development Paper in an Externally Refereed Publication

The award for outstanding development paper published in an externally refereed publication in 2019 went to Ra’id S. Awadallah, Timothy A. Sleasman, and Andrew C. Strikwerda for “Sub-Wavelength Focusing in Inhomogeneous Media with a Metasurface Near Field Plate,” published in *Sensors*.⁸ This work demonstrates how to design devices that can create sub-wavelength focuses inside of complex environments like the human body.

Sub-wavelength focusing can provide better resolution than traditional imaging techniques and has the potential to create better, field-deployable, affordable, and noninvasive biological detectors.



The award for outstanding development paper published in an externally refereed publication in 2020 went to Marc B. Airola, Hicham H. Alkandry, Bliss G. Carkhuff, Luke J. Currano, Plamen A. Demirev, Linda J. Frizzell-Makowski, Peter W. Green, Jill C. La Favors, Hasan N. Oguz, James G. Reuster, Rengaswamy Srinivasan, and Michael E. Thomas for “Preventing Cell-to-Cell Propagation of Thermal Runaway in Lithium-Ion Batteries” published in the *Journal of the Electrochemical Society*.⁹ Lithium-ion batteries are currently the most efficient energy-storing and power-delivering systems, and they have a revolutionary impact on global economic and technical development. The team’s experimental findings and computer models have implications for innovative technical solutions aimed at design and fabrication of better and safer fire- and explosion-resistant lithium-ion batteries.

Outstanding Professional Book

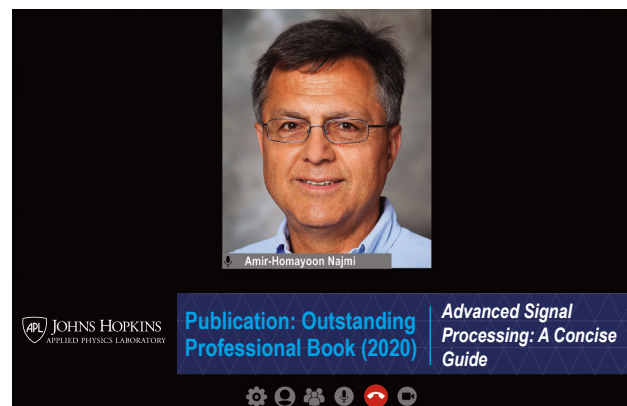
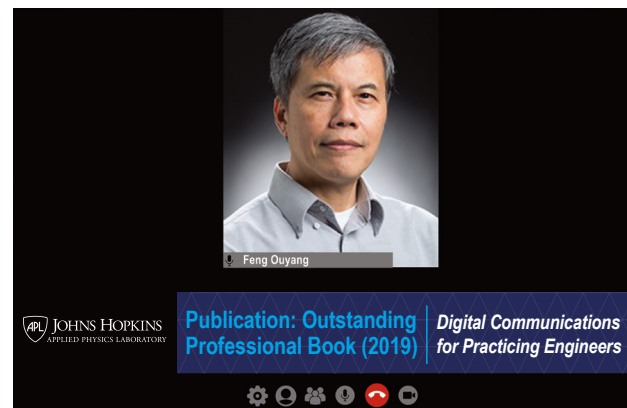
Two professional books published in 2019 were recognized. The first is *Exploring Planetary Climate: A History of Scientific Discovery on Earth, Mars, Venus and Titan* by Ralph D. Lorenz.¹⁰ This book chronicles the history of climate science and planetary exploration, from the earliest telescopic observation of planetary bodies in the 17th century, to the dawn of the space age and the first robotic planetary explorers, right up to the dramatic recent developments in detecting and characterizing exoplanets.

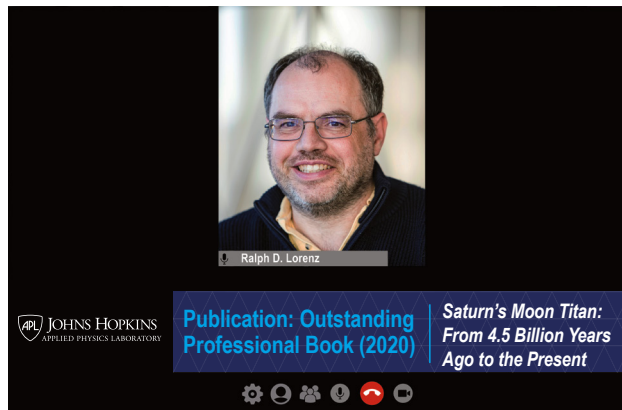
The second award went to the book *Digital Communications for Practicing Engineers* by Feng Ouyang.¹¹ This textbook immerses readers in theories and technologies, starting with Shannon’s theorem and information theory. Modules include modulation, statistical



detection, channel coding, synchronization, and equalization. The book also discusses advanced topics such as orthogonal frequency-division multiplexing, multiple-input multiple-output, and 5G cellular technologies, as well as current research in digital communications.

There were also two awards presented for books published in 2020. The first award recognizes the book *Advanced Signal Processing: A Concise Guide*, with APL author Amir-Homayoon Najmi.¹² Dr. Najmi’s book is a





comprehensive introduction to the mathematical principles and algorithms in statistical signal processing and modern neural networks. With the advances of modern computing, signal processing has become central to all areas of technological innovation and scientific exploration. An article based on a chapter from the book is published in this issue.

The second award recognizes the book *Saturn's Moon Titan: From 4.5 Billion Years Ago to the Present* by Ralph D. Lorenz.¹³ This book summarizes the geology, atmosphere, and exploration of Saturn's moon Titan, the target of the Dragonfly mission and one of the most compelling worlds in the solar system. The book, accessible to a nonspecialist, describes APL's and Dragonfly's role in exploring this new world.

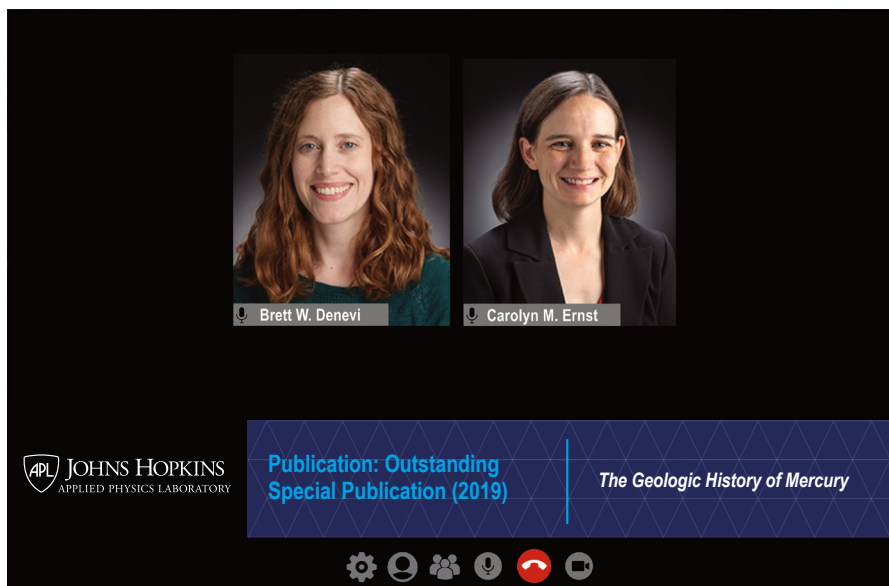
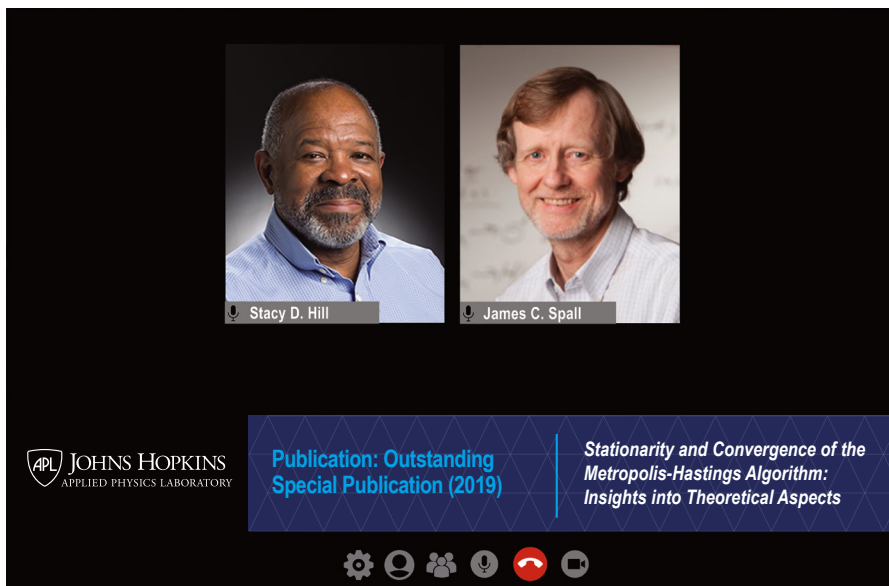
Outstanding Special Publication

Two awards were presented for outstanding special publications in 2019. The first award went to Stacy D. Hill and James C. Spall for "Stationarity and Convergence of the Metropolis-Hastings Algorithm: Insights into Theoretical Aspects," published in *IEEE Control Systems Magazine*.¹⁴ This article discusses some of the theoretical support underlying the Metropolis-Hastings algorithm for Monte Carlo simulation—one of the two most popular general

forms of Markov chain Monte Carlo. The discussion is at a level that does not require expertise in advanced probability theory or general Markov process theory.

The second award for outstanding special publication in 2019 went to Brett W. Denevi and Carolyn M. Ernst for "The Geologic History of Mercury," published in the book *Mercury: The View after MESSENGER*.¹⁵ This book chapter, one of the book's six chapters led by APL authors, documents the overall evolution of Mercury's surface, including its age, major units, and history of formation. The planet is revealed to be ancient, exotic, and unique among the terrestrial planets.

The award for a 2020 publication went to Ariel M. Greenberg for the chapter "Deciding Machines: Moral-Scene Assessment for Intelligent Systems" in the book *Human-Machine Shared Contexts*.¹⁶ This chapter describes a capability called Moral-Scene Assessment.





Rai Munoz-Abujder for “Learning Geocentric Object Pose in Oblique Monocular Images,” published in the *Proceedings of Computer Vision and Pattern Recognition (CVPR)*.¹⁸ The authors developed an encoding of geocentric pose and trained a deep network to compute depth for long-range vision tasks. An object’s geocentric pose, the height above ground and orientation with respect to gravity, is a powerful representation of real-world structure for object detection, segmentation, and localization tasks using red, green, blue, depth, or RGBD, images. The authors’ results dramatically improve localization accuracy and enable accurate alignment of multiple images taken from different oblique viewpoints.

For intelligent systems to operate autonomously, we must instill in them human values. Moral-Scene Assessment endows machines with a proto-conscience that identifies what is morally salient within a scene, to anticipate and avoid harm and to promote well-being. This capability serves as the basis for machines to engage in ethics-sensitive decision-making.

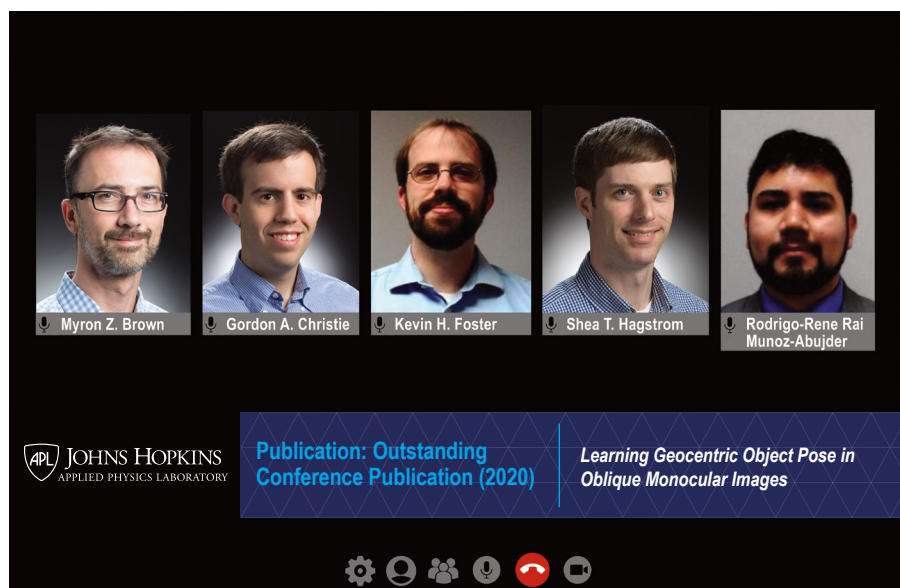
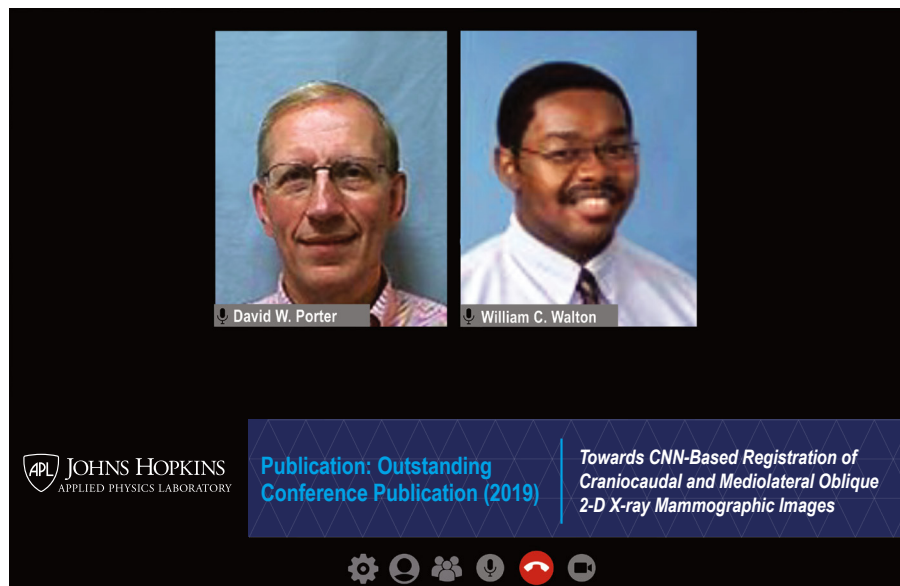
Outstanding Conference Paper

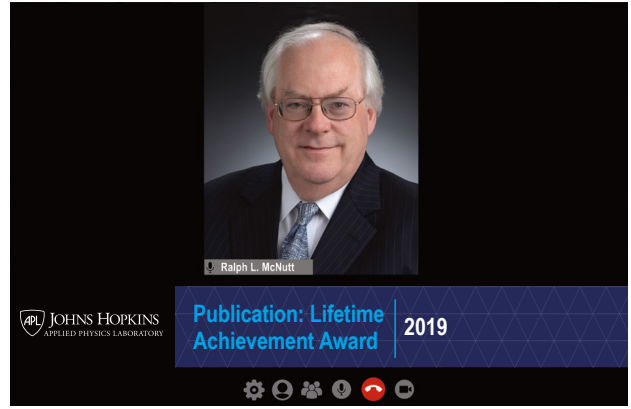
The award for outstanding 2019 conference paper went to David W. Porter and William C. Walton for “Towards CNN-Based Registration of Craniocaudal and Mediolateral Oblique 2-D X-ray Mammographic Images,” published in the *Proceedings of the 41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society*.¹⁷ This paper describes collaborative research between APL and the University of Maryland, Baltimore County, on convolutional neural network–based registration techniques for automatically registering lesions in the two standard mammographic x-ray image views: craniocaudal (CC) and mediolateral oblique (MLO). The capability could improve the accuracy of lesion detection, with potentially life-saving impacts.

The award for outstanding 2020 conference paper went to Myron Z. Brown, Gordon A. Christie, Kevin H. Foster, Shea T. Hagstrom, and Rodrigo-Rene

Lifetime Achievement Publication Award

In addition to the 2019 publications celebrated during the 2020 ceremony, the most prestigious of the





publication awards, the Lifetime Achievement Award, was conferred to Tony Lui and Ralph L. McNutt of APL's Space Exploration Sector. This award, earned by only 15 staff members including Lui and McNutt, is not presented every year, and before the 2020 ceremony it had never been presented to two authors in the same year. The Lifetime Achievement Publication Award honors authors' careers of achievement through a substantial body of publications that are significant in terms of peer recognition, prizes, citation frequency, or influence on the innovation ecosystem. Lui has published nearly 400 papers, and McNutt's body of work spans more than 200 published technical papers and more than 270 published scientific abstracts.

significant contributions that advance science and technology through independent research and development. Sectors and departments recommend candidates, and the Management Forum judges the nominations on their quality and importance to APL. Prizes are awarded in two categories: best research project and best development project.

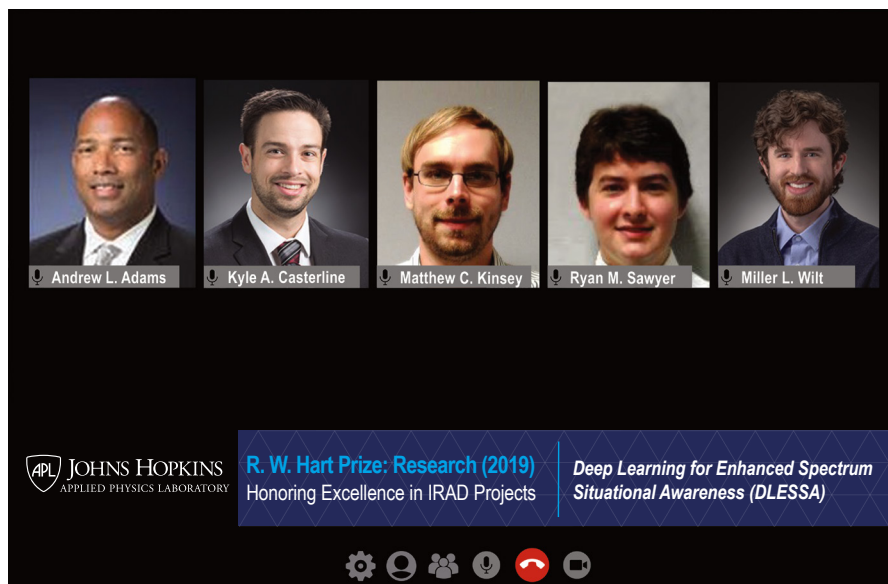
R. W. HART PRIZES FOR EXCELLENCE IN INDEPENDENT RESEARCH AND DEVELOPMENT

The R. W. Hart Prizes for Excellence in Independent Research and Development—first presented in 1989 and named for former APL assistant director for research and exploratory development Robert W. Hart—recognize

Best Research Project

The award for the best 2019 research project went to Deep Learning for Enhanced Spectrum Situational Awareness (DLESSA), with principal participants Andrew L. Adams, Kyle A. Casterline, Matthew C. Kinsey, Ryan M. Sawyer, and Miller L. Wilt. Harnessing the power of artificial intelligence, this project resulted in development of new techniques that have been enablers for a range of missions, including missions focused on intelligence, surveillance, and reconnaissance (or ISR); signals intelligence (or SIGINT); network maneuvers; and wireless cyber defense.

The award for the best 2020 research project went to Julie E. Gleason, Rachel A. Hegab, and Brooke M. Luisi

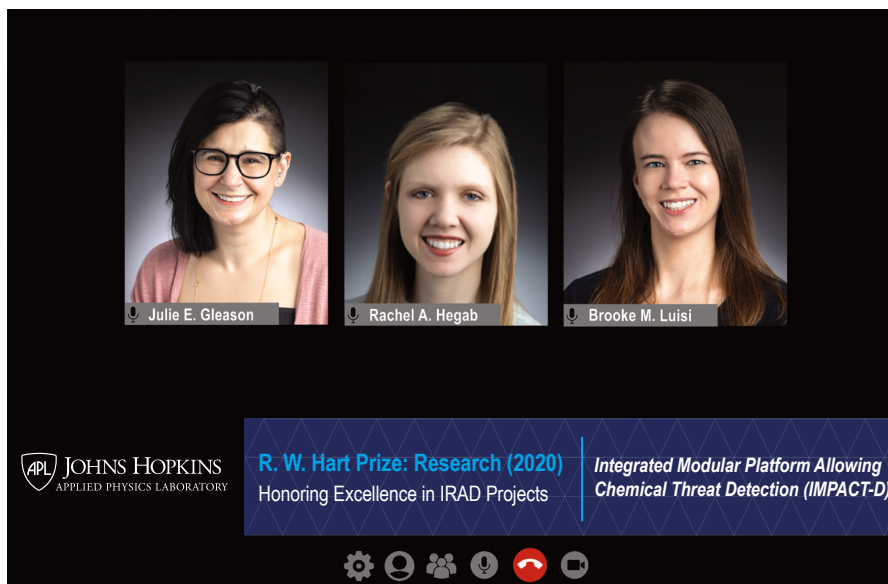


for Integrated Modular Platform Allowing Chemical Threat Detection (IMPACT-D). In this first-of-its-kind achievement, the team designed a self-contained, cell-based, living sensor to provide early indication of exposure to select chemical threats. Using synthetic biology tools, they engineered *E. coli* bacteria to sense low concentrations of organophosphates. When exposed to these organophosphates, microbes react and the sensor turns blue. Coupled with an appropriate containment system, the engineered microbes form the basis of a highly specific wearable sensor that indicates possible exposure to various environmental toxins. This generalizable sensing construct was also demonstrated to sense TNT, lead, and formaldehyde.

Best Development Project

The award for the best 2019 development project went to Sample Preparation for Organic Analyses,¹⁹ with Christopher E. Bradburne, Kathleen L. Craft, Ashley Y. Kilhefner, Korine A. Ohiri, Jennifer S. Benzinger, Tessa B. VanVolkenburg, and Kathleen J. Verratti. This team successfully prototyped a compact device to seek signs of extant life and biosignatures beyond Earth by detecting long-chain polymers like DNA and RNA.

The award for the best 2020 development project went to Flying into the Unknown: Direct Nonlinear Model-Predictive Control (NMPC) for Fast Fixed-Wing Flight in Complex Environments,²⁰ with Max R. Basescu, Matthew D. Hahne, Joseph L. Moore, Adam C. Polevoy, Katie M. Popek, Luca Scheuer, and Bryanna Y. Yeh. These APL investigators developed a nonlinear





model-predictive control technique that enables fixed-wing unmanned aerial vehicles to perform aerobatic maneuvers, allowing them to navigate in constrained spaces. This novel algorithmic approach achieves a first-of-its-kind capability that significantly improves speed and endurance as compared to quadcopters.

AWARDS FOR INVENTION

Government Purpose Innovation Award

The first Government Purpose Innovation Award, recognizing an invention that meets a critical sponsor need, was presented in 2011. Selected by a team of technical leaders from across the Lab who are acquainted

with APL's technology transfer practices, finalist inventions are judged on their novelty and potential impact to the sponsor community.

The award for innovation in 2019 went to Matthew A. Bichay, Michelle L. Bowser, James F. Cahill, Anthony J. Castellani, David E. Colbert, Travis E. Heslop, Michael T. Kelbaugh, Catherine E. Krynick, Jeremy R. Tosh, and Derrick M. Treichler for designing, building, and demonstrating an advanced prototype for Aegis ballistic missile defense mission planning. Their work facilitates optimization of ship positioning and weapon system configuration to carry out the critical ballistic missile defense mission.

The award for innovation in 2020 went to Laura K. Asher, Evan J. Bolt, Beatrice Patricia R. Garcia,



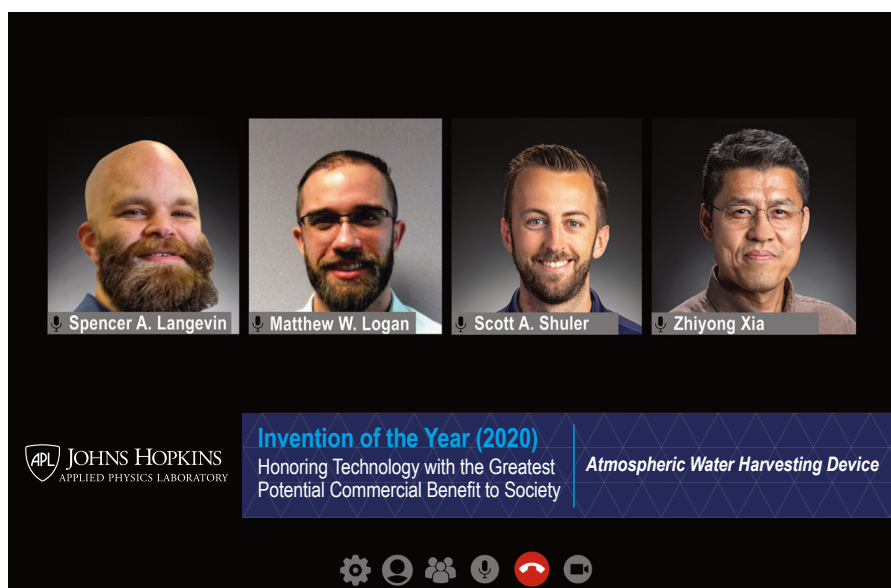


Tamara D. Goyea, Aaron Katz, Ryan D. Lau, Timothy K. Ng, Sarah E. Prata, Jeremy D. Ratcliff, and Miles A. Stewart for Data Collection, Error Correction, and Modeling Platforms for the COVID-19 Pandemic. These APL researchers provided data collection and curation capabilities behind the Johns Hopkins University Coronavirus Resource Center,²¹ which was recognized on *Time* magazine's list of the best inventions of 2020.²² In support of assistant professor Lauren Gardner from the Johns Hopkins Whiting School of Engineering, who created the dashboard, and with colleagues from the Johns Hopkins University Sheridan Library, the APL team created an automated data system that enables accurate and timely analysis of the health data.

Invention of the Year

The Invention of the Year Award was first presented in 2000 to encourage new technology and innovation at APL. To identify the top technology from the preceding year, an independent review panel judges invention disclosures. The judges, including technical and business consultants, technology transfer professionals, and intellectual property attorneys, assess inventions' creativity, novelty, improvement to existing technology, commercial potential, and probable benefit to society.

The winners of the Invention of the Year Award for 2019 were Xiomara Calderon-Colon, Julie B. Patrone, and Olivia N. Tiburzi for creating a new, biocompatible, stable lipid nanoparticle platform that incorporates and delivers drugs that prevent or halt type 1 diabetes,



an autoimmune disease.²³ Because the platform can incorporate a wide range of molecules and drugs, and control their release at targeted sites, the team expects to see similar beneficial effects with other autoimmune disorders.

The winners of the Invention of the Year Award for 2020 were Spencer A. Langevin, Matthew W. Logan, Scott A. Shuler, and Zhiyong Xia for inventing an atmospheric water harvesting device.^{2,24} The team invented a highly adsorbent specialty material composed of a combination of hydrogel and a modified metal organic framework that is effective at extracting water from the humidity in air. This engineered adsorbent has been manufactured, tested, and proven to have the ability to effectively extract water from air.

Master Inventor Award

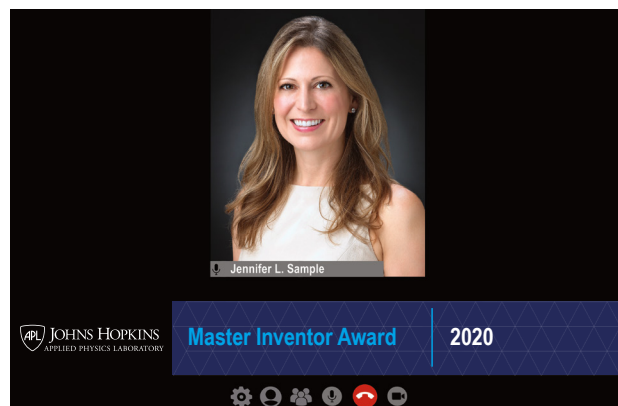
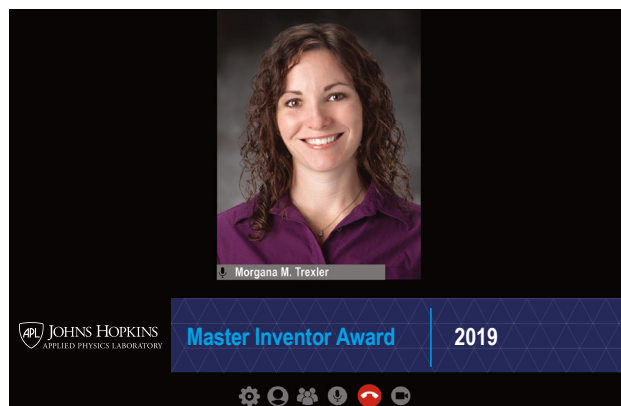
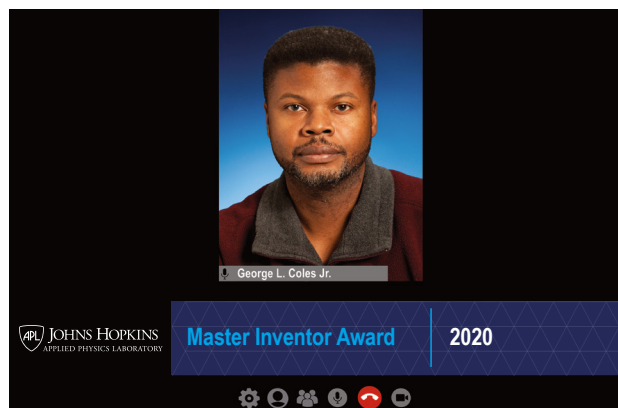
Lab management first presented the Master Inventor Award in 2007 to honor those who have received their 10th US patent while employed at APL. To date, only 30 staff members have attained the honor. The Lab was incredibly proud to add five staff members to the acclaimed list, including the first two women, in 2019 and 2020.

In 2019, Jeffrey P. Maranchi and Morgana M. Trexler earned master inventor status, and in 2020, David W. Blodgett, George L. Coles Jr., and Jennifer L. Sample celebrated this achievement.

AWARDS FOR OUTSTANDING ACCOMPLISHMENTS

Outstanding Mission Accomplishment Awards

The Outstanding Mission Accomplishment Awards, first presented in 2014, recognize major achievements in mission-oriented programs and projects. Awards are given in two categories: a current challenge and an emerging challenge. For both types, a review team of top managers and executives from APL's sectors and mission areas solicits nominations for technical accomplishments in sponsored programs during the previous year. A program has to have achieved a significant milestone within the previous fiscal year to be eligible. The panel judges entries on technical excellence and potential impact.



Mission Accomplishment for Current Challenge

The award for Outstanding Mission Accomplishment for a Current Challenge in 2019 went to Teck H. Choo, Robert E. Erlandson, John A. Landshof, Michael Norkus, Emma S. Rainey, Christopher T. Regan, and Walid Saleh for developing program that provides the Ballistic Missile Defense System with a battle damage assessment capability from space. It comprises a network of small sensors that collect the energy signature of the impact between a threat ballistic missile and an interceptor.

Two awards for Outstanding Mission Accomplishment for a Current Challenge in 2020 were presented during the 2021 ceremony. The first went to the COVID Data and Analytics team, with core team members Jeffrey D. Freeman, Amanda R. Galante, Tamara D. Goyea, Philip B. Graff, Aaron Katz, Ryan D. Lau, Timothy K. Ng, Paul J. Nicholas, Elisha B. Peterson, and Jonathan K. Thornhill. This team provided quick-reaction data sourcing and analytics for the global pandemic response by creating novel, highly automated data and analytical pipelines. The pipelines served the globally recognized Johns Hopkins Coronavirus Resource Center²⁵ and influenced data-driven policy and resource planning decisions for the White House COVID Task Force.

The second 2020 award went to Maritime Targeting Cell – Afloat, with core team members Frank J. Bantell Jr., K. Dewayne Brown, William J. (Jim) Farrell III, William H. Mosberg IV, Adam M. Neiss, Michael D. Palasits, Todd E. Sims, Nik L. Smith-Simmons, Tenee W. Stephenson, and Shane G. Walston. Maritime



Targeting Cell – Afloat, or MTC-A, is an initiative to enhance the US Navy’s ability to provide long-range targeting. Through rapid prototyping, experimentation, and virtual and live exercises, the APL MTC-A team, in partnership with the government sponsor and Northrop Grumman, is moving advanced processing capabilities into the battlespace to take advantage of existing and new data feeds enhancing situational awareness, identification, and targeting at the tactical edge.

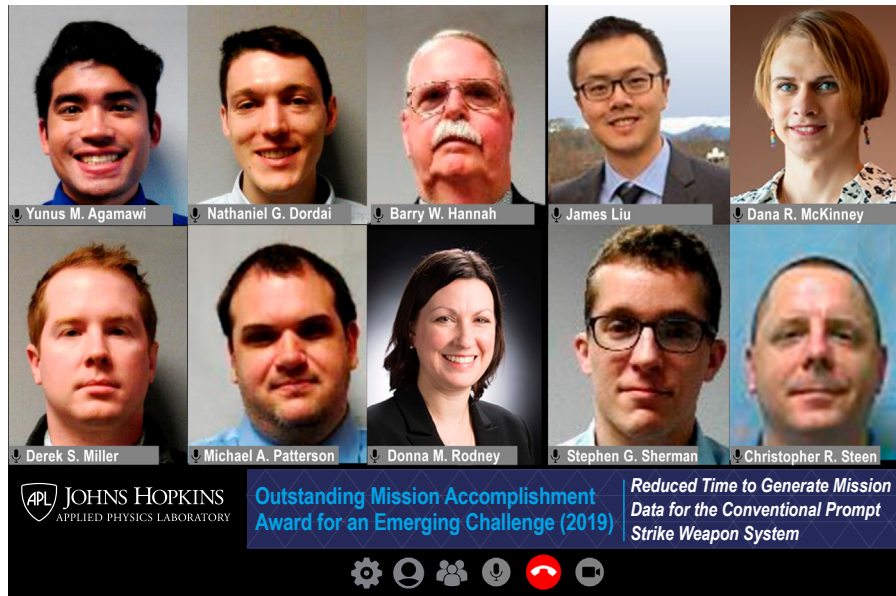
Mission Accomplishment for Emerging Challenge

Two awards for Outstanding Mission Accomplishment for a Current Challenge in 2019 were presented during the 2020 ceremony. The first went to Yunus M. Agamawi, Nathaniel G. Dordai, Barry W. Hannah, James Liu, Dana R. McKinney, Derek S. Miller, Michael A. Patterson, Donna M. Rodney, Stephen G. Sherman, Christopher R. Steen

Michael A. Patterson, Donna M. Rodney, Steve G. Sherman, and Christopher R. Steen for an effort that will greatly reduce the time to generate mission data for the Conventional Prompt Strike weapon system.

The second 2019 award went to Nathan T. Boggs, Christopher E. Bradburne, Elizabeth C. Corson, Brian E. Damit, Audrey E. Fischer Hesselbrock, Sarah L. Grady, F. Connor Sage, Kathlyn Santos, Jennifer H. Therkorn, and Kathleen J. Verratti for a project to significantly strengthen the nation’s biodetection posture and establish a new critical area in biodetection, prompting the community to view biothreat mitigation more progressively.

Two awards were also presented for 2020 accomplishments. The first award went to Badlands, with principal contributors Benjamin M. Brawley, William R. Heimsoth, Casey F. Kane, Paul R. Kucher IV, Megan R.



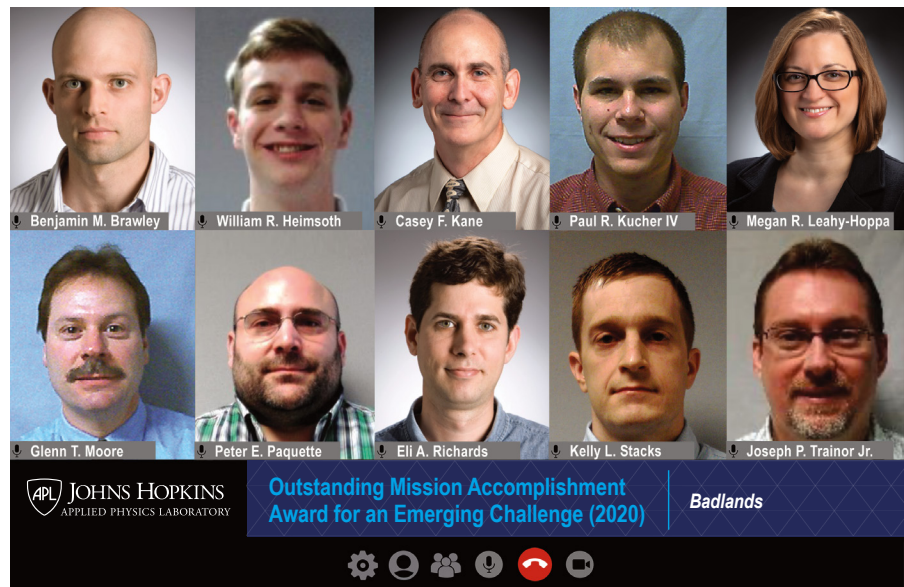
Leahy-Hoppa, Glenn T. (Ty) Moore, Peter E. Paquette, Eli A. Richards, Kelly L. Stacks, and Joseph P. Trainor Jr. The Badlands team evolved and integrated multiple distinguished capabilities with novel algorithms and custom hardware to deliver critical capability for the intelligence community.

The second 2020 award went to DARPA AlphaDogfight Trials,²⁶ with core team members Kelly A. Brady, Christopher R. DeMay, William D. Dunham, Jennifer U. Gebhardt, David A. Handelman, John E. O'Brien, Johnathan A. Pino, Robert L. Shearer III, Lee R. Varanyak, and Edward L. White. The DARPA AlphaDogfight Trials aimed to develop intelligent autonomous agents capable of defeating an adversary aircraft in a simulated dogfight. Enabled by APL, the trials increased the performance of and warfighter trust in artificial intelligence algorithms and started down the path to advance combat autonomy through competition.

Enterprise Accomplishment Award

The Enterprise Accomplishment Award, first presented in 2015, recognizes the enterprise accomplishment with the greatest impact on APL's operations and culture of innovation. Winners are selected by a joint panel of APL's operations executives and managing executives.

The 2019 award recognized APL Navigator: New Hire Onboarding, led by Annamalai Annamalaichettyar, Christopher L. Cavett, Jennifer A. Danick, Steven R. Elkins, Denise L. Hockensmith, Richard F. Jennings, Daniel Leavy, Tristan D. McCall, Deborah L. Noyes, and Maria S. Singletary.





Noyes, and Maria S. Singletary. The team developed an onboarding tool that gives new staff members and their supervisors a digital experience that greatly reduces paper as well as manual data entry and coordination.

Two Enterprise Accomplishment Awards were presented for achievements in 2020. The first award recognized ZoomGov Deployment, led by Timothy P. Alder, Jehan B. Aziz, N. May Boonyobhas, Catherine M. Colangelo, Christy Kiser, Nicholas K. Koutsias, Radha G. Kowtha, Andrew S. Liu, DeAndrea J. Norris, and Daniel R. Wroten. The rapid deployment of ZoomGov supported APL's swift transition to a hybrid workplace during the COVID-19 pandemic, fully supporting the Laboratory's need to collaborate and communicate internally and with sponsors during this unprecedented national emergency. This deployment shines as an example of APL's resilience in a rapidly changing world.

The second 2020 award recognized Decision Support Center (DSC) and APL COVID-19 Statistics, led by Joshua D. Baker, David W. Booth, Michael H. Brown, Bradley C. Garrett, Amara I. Hamdani, Jessie D. Jamieson, Scott S. Kallmeyer, Arthur G. Kang, Anne M. Marcotte, and Farrah S. O'Colman. The APL DSC was established during the first pandemic in over 100 years to rapidly digest and aggregate large amounts of data in order to produce a common operating picture. This effort enabled APL's Executive Council to make timely and effective decisions and facilitate appropriate actions and enabled staff members' awareness and personal daily planning.

The Alvin R. Eaton Award

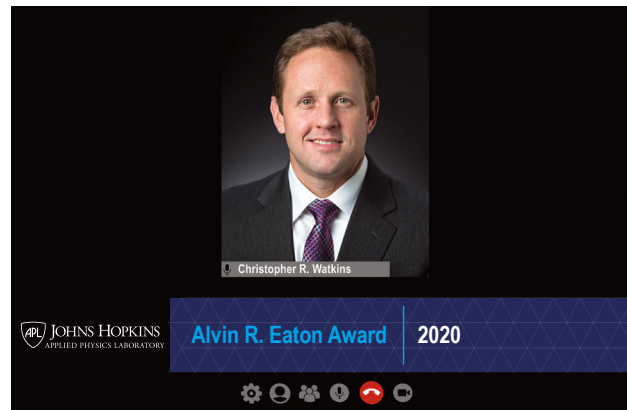
The Alvin R. Eaton, or ARE, Award has been presented annually since 2001 but was not presented publicly



during the awards ceremony until 2016. It honors staff members who have spent much of their careers leading remarkable achievements that we cannot talk about openly. Awardees are selected by APL's director and assistant director for programs.

Peter J. Sharer, the chief engineer in the Space Exploration Sector, earned the 2019 Alvin R. Eaton Award for his critical contributions to the Department of Defense and the Intelligence Community in the fields of space domain awareness, counter-space operations, and space security and defense on numerous highly classified programs with APL sponsors.

Christopher R. Watkins, sea control mission area executive in the Force Projection Sector, earned the 2020 award for his energy, leadership, and technical contributions to the nation's undersea capabilities. In addition to being directly responsible for new and significantly improved capabilities for the United States through his contributions to and leadership on sponsored programs and internal research, Watkins has provided significant contributions to Defense Science Board studies pertaining to the undersea.



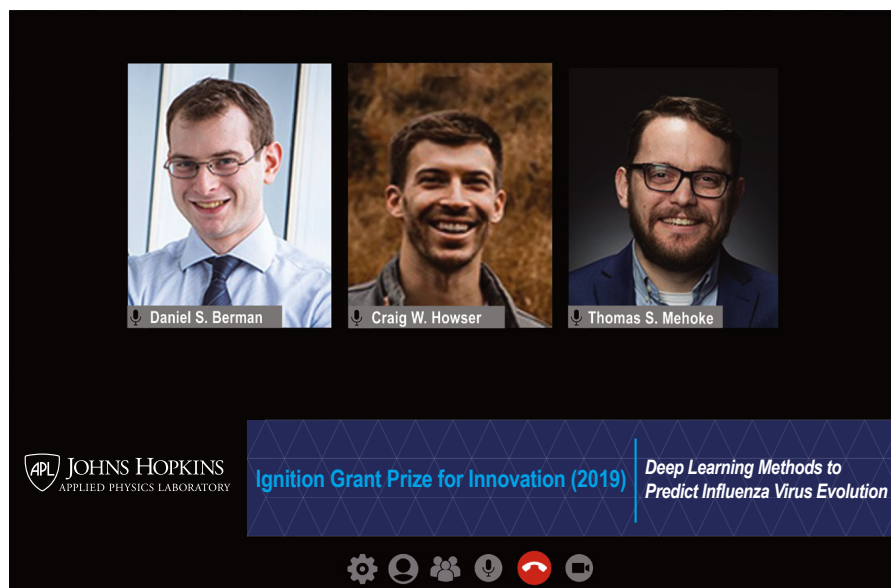
AWARDS FOR INNOVATION

To position the Lab to respond to increasingly complex national challenges and to capitalize on rapid technological advances, APL's leaders have introduced several initiatives to encourage innovation across the Lab.²⁷ One of these initiatives, Project Catalyst, offers staff members three funding opportunities for bold, high-risk, transformational ideas that will ensure our nation's preeminence in the 21st century. Staff members submit ideas in response to challenges posted during several cycles throughout the year. Peers vote on the submissions, and finalists receive funding to develop their ideas.

Ignition Grant Prize for Creativity and Potential Impact

The inaugural Project Catalyst award, the Ignition Grant Prize, was presented for the first time in 2013 for the project judged to be most creative and to have the greatest potential impact.

The 2019 award went to Daniel S. Berman, Craig W. Howser, and Thomas S. Mehoke for experimenting with



state-of-the-art deep learning methods to predict influenza virus evolution.

The 2020 award went to Anissa N. Elayadi, Toni C. Ponniah, and Susan K. Wu for RIVAL: Repurposing Infant Vaccines Against Lethal COVID-19. The results of the team's work indicate that childhood vaccines appear to be inducing cross-reactive antibodies against COVID-19 proteins and therefore could be repurposed to be used as vaccines against COVID-19 or future viruses.

Combustion Grant Prize for High-Risk, High-Impact Technical Ideas

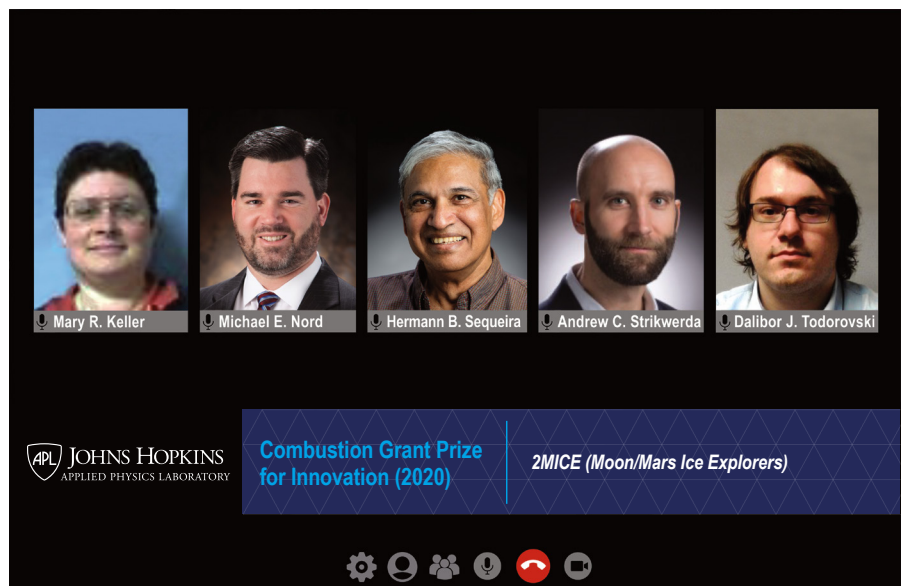
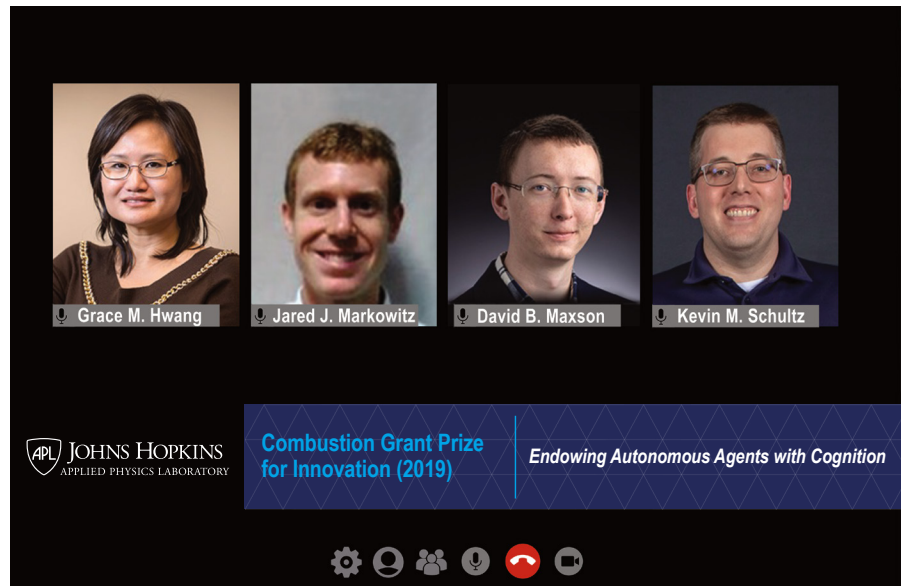
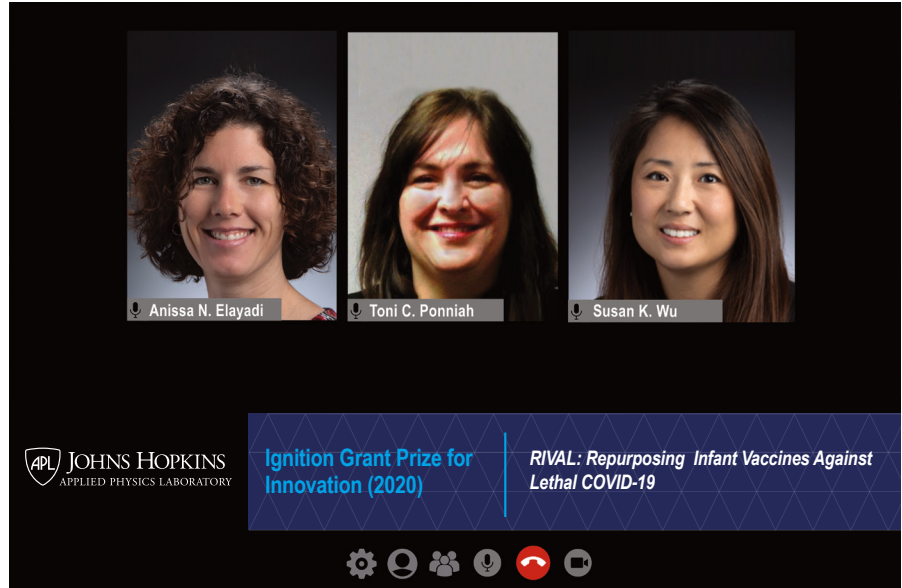
The Combustion Grant Prize, first presented in 2017, recognizes high-risk, high-impact technical ideas.

Grace M. Hwang, Jared J. Markowitz, David B. Maxson, and Kevin M. Schultz were recognized for their 2019 work creating a foundation for a novel architecture to represent the adaptation of knowledge, enabling rapid machine learning in changing environments.

Mary R. Keller, Michael E. Nord, Hermann B. Sequeira, Andrew C. Strikwerda, and Dalibor J. Todorovski earned a 2020 award for 2MICE (Moon/Mars Ice Explorers), a novel smallsat mission that has the potential to unambiguously detect and map water ice deposits. Water ice deposits in permanently shadowed craters of the Moon or at mid-latitudes on Mars are a desirable resource for in situ production of fuels and life-support materials.

Year 3 Propulsion Grant Award

And, finally, presented for the first time in 2018, the Propulsion Grant Award honors



ideas that were selected for their third year of funding.

The first 2019 award went to Seneca L. Bessling, Nathan T. Boggs, Sarah L. Grady, Evan P. Lloyd, and Kaitlin R. Lovett for creating a new approach to surveillance and exfiltration of information by using a listening device devoid of electronics.

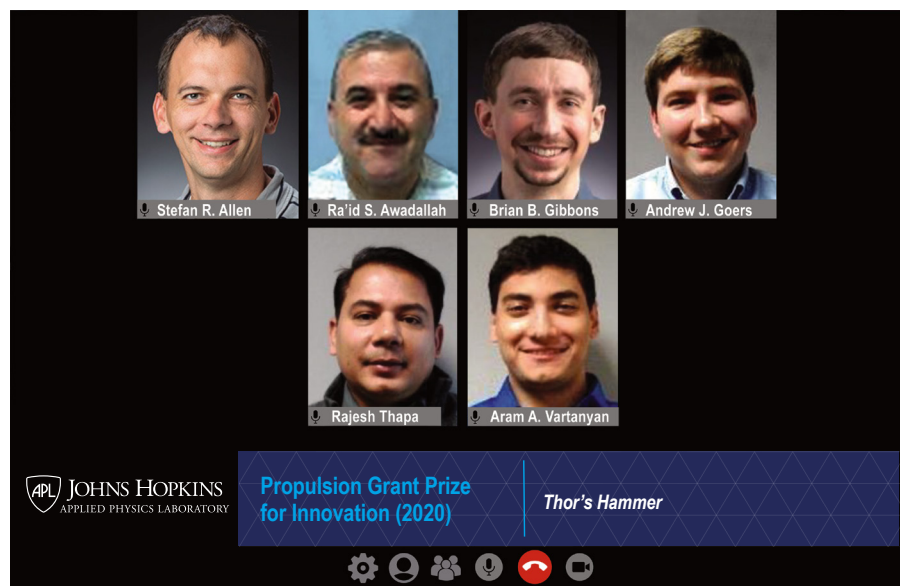
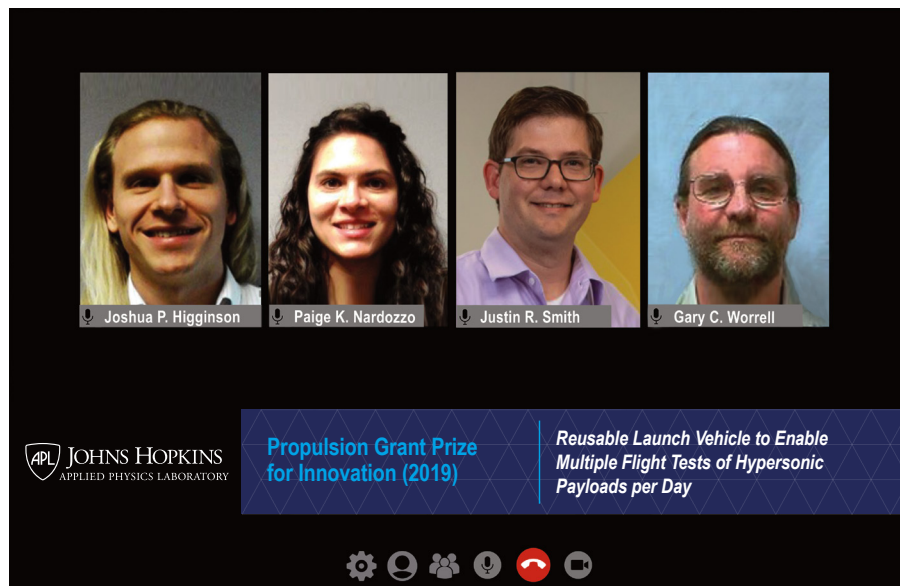
The second 2019 award went to Joshua P. Higginson, Paige K. Nardozzo, Justin R. Smith, and Gary C. Worrell for developing a way to enable multiple flight tests of hypersonic payloads per day with a reusable launch vehicle.

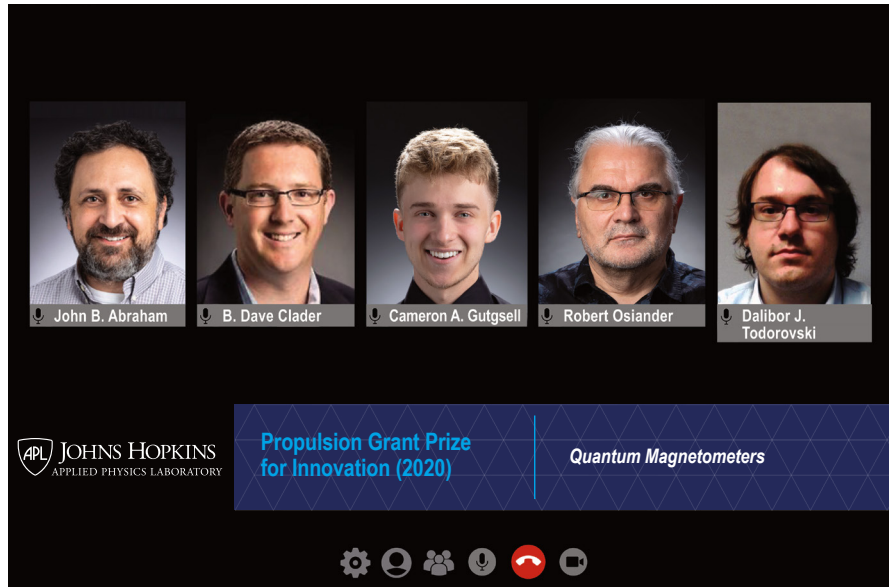
The first 2020 award went to team principals Stefan R. Allen, Ra'id S. Awadallah, Brian B. Gibbons, Andy J. Goers, Rajesh Thapa, and Aram A. Vartanyan for Thor's Hammer, an investigation into the physics of the emission of a broadband radio frequency impulse and acoustic waves when an ultra-short pulse laser interacts with a metallic surface. The team also explored the interaction of the acoustic waves with small uncrewed aerial vehicle inertial measurement units.

The second 2020 award went to John B. Abraham, B. Dave Clader, Cameron A. Gutsell, Robert Osiander, and Dalibor J. Todorovski for Quantum Magnetometers, a project investigating how to leverage quantum computing and information technologies to develop ultra-precise quantum-enabled magnetometers.

DIRECTOR'S AWARD FOR SPECIAL ACHIEVEMENTS

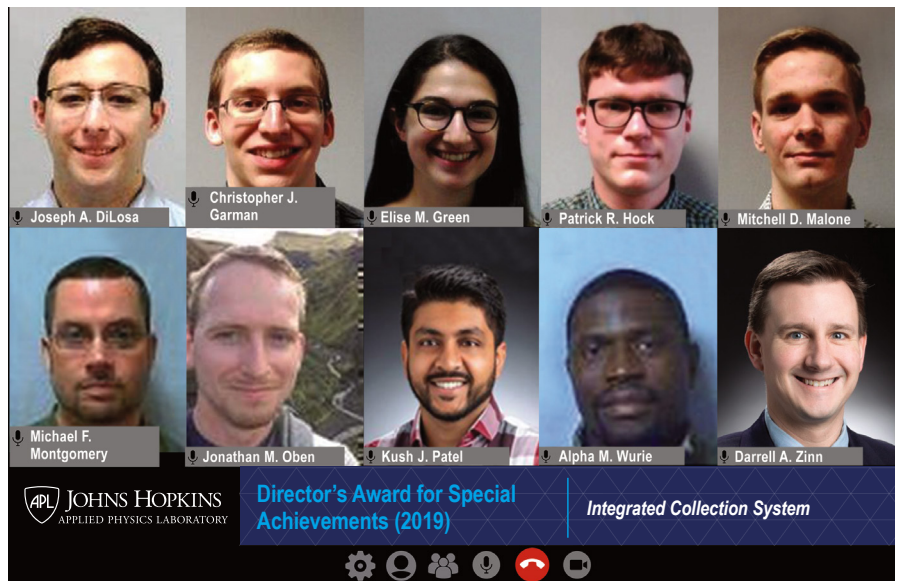
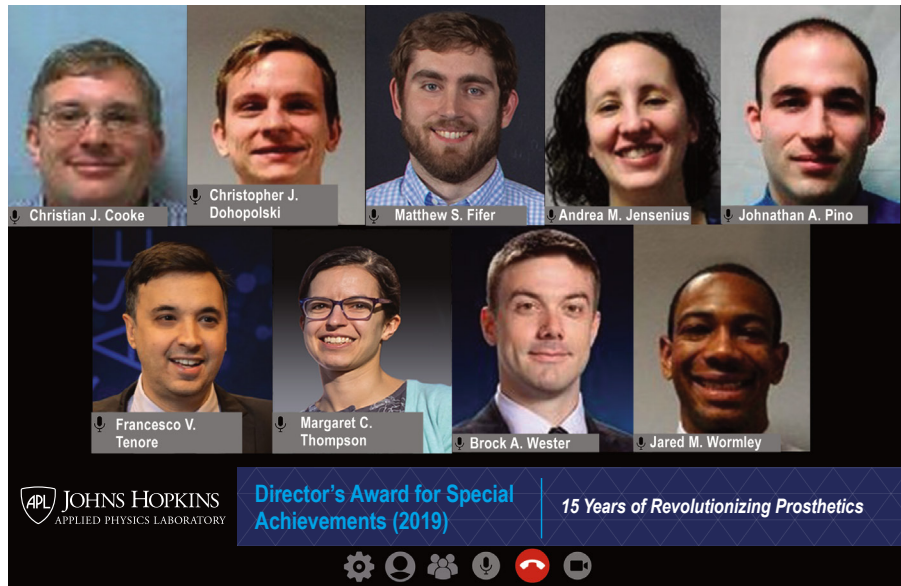
Sometimes a major accomplishment is outside the usual award categories. The Director's Award for Special Achievements recognizes such accomplishments. This award was first presented in 2017.





Two awards were presented for special achievements in 2019. The first 2019 award recognized Christian J. Cooke, Christopher J. Dohopolski, Matthew S. Fifer, Andrea M. Jensenius, Johnathan A. Pino, Francesco V. Tenore, Margaret C. Thompson, Brock A. Wester, and Jared M. Wormley for their collaboration with Johns Hopkins Medicine on a system that allows a human to control two of APL's modular prosthetic limbs²⁸ while perceiving sensory feedback when the mechanical fingers touch objects in the environment. These advances have significantly pushed the boundaries of what is possible in rehabilitation after high spinal cord injury.

The second 2019 award recognized Joseph A. DiLosa, Christopher J. Garman, Elise M. Green, Patrick R. Hock, Mitchell D. Malone, Michael F. Montgomery, Jonathan M. Oben, Kush J. Patel, Alpha M. Wurie, and Darrell A. Zinn for their development of a classified system that responded to an urgent operational need and grew into a suite of



capabilities that are in near-constant operation in support of national security.

Two awards were again presented for special achievements in 2020. The first 2020 award recognized the Environmental Health and Safety COVID-19 Response team, represented by Daniel H. Anna, Shirley A. Barcase, Kathryn A. Connors, Michael Ginther, Kelsey B. Nutter, Sara I. Parton, Katie M. Reiter, and Julie L. Stipes. The team provided expert guidance to the Laboratory throughout the COVID-19 pandemic, delivering novel approaches for Laboratory health and hygiene, contact tracing, and vaccine administration. Through the team's incredible efforts, APL was able to keep staff safe and continue its critical work for government sponsors.

The second 2020 award recognized the Future Systems Integration 2020 Flight Test team, represented

by Matthew S. Cheetham, Mark T. Galligan, Ravi P. Goonasekaram, Corrie L. James, Erik D. Justen, Peter L. Kirby, Taylor M. Lowe, Kevin J. Proska, David M. Rouse, and Brennan N. Thews. While this is a project that we cannot discuss openly, we can say that it has resulted in development of unparalleled revolutionary air and missile defense capabilities that will benefit our nation for years to come.

THE BOLDIES

In early 2018, Lab management brought together a team of technical leaders and contributors and asked them what they would recommend to increase APL's boldness. This group, Team Bold, proposed instituting two formal awards to celebrate boldness.



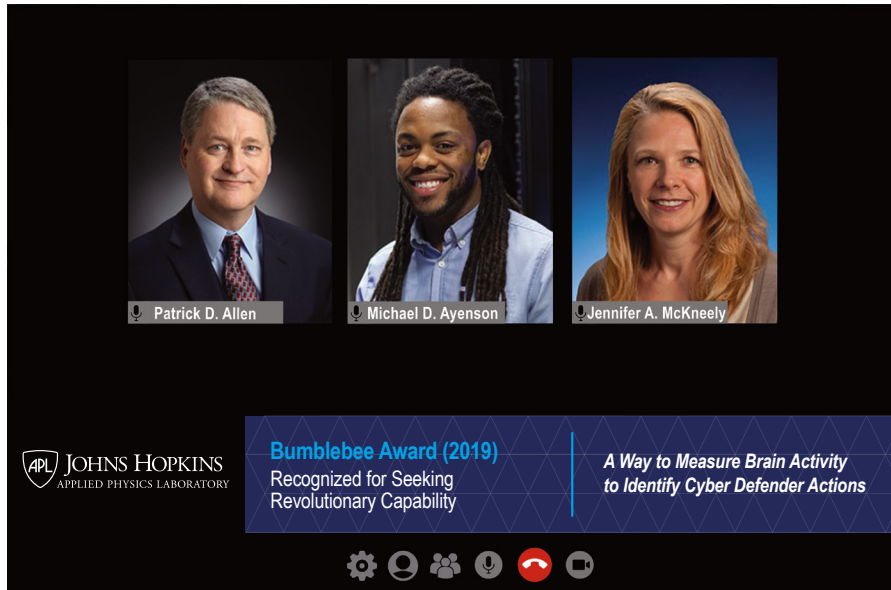
Bumblebee Award

The first award, the Bumblebee Award, recognizes improbable designs that had remarkable results, much like APL's historic Bumblebee program, whose name was inspired by a quote attributed to aviation pioneer Igor Sikorsky: "According to recognized aerotechnical tests the bumblebee cannot fly because of the shape and weight of his body in relation to the total wing areas. BUT, the bumblebee doesn't know this, so he goes ahead and flies anyway."

The Bumblebee Award recognizing 2019 achievements was presented to Patrick D. Allen, Michael D. Ayenson, and Jennifer A. McKneely for creating a way to measure brain activity in a quest to identify cyber defender actions that cause the greatest frustration,

delay, and confusion for a cyber adversary. The effort, if successful, will lead to identifying the techniques that shift the cyber advantage toward defenders.

The Bumblebee Award recognizing 2020 achievements was presented to Joshua B. Broadwater, Michael S. Burks, Dean R. Fisher Jr., Michael D. Heyman, Kevin M. Ligozio, Katie J. Meixner, and Casey L. Richardson for Smart Sensor, an autonomous perception and reasoning system for an intelligence mission in challenging tactical operational environments. Called the Autonomous Sensor Platform, or ASP, this artificial intelligence-enabled "brain" is intended for large uninhabited autonomous systems and enables continued, autonomous flight and sensor operations in GPS- and communications-denied environments.



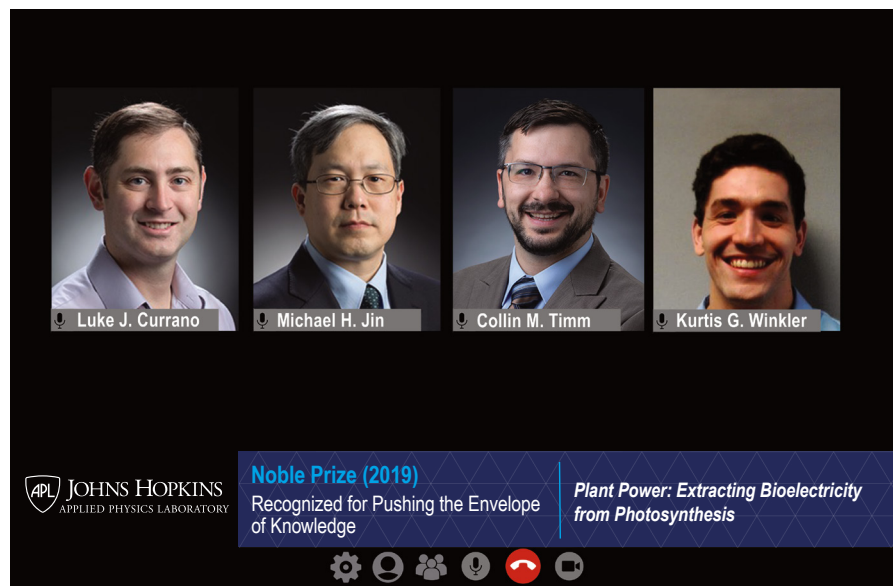
The Noble Prize

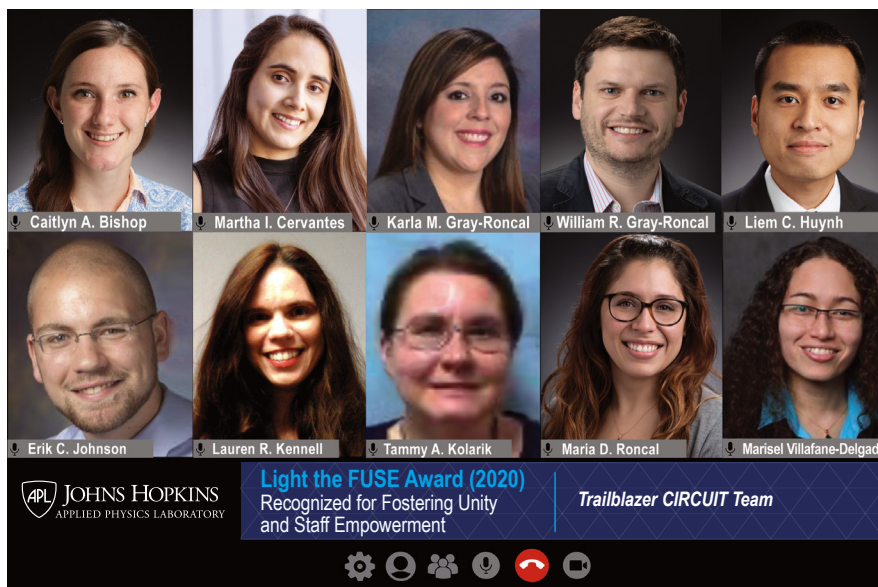
The second award in this category, the Noble Prize, celebrates work that was not fully successful but taught us a lot. Its name is a play on Nobel Prize and noble failure.

The Noble Prize for 2019 was awarded to Luke J. Currano, Michael H. Jin, Collin M. Timm, and Kurtis G. Winkler for attempting to leverage the natural life processes of plants to create a power source. Although they were not successful, their research led them to possible ways to improve the plant microbial fuel cell system approach in the future.

The Noble Prize for 2020 was awarded to Anurupa I. Bhonsale, Sarah L. Brewer, Nicole L. Brown,

Lindsey M. Gilbert, Brooke M. Luisi, Leif E. Powers, Kristin S. Sotzen, Christopher D. Stiles, William D. Stone, and Andrea C. Timm for their work on multi-layer biofilm tablets to overcome planetary extrema. The team developed a terraforming strategy (terraforming is the construction of a designed ecosystem) around the idea that a self-sustaining, multi-species biofilm ecosystem could survive in a harsh environment with minimal resources and perform multiple functions as it grows, expands, and matures to make another planet more hospitable. While the team was unable to develop a viable strategy to terraform Venus, there were some positive indications of an approach applicable to Mars. The results also hold promise for bioremediation on Earth.





LIGHT THE FUSE AWARD

The Light the FUSE Award is a new award, first presented during the 2021 ceremony for contributions in 2020. The award name is a play on the acronym FUSE, referring to APL's FUSE employee resource group, which created this award, as well as the Lab's general innovation theme. FUSE, which stands for Fostering Unity and Staff Empowerment, is a consolidation of representatives from APL's affinity groups, sectors, and departments who are focused on enhancing the Lab's work environment and culture of innovation. This award recognizes significant contributions that promote a positive, diverse, and inclusive culture at the Laboratory, increasing APL's potential for innovation. In the award's first year, the FUSE team selected from 7 impressive nominations involving 35 staff members who are demonstrating how diversity and inclusion improve both direct and indirect work.

The inaugural Light the FUSE Award was presented to the Trailblazer CIRCUIT²⁹ team, with leaders Caitlyn A. Bishop, Martha I. Cervantes, Karla M. Gray-Roncal, William R. Gray-Roncal, Liem C. Huynh, Erik C. Johnson, Lauren R. Kennell, Tammy A. Kolarik, Maria D. Roncal, and Marisel Villafane-Delgado. CIRCUIT team members have inspired and connected a new generation of trailblazing innovators with APL through a groundbreaking college internship program. In an effort to further a culture of inclusion and diversity, the leaders of CIRCUIT, which stands for Cohort-based Integrated Research Community for Undergraduate Innovation and Trailblazing, quickly grew the program beyond its original Johns Hopkins University borders to include other institutions.

For a brief history of APL's awards program, see the article by Richardson and Livieratos in the issue commemorating APL's 75th anniversary.³⁰ This same issue includes a complete list of winners through 2017 (for 2016

achievements).³¹ Summaries of the winners for achievements in 2017³² and 2018³³ are also available in the *Digest*.

REFERENCES

- ¹G. Quiroz, "Robust quantum control for adiabatic quantum computation," *Phys. Rev. A*, vol. 99, no. 6, article 062306, 2019, <https://doi.org/10.1103/PhysRevA.99.062306>.
- ²M. W. Logan, S. Langevin, and Z. Xia, "Reversible atmospheric water harvesting using metal-organic frameworks," *Sci. Rep.*, vol. 10, article 1492, 2020, <https://doi.org/10.1038/s41598-020-58405-9>.
- ³N. Drenkow, J. Joyce, J. Matelsky, J. Heiko, R. Larabi, B. Wester, D. Kleissas, and W. Gray-Roncal, "Leveraging tools from autonomous navigation for rapid, robust neuron connectivity," in *Medical Image Computing and Computer Assisted Intervention – MICCAI 2020, Lecture Notes in Computer Science*, vol. 12265, A. L. Martel, P. Abolmaesumi, D. Stoyanov, D. Mateus, M. A. Zuluaga, S. K. Zhou, D. Racoceanu, and L. Joskowicz, Eds., 2020, pp. 109–118, https://doi.org/10.1007/978-3-030-59722-1_11.
- ⁴M. R. Jones, K. A. Fretz, S. D. Kubota, and C. A. Smith, "Integrating reliability engineering with fault management to create resilient space systems," *Johns Hopkins APL Tech. Dig.*, vol. 34, no. 4, pp. 462–470, 2019, <https://www.jhuapl.edu/Content/techdigest/pdf/V34-N04/34-04-Jones.pdf>.
- ⁵D. P. McMullen, M. S. Fifer, K. D. Katyal, R. Armiger, G. Hotson, J. D. Beaty, A. Chi, D. B. Drachman, and B. A. Wester, "Design and preliminary evaluation of an augmented reality interface control system for a robotic arm," *Johns Hopkins APL Tech. Dig.*, vol. 35, no. 3, pp. 220–230, 2020, <https://www.jhuapl.edu/Content/techdigest/pdf/V35-N03/35-03-Wester-Prosthetics.pdf>.
- ⁶K. Schultz, "Exponential families for Bayesian quantum process tomography," *Phys. Rev. A*, vol. 100, no. 6, article 062316, 2019, <https://doi.org/10.1103/PhysRevA.100.062316>.
- ⁷M. W. Logan, S. Langevin, B. Tan, A. W. Freeman, C. Hoffman Jr., D. B. Trigg, and K. Gerasopoulos, "UV-cured eutectic gel polymer electrolytes for safe and robust Li-ion batteries," *J. Mater. Chem. A*, vol. 8, no. 17, pp. 8485–8495, 2020, <https://doi.org/10.1039/D0TA01901A>.
- ⁸A. C. Strikwerda, T. Sleasman, W. Anderson, and R. Awadallah, "Sub-wavelength focusing in inhomogeneous media with a metasurface near field plate," *Sensors*, vol. 19, no. 20, article 4534, 2019, <https://doi.org/10.3390/s19204534>.
- ⁹R. Srinivasan, M. E. Thomas, M. B. Airola, B. G. Carkhuff, L. J. Frizzell-Makowski, H. Alkandry, J. G. Reuster, H. N. Oguz, P. W. Green, J. La Favors, L. J. Currano, and P. A. Demirev, "Preventing cell-to-cell propagation of thermal runaway in lithium-ion batteries" *J. Electrochem. Soc.*, vol. 167, no. 2, article 020559, 2020, <https://iopscience.iop.org/article/10.1149/1945-7111/ab6ff0>.

- ¹⁰R. D. Lorenz, *Exploring Planetary Climate: A History of Scientific Discovery on Earth, Mars, Venus and Titan*, Cambridge, UK, Cambridge University Press, 2019.
- ¹¹F. Ouyang, *Digital Communications for Practicing Engineers*, Hoboken, NJ, IEEE, 2019.
- ¹²A.-H. Najmi and T. Moon, *Advanced Signal Processing: A Concise Guide*, New York, McGraw-Hill, 2020.
- ¹³R. D. Lorenz, *Saturn's Moon Titan: From 4.5 Billion Years Ago to the Present*, Somerset, UK, Haynes Publishing, 2020.
- ¹⁴S. D. Hill and J. C. Spall, "Stationarity and convergence of the metropolis-hastings algorithm: Insights into theoretical aspects," *IEEE Control Syst. Mag.*, vol. 39, no. 1, pp. 56–67, 2019, <https://doi.org/10.1109/MCS.2018.2876959>.
- ¹⁵B. W. Denevi, C. M. Ernst, L. M. Prockter, and M. S. Robinson, "The geologic history of Mercury," in *Mercury: The View after MESSENGER*, S. C. Solomon, L. R. Nittler, and B. J. Anderson, Eds., Cambridge, UK, Cambridge University Press, 2019, ch. 6, pp. 144–175.
- ¹⁶A. M. Greenberg, "Deciding machines: Moral-Scene Assessment for intelligent systems," in *Human-Machine Shared Contexts*, W. F. Lawless, R. Mittu, and D. A. Sofge, Eds., London, Elsevier, 2020, ch. 6, pp. 135–159.
- ¹⁷W. C. Walton, S.-J. Kim, S. C. Harvey, L. A. Mullen, and D. W. Porter, "Towards CNN-based registration of craniocaudal and mediolateral oblique 2-D x-ray mammographic images," in *Proc. 2019 41st Annu. Int. Conf. IEEE Eng. Med. Biol. Soc. (EMBC)*, pp. 2758–2764, <https://doi.org/10.1109/EMBC.2019.8857853>.
- ¹⁸G. Christie, R. R. Munoz Abujder, K. Foster, S. Hagstrom, G. D. Hager, and M. Z. Brown, "Learning geocentric object pose in oblique monocular images," in *Proc. IEEE/CVF Conf. Comput. Vision Pattern Recognit. (CVPR)*, 2020, pp. 14500–14508, <https://doi.org/10.1109/CVPR42600.2020.01452>.
- ¹⁹J. Rehm, "Super signs of life," Laurel, MD, APL, Dec. 8, 2020, <https://civspace.jhuapl.edu/stories/surer-signs-life>.
- ²⁰M. Basescu and J. Moore, "Direct NMPC for Post-Stall Motion Planning with Fixed-Wing UAVs," in *Proc. 2020 IEEE Int. Conf. Robot. Automat. (ICRA)*, 2020, pp. 9592–9598, <https://doi.org/10.1109/ICRA.2011.5980409>.
- ²¹J. Surowiec, "We had to get this right—How Johns Hopkins built the Coronavirus Tracking Global Dashboard: An oral history," Laurel, MD, APL, Apr. 26, 2021, <https://www.jhuapl.edu/FeatureStory/210426-JHU-COVID-dashboard-oral-history>.
- ²²"Best inventions of 2020," *Time*, Nov. 19, 2020, <https://time.com/collection/best-inventions-2020/5911434/johns-hopkins-coronavirus-resource-center/>.
- ²³Y. Zhang, J. Wang, X. Calderon-Colon, O. Tiburzi, M. Iglesias Lozano, J. Patrone, and G. Raimondi, "Lipid nanoparticle-mediated delivery of enhanced costimulation blockade to prevent type 1 diabetes," *Diabetes*, vol. 68 (Suppl. 1), article 94–OR, <https://doi.org/10.2337/db19-94-OR>.
- ²⁴P. Campbell, "Saving the planet, one drop at a time," press release, Laurel, MD, APL, Jan. 30, 2020, <https://www.jhuapl.edu/PressRelease/200130>.
- ²⁵Coronavirus resource center website, Johns Hopkins University, <https://coronavirus.jhu.edu> (accessed Oct. 5, 2022).
- ²⁶J. Surowiec, "AI bests human fighter pilot in AlphaDogfight trial at Johns Hopkins APL," press release, Laurel, MD, APL, Aug. 28, 2020, <https://www.jhuapl.edu/PressRelease/200828-AI-bests-human-fighter-pilot-in-AlphaDogfight-trial-at-APL>.
- ²⁷A. E. Kedia and J. A. Krill, "Inspiring innovation and creativity at APL," *Johns Hopkins APL Tech. Dig.*, vol. 35, no. 4, pp. 363–379, 2021, <https://www.jhuapl.edu/Content/techdigest/pdf/V35-N04/35-04-Kedia.pdf>.
- ²⁸Revolutionizing Prosthetics website, APL, <https://www.jhuapl.edu/Prosthetics/> (accessed Oct. 5, 2022).
- ²⁹CIRCUIT website, APL, <https://www.jhuapl.edu/circuit/> (accessed Oct. 5, 2022).
- ³⁰E. M. Richardson and K. K. Livieratos, "APL achievement awards and prizes," *Johns Hopkins APL Tech. Dig.*, vol. 34, no. 2, pp. 306–325, 2018, <https://www.jhuapl.edu/Content/techdigest/pdf/V34-N02/34-02-Richardson.pdf>.
- ³¹"APL achievement awards and prizes: Complete history of winners through 2017," *Johns Hopkins APL Tech. Dig.*, vol. 34, no. 2, pp. S1–S16 (online only), 2018, <https://www.jhuapl.edu/Content/techdigest/pdf/V34-N02/34-02-CompleteAwards.pdf>.
- ³²E. M. Richardson, "APL achievement awards and prizes," *Johns Hopkins APL Tech. Dig.*, vol. 34, no. 3, pp. 407–416, 2018, <https://www.jhuapl.edu/Content/techdigest/pdf/V34-N03/34-03-Awards.pdf>.
- ³³APL Staff Writers, "APL achievement awards and prizes: The Lab's top inventions, discoveries, and technical accomplishments in 2018," *Johns Hopkins APL Tech. Dig.*, vol. 35, no. 2, pp. 147–154, 2022, <https://www.jhuapl.edu/Content/techdigest/pdf/V35-N02/35-02-Awards.pdf>.