Riverside Research is a not-for-profit organization chartered to advance scientific research for the benefit of the US government and in the public interest since 1967. Our not-for-profit status enables us to be independent, unbiased, and unencumbered by short-term financial objectives. This allows us to reinvest our earnings into the continuous development of our technical workforce and an open innovation approach to research. Our open innovation R&D model encourages both internal and external collaboration to accelerate innovation, advance science, and deliver trusted solutions.
Since joining the company as President and CEO in March 2016, it has been a great honor and privilege to lead the company in its 49th year of service to the nation. Fueled by our employees’ passion, commitment, and dedication, we built on our past successes and laid a solid foundation for fruitful partnerships with the US Government and our other mission partners for years to come.

Throughout 2016, we continued to add emphasis on research as we made substantial progress on equipping the Open Innovation Center, which opened in late 2015 at our Dayton Research Center near Wright-Patterson Air Force Base, Ohio. Our multi-disciplinary laboratory environment saw the addition of a custom-built, extensible vacuum chamber, optics and photonics equipment, and advanced technology workstations. We have several collaborative projects underway, and our integrated approach to research has been bolstered by new contract wins with important customers that highlight our expanded capabilities in plasma physics, optics, machine learning, RF systems, electromagnetics, cyber, and biomedical engineering. Our open innovation R&D model encourages both internal and external collaboration to accelerate innovation, advance science, and deliver trusted solutions.

In concert with our renewed emphasis in research, we began increasing our presence in the National Capital Region. Riverside Research opened its Washington Research Office in 1970, and we have strengthened our focus in the area to better align with key customer organizations and in preparation for moving our headquarters to the region. This will help us continue providing the high-end services our customers have come to expect.

We have delivered on these customer expectations throughout the year, driving innovation for our customers and helping them embrace advancements in technology. As the DOD has accelerated the adoption of advanced technologies, Riverside Research has facilitated this process for many of our customers by migrating important services and architectures to the cloud and by developing solutions using big data analytics to extract value from cumbersome amounts of data.

Through these efforts during this last year, we have worked hard to build an organization that is well-positioned for the future. I am looking forward to a great 2017 as we celebrate our 50th anniversary as a trusted, not-for-profit mission partner.

Sincerely,

Dr. Steven R. Omick
President and CEO

Dear Colleagues and Friends of Riverside Research:

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President and CEO
The 30,000 square-foot Riverside Research Open Innovation Center (OIC), located in the Dayton Research Center in Dayton, Ohio, completed its first full operational year of research and development. The OIC continues to serve as a collaborative work environment with secure, dedicated laboratory spaces that are interconnected to our other specialized lab facilities and support research in the areas of:

- Plasma Physics
- Optics
- Machine Learning
- RF Systems
- Electromagnetics
- Cyber
- Biomedical Engineering

The mission of the OIC is to drive innovation and develop technology solutions that will ultimately benefit existing and potential customers. Our Open Innovation concept is a construct that fosters creativity, ensures mission synergy, and delivers innovative solutions through collaboration with government, industry, and academic partners. We support technical research concept maturation through sustained, multi-year strategic initiatives as well as independent research and development projects. As a not-for-profit, our financial strategy provides significant internal funding enabling us to do more R&D than companies many times our size. In short, our OIC empowers our workforce and partners to turn ideas into solutions.
An exceptionally notable piece of equipment housed within the OIC is Riverside Research’s custom-built, extensible vacuum chamber manufactured by Pfeiffer Vacuum. It was installed in January 2016 and enables advanced research and development of applications for ionospheric, space, and hypersonic plasma environments, plasma-magnetic field interactions, dusty plasmas, and in-space propulsion devices.

Upon installation of the vacuum chamber, Riverside Research experts conducted a successful performance acceptance test. The operational vacuum test was conducted over the course of eight hours, and the chamber ultimately achieved a base pressure of $3.1 \times 10^{-7}$ Torr, which is over one billion times lower than the standard atmospheric pressure at sea level. This pressure corresponds to an altitude of approximately 200 miles above sea level, which is midway between the 100–300 mile altitudes that low earth orbit satellites typically fly.

In November of 2016, Riverside Research hosted its first Plasma Science and Technology Technical Interchange Meeting at its Dayton Research Center. The goal of the meeting was to develop a better understanding of the mechanisms responsible for the effects of plasma on propagation and scattering of electromagnetic waves. Along with Riverside Research, members from the Air Force Research Laboratory, Eastern Michigan University, and Voss Scientific presented plasma-related studies significant to the defense industry in the areas of communication, navigation, and performance of sensors.

"The event provided attendees with a forum to discuss their latest research and interact with colleagues," said Open Innovation Center Executive Director, Dr. Jeffrey Pursel. "It encouraged the potential for future partnerships and collaborations in plasma research across government, industry, and academia."

Dr. Jeffrey Pursel, Executive Director of the Open Innovation Center
In 2016, the optics and photonics research program was established within the OIC. The optics lab is home to one of our significant research and development efforts—the Defense Advanced Research Projects Agency (DARPA) Leveraging the Analog Domain for Security (LADS) Program. In collaboration with the cyber lab, Riverside Research is developing a novel and innovative optical system for remote sensing of cyber threats.

DARPA LADS seeks to develop a new protection paradigm that separates security-monitoring functionality from the protected system, focusing on low-resource, embedded, and Internet of Things devices. The program will also explore technologies to associate the running state of a device with its involuntary analog emissions across physical modalities. Riverside Research aims to use multi-modal analog sensing technology to capture passive emissions from digital devices and correlate these emissions with the internal operation of the device. When fully developed, this technology could ensure executing software has not been modified and that no changes have been made to the hardware itself. Ultimately, this research will help improve the security of our nation and establish Riverside Research as a premier innovator and solution provider in cybersecurity.

In addition, the optics lab expanded its portfolio to perform cutting-edge research in terahertz (THz) sensing, adaptive optics, high-resolution spectroscopy, and 3D vibrometry. The suite of tools and equipment that were added include, but are not limited to, THz antennas, modular optics, custom-developed high-resolution microscopes, an array of lasers, and scanning stages.
Machine Learning (ML) is a subset of artificial intelligence (AI) that employs advanced algorithms to learn from data autonomously. Machine learning systems are not explicitly programmed; they are able to modify and improve their algorithmic performance without human intervention. Machine learning applications are becoming ubiquitous across the technological baseline of our society, enabling and automating many previously unrealizable technologies such as real-time language translation, voice control of phones and computers, self-driving cars, and even AI sports reporters.

AI/ML is revolutionizing modern approaches to intelligence, surveillance, and reconnaissance (ISR) data processing. By integrating AI/ML with advanced sensor technologies, Riverside Research’s machine learning lab is developing intelligent automated sensing systems that can learn and adapt to their environment, perform complex problem solving tasks, and ultimately make intellectual decisions.

The machine learning lab is the evolution of several years of internal research and development that focused on the application of advanced computing technologies to solve ISR challenges with emphasis on the analyst. By maximizing the use of ML systems to automate data processing and exploitation—allowing computers to accomplish what they are best suited to do—our techniques give the human more time to focus on important analytical tasks.
In collaboration with medical device startup, Sonify Biosciences, Riverside Research installed an ultrasound-based hyperthermia system that investigates how ultrasound-induced heating and mechanical forces can help hinder the growth of melanomas, skin cancers, and other superficial tumors. While initial experiments were performed with tissue samples, the ultimate goal is to develop a clinical device to treat skin cancer.

Along with New York University (NYU) Skirball Institute of Biomolecular Medicine and NYU Tandon School of Engineering, Riverside Research was awarded a $2 million, four-year National Institutes of Health (NIH) grant for the In-utero Mouse Embryo Phenotyping with High-frequency Ultrasound project. The goal of the project is to implement image processing and segmentation algorithms to detect genetic mutations in mouse embryos using 3D data sets acquired with high-frequency ultrasound. The project will provide in vivo information for investigating mutations that appear at embryonic or perinatal stages, including many that serve as models of human birth defects and congenital diseases.

Now in the second year of a $2 million, four-year project funded by the NIH, Riverside Research has been providing instrumentation and data-analysis support to Dr. Ronald Silverman, Columbia University Medical Center, on a project to image blood flow in the choroid at the back of the eye in order to study perfusion in glaucoma. The project uses state-of-the-art ultrasound equipment capable of transmitting plane waves at a very-high frame rate. These data can then be processed to obtain Doppler blood-flow information in a large region of interest at a temporal resolution not possible with current clinical ultrasound equipment. Human-subject experiments are underway for the project, and a peer-reviewed paper was published in the Investigative Ophthalmology and Visual Science Journal. Riverside Research has been collaborating with Dr. Silverman for over 25 years.

GE Global Research, Stony Brook Medicine, and Kuakini Medical Center

In partnership with GE Global Research, Stony Brook Medicine in New York, and Kuakini Medical Center in Hawaii, Riverside Research is now entering the second year of a $4 million, five-year academic-industrial partnership funded by a grant from the NIH. This study will develop and refine methods of using quantitative ultrasound (QUS) and 3D imaging to identify cancers in lymph nodes that would be missed using conventional methods.

Our scientists have been proving the effectiveness of QUS in detecting cancers for more than 30 years and continue to create innovative methods that reduce the cost of care and improve patient outcomes,” said Dr. Ernest Feleppa, Director of Biomedical Engineering. “We are excited about the prospect of improving current procedures for detecting cancers that have spread to lymph nodes, but our team is now focused on applying these methods to detecting cancer in nodes while they remain within the body. Evaluating lymph nodes without surgical removal would expedite staging and avoid unnecessary excisions of cancer-free lymph nodes.”
CLOUD-BASED SATELLITE COLLECTION PLANNING

As our government customers explore the implementation of the cloud, Riverside Research is also evolving from thick-client applications to new thin-client services. This evolution consists of moving our single-user desktop applications to multiple-user web-based (and cloud-based) services. Over the past year, Riverside Research migrated its legacy Automated Collection Planning Tool (ACPT) to the new Collection Planning Suite (CPS). After extensive engineering and implementation of modern software development techniques, we were able to disassemble key components of ACPT and create services that can independently support large-scale computations during off-peak hours, elastic processing for high OPS-Tempo information needs, and 4D graphics. CPS has a Technical Readiness Level of 9 (TRL-9) and is operational in the National Geospatial Intelligence Agency enterprise. Its cloud-compliant framework supports satellite collection research and analysis, feasibility studies, strategy development, and daily planning for multi-phenomenology constellation. With its optimized and interactive features, CPS allows planners and researchers to visualize collection plans complete with terrain, imagery, and other geographic information system layers.

These advancements in cloud-based, multi-thread data processing can also be adapted to support the computational mission planning demands anticipated with the emergence and imminent explosion of SMALLSAT and NANOSAT systems and constellations. CPS supports the multi-satellite, multi-mission, and multi-security variables expected in future mission planning which results in a powerful solution for the GEOINT community.

MIGRATING DOD ARCHITECTURE TO THE CLOUD

To enable advanced processing capabilities for evolving mission needs and directives for cloud integration, Riverside Research redesigned an architectural framework for a long-standing DoD customer by developing a more cost-effective cluster-computing solution. This architecture has enabled early integration of capability into the IC cloud environment.

The new framework was built using fully open source solutions, providing high availability, high performance, and scalability. The platform was built upon Apache Mesos—an open source cluster manager that enables resource sharing and framework schedules—and various scheduling frameworks, including Chronos, Scale, and Marathon. These scheduling frameworks are responsible for running jobs and algorithms requested by users or software. All of the algorithms and software that run in the platform will be integrated with Docker containers, which allows them to be spun up and down quickly upon request, increasing processing speed and availability. This framework reduces the need for a specialized development base and substantially reduces integration time and risk for software updates.

After the initial deployment, the architecture was further refined to use Mesosphere’s DCOS (data center operating system), which provides a wrapper for installation of Mesos, Docker, and the scheduling frameworks. DCOS features an interactive and user-friendly interface that allows users to easily manage and scale the infrastructure. This framework reduces the need for a specialized development base and substantially reduces integration time and risk for software updates.

OPEN ARCHITECTURE SOLUTIONS

Riverside Research was selected for an award by the Air Force Research Laboratory Sensors Directorate for its Mission Systems Open Architecture Science and Technology (MOAST) Program. The objective of the MOAST Program is to conduct applied and advanced research and development, as well as advanced component and prototype development, in order to evolve and expand emerging open architecture standards and approaches for current and next-generation Air Force weapon systems. Utilizing an open architecture environment will allow the Government to increase its efficiency by not being locked into a single vendor when making modifications to systems.

The focus of Riverside Research’s efforts will be to develop and demonstrate cybersecurity countermeasures to detect and mitigate cyberattacks against open architecture based mission systems and ensure continued mission operations.

BIG DATA ANALYTICS FOR SUSTAINMENT ENGINEERING

Weapons System Program or Portfolio Managers may experience cost overruns, schedule delays, system performance problems, and/or sustainability issues. Riverside Research developed Own the Technical Baseline™ (OTB)—a tool suite built on an open source, commodity platform with a data-processing pipeline that rapidly ingests diverse data sets, such as maintenance logs or integrated parts lists, to create a global, dynamic view of predicted sustainment costs and risks. The OTB platform allows it to be primarily vendor agnostic by allowing it to ingest data across varying standards and databases with simple interfaces to the data storage device or artifact. Once the data is ingested, the application services are easily added and configured based on user requirements. Ultimately, OTB provides system owners the ability to make confident decisions regarding their technical baseline with minimal disruption.
Community Outreach

During the summer of 2016, Riverside Research had seven community outreach interns working in research offices in Boston, Massachusetts, Centreville, Virginia, and Dayton, Ohio. The interns worked closely under the mentorship of subject matter experts on projects that provided them with real-world experience.

Through a partnership with the United States Geospatial Intelligence Foundation, Riverside Research’s first Ken Miller Scholarship for Advanced Remote Sensing was awarded to Anne Aryadne Bennett of the University of Southern California (USC) in the fall of 2016. Anne received both bachelor’s and master’s degrees in mechanical engineering from California Polytechnic State University and will use the scholarship toward her graduate studies in astronautical engineering at USC.

First Ken Miller Scholarship for Advanced Remote Sensing

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The Ken Miller Scholarship for Advanced Remote Sensing Applications, named after a founding father of measurement and signature intelligence, provides financial support to students engaged in the study of defense or intelligence-related disciplines. It is funded by proceeds from the Riverside Research-authored textbook, The Phenomenology of Intelligence-focused Remote Sensing.
Welcome New Board Members

Theodore York
Theodore York joined Riverside Research’s Board in March 2016. He was previously a member of the Board of Directors for Applied Research Solutions, Riverside Research’s small business subsidiary. Mr. York brings an extensive background in general management, board-level insight, and operations.

Angelina Rouse
Angelina Rouse joined Riverside Research’s Board in September 2016. Ms. Rouse is a senior executive with over 30 years of experience across a wide range of financial and operational functions. She currently conducts leadership training and has a consulting business focused on strategic finance transformation.

2015 Board of Trustees Award Winners

The Ralph J. Mastrandrea Memorial Award and the Lawrence H. O’Neill Award for Sustained Excellence are annual honors given to select employees who exemplify the selfless dedication, professionalism, and integrity of our founding principles.

The Riverside Research Board of Trustees congratulates the following recipients for the year 2015.

Also pictured: Dr. Steven Omick, President & CEO (far left) and Thomas Pitts, Chairman of the Board of Trustees (far right).

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Applied Research Solutions (ARS), a small business subsidiary of Riverside Research, finished 2016 in great standing, exceeding financial goals in revenue and profit. All current contracts remained fully staffed with highly rated performance by customers, and the company maintained a “superior” rating for security.

ARS and teammate Credence Management Solutions, LLC were awarded a recompete for the Project Support Services (PSS) and MASINT Advanced Engineering & Science Technical Requirements Offering (MAESTRO) contracts with the Air Force Institute of Technology. The new five-year award through the GSA OASIS EPASS Program Office will provide ARS with added stability as a continuing core contract. ARS expects to grow the contract over time in partnership with the new prime contractor Credence, who is a minority-owned, disadvantaged 8(a) small business.

ARS also expanded into a new market, which aligns with their corporate strategy for growth in the intelligence, surveillance, and reconnaissance (ISR) mission area. Alongside CACI International, ARS was selected to support the Army 51st Military Intelligence Brigade (MIB) GEOINT Enterprise TPED (GETS) Program in Augusta, Georgia. The 51st MIB is a unit of the US Army and subordinate to the US Army Intelligence and Security Command. Its mission is to provide tailored, multi-disciplined intelligence and related intelligence capabilities in support of Army CENTCOM (ARCENT) and other Commandants to defeat adversaries, promote regional stability, support partners and allies, and protect US interests.