SPRING 2024

40 YEARS OF TECHNOLOGY TODAY®

SOUTHWEST RESEARCH INSTITUTE®

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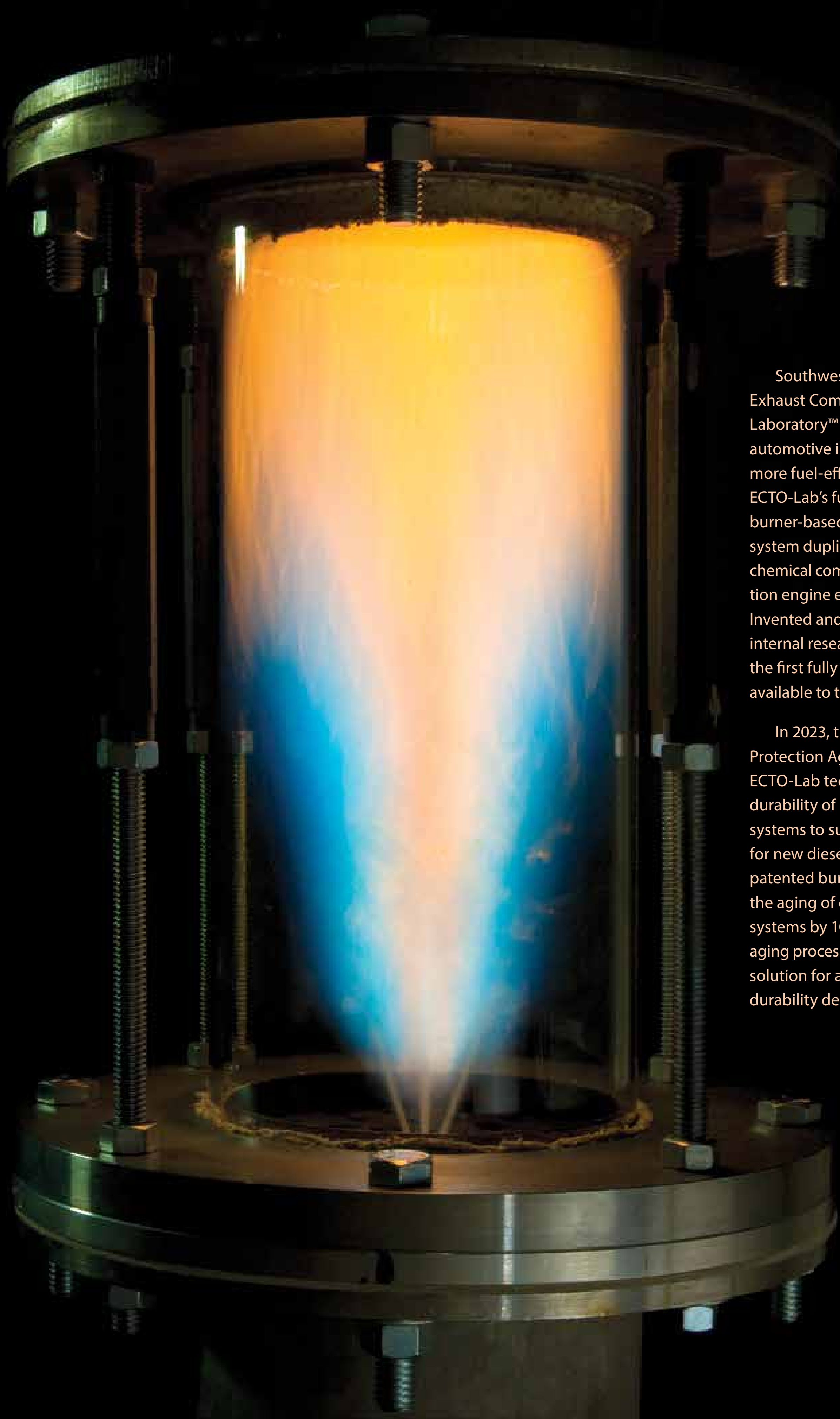

Southwest Research Institute's Exhaust Composition Transient Operation Laboratory™ (ECTO-Lab™) helps the automotive industry develop cleaner, more fuel-efficient vehicle technologies. ECTO-Lab's fully automated, multi-fueled, burner-based continuous flow reactor system duplicates the thermal energy and chemical composition of internal combustion engine exhaust gas streams. Invented and developed by SwRI with internal research funding, ECTO-Lab is the first fully transient, full-size reactor available to the global market.

In 2023, the U.S. Environmental Protection Agency approved SwRI's ECTO-Lab technology to assess the durability of engine emissions control systems to support certification processes for new diesel engine families. SwRI's patented burner technology accelerates the aging of diesel engine aftertreatment systems by 10 times that of conventional aging processes, providing a cost-effective solution for aftertreatment screening and durability demonstrations.

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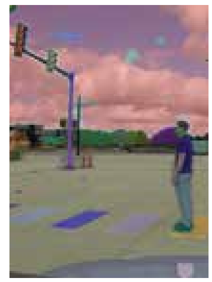

SwRI applies novel artificial intelligence/machine learning algorithms to sensor data to allow automated driving systems to detect objects and better understand their environment with the ultimate goal of making vehicles safer on our roadways. For more about SwRI's automated driving systems, see article on p. 8.

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IN THIS ISSUE

For the last 26 years, I have served as administrator of Southwest Research Institute's Internal Research and Development (IR&D) program, which is the focus of this issue of Technology Today. It's one of the things that I am most proud of in my 45 years at the Institute, because I think IR&D serves as a key driver of innovation at SwRI.

The Advisory Committee for Research, which oversees the program, is made up of the senior technical people at SwRI, those who have achieved the rank of Institute scientist or engineer. In the last 10 years, the ACR has approved more than $75 million to fund fascinating and/or functional internal research projects to explore new ideas for the mutual benefit of the Institute, our clients and especially our staff.

Within the first decade of its existence, SwRI had codified the program to expand existing expertise while developing completely new capabilities. IR&D encourages creative and innovative solutions to high-risk problems, creating novel inventions and organizational intellectual property.

SwRI internal research plants seeds to grow external support in related arenas. And IR improves the skills and professional stature of our staff, stimulating internal collaboration as well as promoting external co-investigators.

The Institute's IR&D Program represents a significant investment of time and financial resources to demonstrate the viability of innovative technologies in potential applications. IR&D has driven the development of award-winning technology, as illustrated in the infographic on p. 16–17.

I hope you enjoy reading about just a few of the programs that have grown from the Institute's investment in tomorrow's technology.

Sincerely,

Walter D. Downing

Walter D. Downing, P.E.
Executive Vice President/COO

IR&D

SwRI'S SECRET WEAPON: INTERNAL RESEARCH & DEVELOPMENT

Since its first decade of operations, Southwest Research Institute has used part of its net income to invest in tomorrow's innovations, broadening the Institute's technology base and encouraging the staff's professional growth. In the last decade, SwRI has invested more than $77 million in internal research, initiating 103 new projects for nearly $9.4 million last year alone. Internal Research & Development (IR&D) fulfills the Institute's objective of conducting innovative activities for the benefit of industry, the government and humankind. This issue of Technology Today will focus on the success of the Institute's IR&D program.

Investing in technology that our clients may need in the future through internal research expands SwRI's technical capabilities and reputation as a leader in science and technology. The program also allows engineers and scientists to grow in their technical fields by providing freedom to explore innovative and unproven concepts without contractual restrictions and expectations. IR&D is frequently cited as a key enabling factor leading to new projects and completely new research arenas within the Institute, from novel antenna arrays, clean energy technology, new pharmaceuticals and vehicle systems to addressing traffic congestion and developing alternative fuels.

MARTI is one of SwRI's IR&D success stories, initially funded in 2005 to develop vehicle automation technology. Since then, more than 20 vehicles have been automated and projects have generated around $150 million in revenue. See more about this multifaceted automated driving program today on p. 8 of this issue. Active-Vision is a more recent success story in the intelligent transportation arena, featured on p. 18.

Internal funding has played a crucial role in the Institute's ability to develop and evaluate flightworthy space science instruments, from completely new technology to expanding the capabilities of proven heritage instruments. IR&D supported some of SwRI's earliest space technology, including a line of rugged spacecraft computers as well as the Cassini Plasma Spectrometer, which flew aboard the Cassini spacecraft exploring the Saturn system.

SwRI also invested in the development of a family of ultraviolet spectrometers that have flown on ESA's Rosetta comet orbiter, NASA's New Horizons spacecraft to Pluto and the Kuiper Belt, the Lunar Reconnaissance Orbiter, the Juno spacecraft now orbiting Jupiter, and ESA's Jupiter Icy Moons Explorer (JUICE) to explore Jupiter and three of its largest moons, as well as NASA's Europa Clipper mission, which will launch in October of this year to focus on Jupiter's moon Europa.

Today, SwRI is an acknowledged leader in spaceflight instruments and has developed and flown instruments on dozens of NASA missions. Both overall instrument performance and proven technical readiness are key to the selection process for an instrument. This issue will feature three of the latest space instruments supported by internal research — CoDICE, MASPEX and CODEX.

CoDICE

With the early success of the Interstellar Boundary Explorer, which has mapped the dynamic interaction between our heliosphere and the local interstellar medium over an entire solar cycle, Southwest Research Institute used internal research funding to develop higher resolution and more sensitive technology for an expected follow-on mission. In 2018, NASA selected SwRI's Compact Dual Ion Composition Experiment (CoDICE) as one of 10 instruments for the Interstellar Mapping and Acceleration Probe (IMAP) mission scheduled to launch in 2025. SwRI is also managing the payload and payload systems engineering for the mission, while supporting other instrument technology on the spacecraft.

IMAP will help researchers better understand the boundary of the heliosphere, a sort of bubble surrounding and protecting the solar system. This region is where the constant flow of particles from the Sun, called the solar wind, collides with material from the rest of the galaxy. This bubble limits the amount of harmful cosmic radiation entering the heliosphere. IMAP instruments will collect and analyze particles that make it through.

CoDICE combines the capabilities of multiple instruments into one patented sensor about the size of a 5-gallon paint bucket and weighing about 22 pounds. The instrument measures the distribution and composition of interstellar pickup ions (PUIs), characterizes the abundances of solar wind ions, and determines the mass and composition of highly energized "suprathermal" particles from the Sun.

The novel instrument integrates an electrostatic analyzer with a time-of-flight versus energy subsystem to simultaneously measure the velocity, arrival direction and ionic charge state and mass of ions originating from the Sun as well as from the local interstellar medium that surrounds our solar system. These measurements are critical in determining the composition and flow properties in the local interstellar medium while advancing the understanding of enigmatic properties of the solar wind and the acceleration of particles within the heliosphere.

In addition, SwRI invested internal funding to develop more effective conversion surfaces that allow the IMAP-Lo instrument to collect and analyze particles. Conversion surfaces are ultra-thin, super-smooth surfaces covering a silicon wafer that convert neutral atoms into ions to better characterize particles from outer space.

Changing the charge of particles simplifies and enhances their measurement and analysis. SwRI space scientists collaborated with materials engineering specialists to develop novel conversion surfaces that remain super-smooth and ultra-hard over the course of sometimes decades-long missions.

When particles enter the instrument from outer space, they bounce off the conversion surface and either gain or lose an electron, making their electrical charge unbalanced. This makes it easier to increase the speed or the energy of particles to analyze mass and other properties.

The thickness of the conversion surface must be less than 50 nanometers, about 1,000 times thinner than a human hair. The surface must also be as smooth as possible — close to perfect. If the surface is too rough, particles will be slowed by energy scattering, making it more difficult to detect and analyze particle properties.

SwRI is uniquely capable of tackling this kind of challenge, with considerable expertise in both spacecraft instrumentation and thin films. Interdisciplinary collaboration and internal research investment allowed SwRI to make better, stronger conversion surfaces for IMAP-Lo, work that continues to support future missions.

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SwRI space scientists collaborated with materials specialists to create more effective particle detection surfaces for spacecraft instruments. Pictured is a conversion surface substrate developed specifically for the IMAP-Lo instrument.

CoDICE combines the capabilities of multiple instruments into one patented sensor about the size of a 5-gallon paint bucket and weighing about 22 pounds.

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MASPEX

The search for extraterrestrial life in the solar system, much less elsewhere throughout the galaxy, has intrigued scientists for decades. However, processes that would be recognized as indicative of life are difficult to detect. For one thing, the signs are subtle. For a spacecraft to sniff out the telltale chemicals that predict a habitable planet or moon while flying past at an altitude of hundreds or even thousands of miles, its sensors must be exceedingly sensitive.

The Cassini mission to Saturn revealed that Enceladus, the planet's sixth-largest moon, has essentially all the ingredients needed for life, and that mission energized a pivot to the exploration of "ocean worlds,"such as Europa. Lessons learned during Cassini's mission were applied to NASA's Europa Clipper mission, scheduled to launch in October 2024. Europa Clipper will make dozens of flybys of Jupiter's icy moon to determine whether the ocean below the surface could support life.

Based on what was needed for the mission to Europa, Southwest Research Institute began an internal research program to develop the MAss Spectrometer for Planetary EXploration (MASPEX) to "sniff" Europa's atmosphere, looking for chemical compounds that would indicate that the icy moon could host life. SwRI scientists and engineers developed MASPEX through a combination of internal SwRI and NASA funding to create a multi-bounce time-of-flight mass spectrometer with a resolution and sensitivity unparalleled in spacecraft-borne instruments of this type.

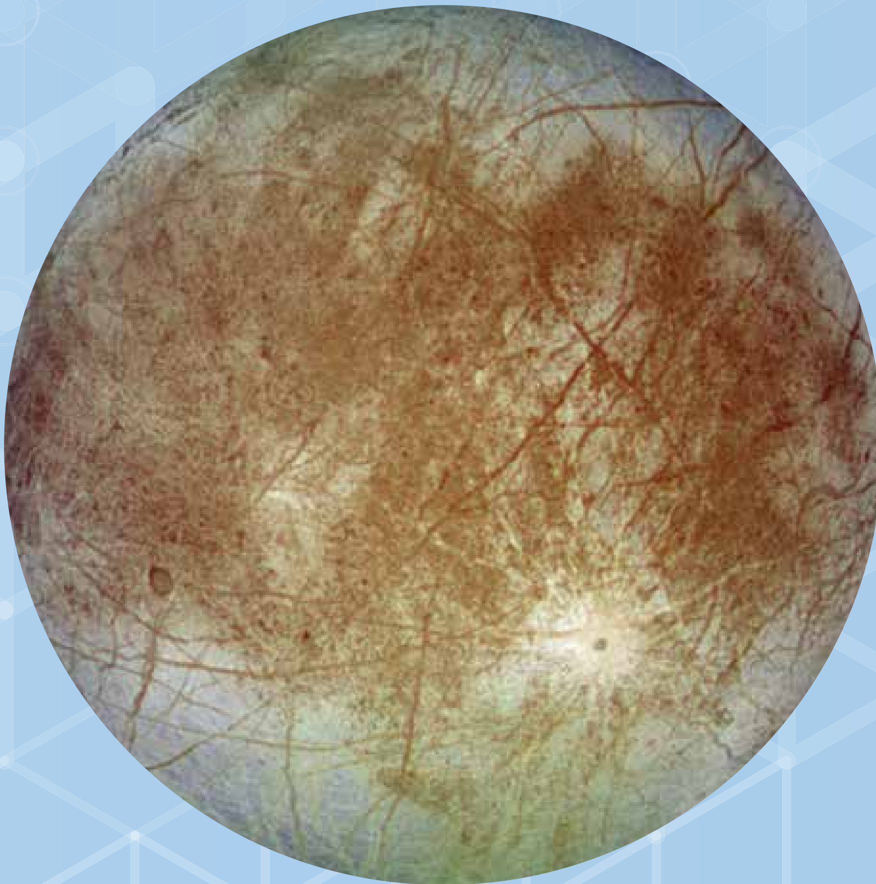

IMAGE COURTESY NASA/JPL/DLR

Europa is approximately 1,950 miles (3,160 kilometers) in diameter, or about the size of Earth's moon. This image was taken on September 7, 1996, by the solid-state imaging television camera onboard the Galileo spacecraft.

Led by Senior Vice President Dr. Jim Burch, MASPEX is one of nine instruments designed to precisely sample the ambient Europan atmosphere to understand the complex interactions between the moon's interior, surface and atmosphere. A particularly tantalizing aspect of the MASPEX experiments is the possibility of flying through and sampling material released in plumes from the subsurface. Scientists can use these measurements to infer the composition of Europa's interior, and by extension, its internal ocean.

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Engineers integrate the electronics box for SwRI's novel MASPEX instrument, which will sample gases in Europa's faint atmosphere and possible plumes of materials escaping from surface cracks to determine the chemistry of the moon's surface and internal ocean.

The concentration ratios of common volatiles such as carbon dioxide, carbon monoxide, water, nitrogen, hydrogen, methane and simple organic compounds provide hints about habitability. The abundance of these compounds creates a record of environmental conditions in the ocean such as temperature, acidity and oxidation, which also affect how habitable the ocean is. MASPEX will analyze the abundance of these compounds in any plumes and in gas produced from the surface of Europa from processes like solar irradiation, micrometeorite impacts and radiation sputtering. In this case, scientists are specifically looking for similarities in environmental conditions to deep sea vents on Earth, where life may have first formed. These hydrothermal vents in sea floors serve as hothouses for marine life that thrive in the dark, subsisting on the chemical energy the vents provide.

The novel MASPEX instrument uses a beam of electrons to bombard incoming gas molecules, converting them to positively charged particles or ions, which are then extracted into the instrument's "drift tube" that gives MASPEX its unique baguette shape. Samples will consist of a mixture of different chemical compounds, many with similar molecular masses. A time-of-flight mass spectrometer separates these molecules by speed to determine their mass, which is determined by their composition. Because lighter ions travel faster than others, the longer the flight path the ions must cover, the more their different velocities will separate them and the greater the instrument's resolution.

MASPEX uses novel "folded-ion optics" that provide a variable-length flight path for the ions within a compact instrument. To do this, SwRI scientists installed paired electronic devices called reflectrons that create an electrostatic field in the drift tube. The lighter the ion, the faster it moves through the field. MASPEX bounces the ions back and forth up to 800 times in the drift tube before the instrument detects them. The total distance they travel increases their difference in arrival time, magnifying their mass difference. An analogy is two siblings in a footrace. Racing across their backyard, they might finish at almost the same time. But if they run around the block, the difference in speed is easier to observe.

Flight paths of more than 500 meters are readily achievable, even though MASPEX is less than a meter long. The spectrometer also has excellent sensitivity due to an ion source that can store 200,000 ions every half-millisecond before releasing the ions into the ion optical path. Even with its great sensitivity, MASPEX has difficulty collecting enough gas to see the rarest molecules during the rapid measurements that are necessary when the spacecraft is traveling above Europa's surface at more than four miles a second. For that, SwRI engineers incorporated a cryotrap into the instrument. This device freezes and concentrates gas samples, then uses long, slow measurements to boost the instrument's sensitivity by a factor of 10,000. On every flyby, MASPEX will both directly sample the atmosphere and concentrate a sample of the atmosphere, using a frigid surface to trap the gas. After the flyby, this cryotrap releases the sample into MASPEX's detectors, providing a concentrated sample of Europa's atmosphere and effectively increasing the instrument's sensitivity.

The groundbreaking MASPEX instrument has been integrated into the Europa Clipper spacecraft, preparing for a scheduled October 2024 launch.

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Space scientists used IR&D and NASA funding to develop MASPEX, a groundbreaking new mass spectrometer for the Europa Clipper mission to study the potential habitability of Jupiter's moon Europa.

CODEX

Nearly two decades ago, NASA funded the development of a laser-based, time-of-flight mass spectrometer to detect elements and isotopes that could determine the age of rocks and inform the search for life in our solar system. Since then, a team of Southwest Research Institute-led scientists has leveraged IR&D funds to win multiple additional NASA grants to increase the speed and accuracy of a laboratory-scale instrument designed to determine the age of planetary samples. At the same time, the team has progressively miniaturized the instrument, called the Chemistry, Organics and Dating Experiment (CODEX), to reach a size suitable for spaceflight and lander missions.

Last year that research paid off when NASA selected SwRI to lead a $50 million lunar lander/rover instrument suite. The suite, called “Dating an Irregular Mare Patch with a Lunar Explorer,” or DIMPLE, is designed to understand if the Moon has been volcanically active in the geologically recent past. The CODEX instrument is a critical component of DIMPLE, which will exploit its novel radioisotope dating technology to determine the age and composition of an anomalously young-looking patch of lunar basalt named Ina. Institute Scientist Dr. Scott Anderson leads DIMPLE as well as the CODEX instrument.

The CODEX instrument is the first-ever, purpose-built radioisotope-rock-dating instrument for use in space. Dating is a challenging process. Traditional techniques are not easily adapted to spaceflight, requiring a sizable laboratory and several months to determine age. By contrast, the entire DIMPLE payload will weigh around 110 pounds (50 kg) and run autonomously on the Moon.

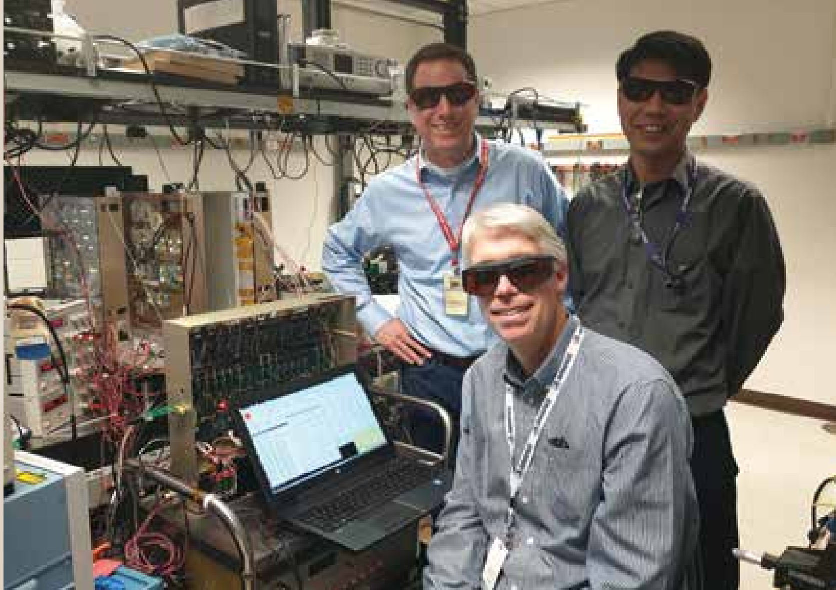
CODEX uses an ablation laser to vaporize a series of tiny bits of rock samples, detecting elements directly from the vapor plume to identify its composition. Other CODEX lasers selectively pick out and quantify the abundance of trace amounts of radioactive rubidium (Rb) and strontium (Sr). Radioactive decay is a clock that ticks at an established rate. An isotope of Rb decays into Sr over known amounts of time, so measuring both Rb and Sr can determine how much time has passed since the rock formed.

While radioactivity is a standard technique for dating samples on Earth, few other places in the solar system have been dated this way. Instead, scientists have partially constrained the chronology of the inner solar system by counting impact craters on planetary surfaces — concluding the more craters, the older the surface. The new technology accurately determines the ages of rocks and minerals, allowing scientists to date events such as crystallization, metamorphism and impacts.

SwRI lab studies demonstrated that CODEX can accurately date rock samples like those expected at Ina with a precision of better

D019149

Institute Scientist Dr. Scott Anderson stands behind the SwRI-developed laboratory prototype mass spectrometer for the CODEX instrument, which allowed the team, with IR&D support, to determine the optimal operational parameters for the instrument. The instrument has since been demonstrated with an even smaller miniature mass spectrometer from the University of Bern.



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From left, Dr. Scott Anderson collaborated with William Crain and Xiaodong Mu at Aerospace Corporation to build the miniature lasers and electronics (far left and rear) that CODEX required to enable an instrument capable of landing on the Moon.

than ±375 million years, which is more than sufficient to situate the origin of Ina in the billions-of-years-long history of the Moon.

Ina is an enigmatic formation of unusually smooth mounds surrounded by rough troughs, all inside the central crater of a large volcano. The lack of impact craters suggests Ina is younger than other places on the Moon.

A geologically recent eruption requires unexpectedly long-lived heat sources in the lunar interior. If Ina really is as young as it appears, that means that the Moon has been volcanically active much more recently than scientists have thought. Or perhaps Ina is as old as typical lunar rocks, which indicates that the material properties of certain rocks could deceive scientists using cratering to understand the ages of planetary surfaces throughout the solar system.

If rock formations like Ina do not give rise to impact craters, or do not preserve them over the eons, then some current ideas about solar system history could be wrong.

A camera, sample collection arm and the CODEX instrument will remain on the lander, while a rover equipped with a camera and rake will scoop and transport samples back to the lander instruments for detailed study. The DIMPLE team includes The Aerospace Corporation, the University of Bern in Switzerland, Colgate University and Lockheed Martin.

DIMPLE is part of NASA's Payloads and Research Investigations on the Surface of the Moon (PRISM) program, which will deliver multiple science payloads to the Moon through the Commercial Lunar Payload Services (CLPS) initiative. CLPS is a key part of NASA's Artemis lunar exploration plans. The science and technology payloads sent to the Moon's surface will help lay the foundation for human missions on and around the Moon. In addition to a series of SwRI IR&D projects, the CODEX instrument has been supported by NASA's Planetary Instrument Concepts for the Advancement of Solar System Observations (PICASSO), the Maturation of Instruments for Solar System Exploration (MatISSE), the Development and Advancement of Lunar Instrumentation (DALI), the Planetary Instrument Definition and Development programs, and the Defense Intelligence Agency Measurement and Signature Intelligence program (DIA MASINT).

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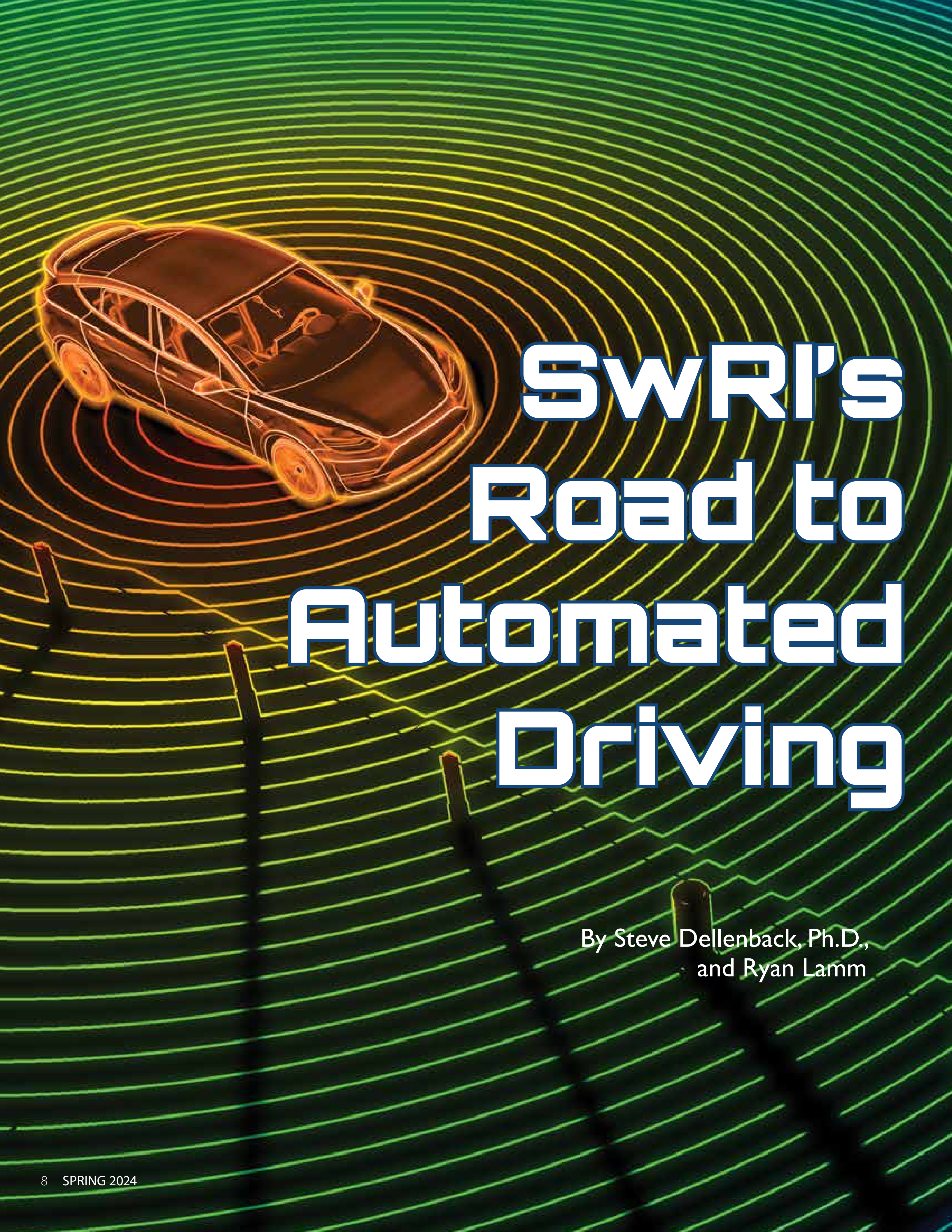

SwRI's Road to Automated Driving

By Steve Dellenback, Ph.D., and Ryan Lamm

The first driverless motor vehicle was probably a 1926 Chandler automobile retrofitted for radio control and operated by a trailing chase car — a journey that ended in a crash. The United States automotive industry's next foray into self-driving cars — or automated driving systems (ADS) — was in the 1950s and 1960s and largely visionary. Forward-thinking original equipment manufacturers (OEMs) and research labs created imagery suggesting that, someday, people would sit in vehicles and be transported with no human control. While the visions and dreams were thought-provoking, no tangible products were offered for purchase.

IMAGE BY ARTHUR RADEBAUGH, CIRCA 1939 D026597

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SwRI's IR&D program invested around $400,000 in hardware loaded in the back of an SUV to create its first automated driving platform, MARTI 1.

THE EARLY YEARS OF AUTOMATED DRIVING

Fast forward a few decades and Congress passed a 1991 transportation bill that included a requirement for the Federal Highway Administration (FHWA) to create and fund an "Automated Highway System" program aimed at developing vehicle prototypes and highway technology that could support self-driving vehicles. In 1997, the program culminated with the demonstration of self-driving passenger vehicles, buses and trucks on an isolated corridor of a San Diego interstate — these vehicles did not interact with traditional human-driven vehicles. Once the funding was exhausted, FHWA interest in the program stopped.

Around the turn of the 21st century, Congress again took interest and issued an unfunded mandate that the U.S. Army should have 25% of its fleet automated within 15 years. Despite the lack of direct funding, more companies and universities began exploring how to meet this ambitious goal. The Defense Advanced Research Projects Agency (DARPA) initiated the Grand Challenge to demonstrate self-driving vehicles in off-road environments. Teams formed between companies and universities, but no one completed the course in the first challenge held in 2004. However, several teams completed the subsequent course in 2005. Realizing that off-road autonomy would not support most of the vehicle miles traveled in the United States, DARPA initiated the Urban Challenge, which was held on an abandoned military base in 2007. Results varied, but at the end of the challenge, DARPA declared their work "done." It was up to industry to commercialize.

While DARPA held the challenges, several engineers at Southwest Research Institute — some who had participated in the DARPA challenges as students — began to talk about how SwRI could become involved. After some discussion, the consensus was that getting in the automated driving game made sense. SwRI had most of the necessary skills across the Institute as well as growing staff excitement. Technical leads organized to develop an automated driving initiative from five of SwRI's technical divisions. The capabilities they brought to the table included program leadership, perception, safety, testing, intelligence, and command and control.

SwRI had a working automated driving system ready to deploy on New York City streets during a technology demonstration at the 2008 ITS World Congress.

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Mobile Autonomous Robotics Technology Initiative
MARTI
SwRI
®

The MARTI acronym is also a nod to SwRI's visionary second president, Martin Goland, who led the Institute from 1959–97.

DETAIL

ADS LAUNCH

In 2005, the team launched SwRI's ADS program with $4 million in internal research (IR) funding along with a $500,000 capital work order to create a working prototype. SwRI provided an additional $500,000 in IR funding to get the project across the finish line for a total of $5 million in IR investment. The project was initially called the Southwest Safe Transport Initiative, or SSTI. However, the acronym did not roll off the tongue, so the project was rebranded as MARTI, which stands for Mobile Autonomous Robotic Technology Initiative. Five divisions formed the project's steering committee to track work orders and monitor technology under development.

The highly multidisciplinary team began technical development, installing about $400,000 in hardware into a stock 2006 Ford Explorer to make this original platform. The hardware filled the back of the SUV and included external sensors attached to its exterior. The team developed and tuned algorithms using a variety of test environments to duplicate DARPA test protocols. The testing team also evaluated vehicles participating in the DARPA Urban Challenge to gain insights into other approaches. The SwRI team focused on having a vehicle ready to publicly display and demonstrate at the Intelligent Transport Systems (ITS) World Congress in New York City in November 2008.

V2V NICHE

MARTI's journey to New York was not a simple one. The team pushed the state of the art in sensor technology and computer power up against the maximum capacity for data collection and processing. The team developed and patented a range of new technologies to develop a viable product. SwRI's solution was unique to the industry because it included vehicle-to-vehicle, or V2V, communications technology that allows vehicles to share sensor information, effectively expanding what a single vehicle can see by augmenting it with data from other vehicles. SwRI was an early pioneer of the U.S. Department of Transportation's V2V program and is still considered an expert in the area. In contrast to today's commercial offerings, SwRI remains the only organization to include V2V technology on every automated driving platform it has developed, which now number in the twenties.

In 2008, the half-million-dollar-plus vehicle was loaded into a trailer to transport it to New York City, where the team demonstrated automated driving and connected vehicle capabilities on the streets of Manhattan to approximately 10,000 participants at the ITS World Congress. While access to the streets was restricted during the demonstration, no special infrastructure modifications were needed to showcase the technology.

Unfortunately, the Great Recession hit in the same timeframe so the opportunity to deploy the technology in commercial vehicles evaporated as auto companies fought for their very existence.

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The economic environment required SwRI to pivot to military applications, demonstrating MARTI at "robotics rodeos" and operating on unpaved roads and grassy fields to simulate potential military theaters.

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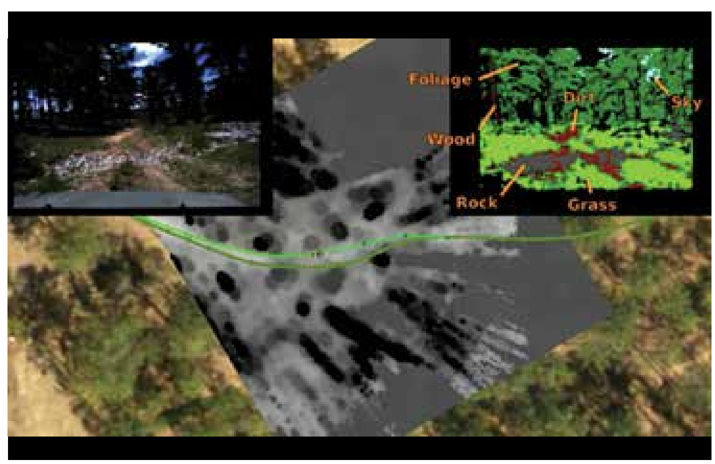
SwRI developed gesture recognition capabilities for automated driving systems used in military, highway work convoy and other applications. Image-processing algorithms identify and distinguish different arm gestures from a designated pedestrian that allow more natural, efficient interaction with an automated system.



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SwRI engineers successfully demonstrated automated driving in military applications during 2012. These images illustrate the SUMET system's real-time visualization applications.

MILITARY MOMENTUM

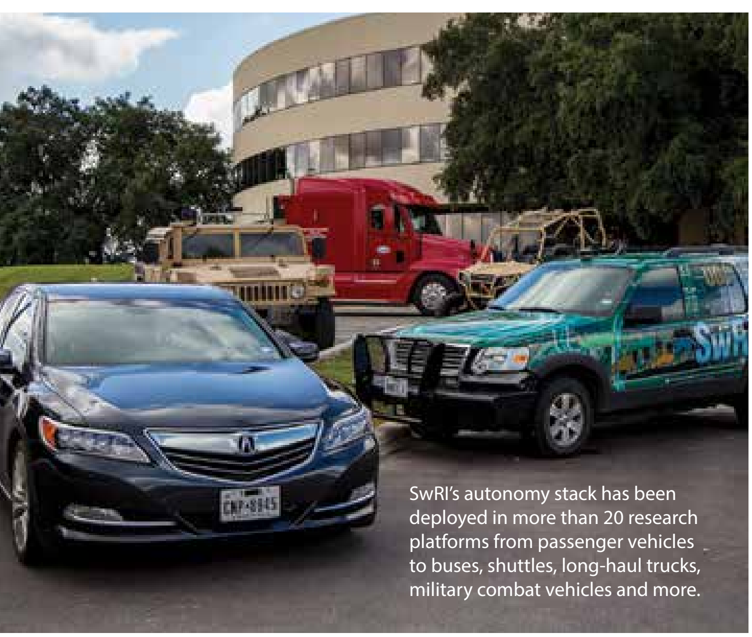
In 2009, the U.S. Army announced a "robotics rodeo," asking companies to demonstrate their automated driving technology at a military base, particularly under conditions found in military theatres. Operating on unpaved roads or across grassy fields is markedly different from driving on paved roads. SwRI engineers converting the on-road systems for "off-roading" was, in hindsight, one of the best decisions made. This effort kicked off 15 years of projects that catapulted SwRI to the forefront of off-road autonomy. The robotics rodeo required convoys of vehicles to follow the automated vehicle, closely observing its performance. SwRI was given limited time — or no time — to test on the base. Often, our initial test was an actual live demonstration.

From the first days of the program, the team invested tremendous effort in business development. As our capabilities and technology offerings grew, we began visiting clients, including commercial and government organizations in both domestic and foreign markets. The team talked to over 125 companies and agencies to identify potential projects.

After the 2009 Robotics Rodeo at Fort Hood in Killeen, Texas, the Office of Naval Research (ONR) contracted SwRI to start an automated ground vehicle program called the Small Unit Mobility Enhancement Tools (SUMET) project, with the goal of having a vehicle operate in an austere, off-road environment with only passive sensors, such as cameras. Lidar methods, considered standard in many automated driving systems, use a pulsed laser light to measure objects and locations. Combatants can detect the light, so lidar was deemed unacceptable. SwRI developed the entire SUMET code and gave ONR government-purpose rights to both kickstart the program and apply to other autonomy programs. Given the camera-only constraint of the system, SwRI also provided code for another IR&D project using visible-spectrum cameras under the same open license.

While the SUMET program continued to grow, it brought additional collaborators to work with SwRI to develop the same code base. In 2012, the U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC) began working with SwRI to leverage the SUMET code base to rapidly deploy a robotic system to Afghanistan by 2014. Building on such a base was the best strategy to meet the aggressive deployment timeline. This effort developed into the Dismounted Soldier Autonomy Tools (DSAT) program. SwRI worked with TARDEC and DCS Corporation to create six automated vehicles for this program: one high-mobility multipurpose wheeled vehicle, or HMMWV; three ultra-light tactical vehicles known as MRZRs, and two Jeep Commandos as the base platform for the concurrent Small Unit Support IED-defeat robotics program scheduled to deploy simultaneously. The TARDEC/SwRI team successfully demonstrated a vehicle at the Army Test and Evaluation Center and, in 2014, SwRI deployed two automated MRZRs to Afghanistan with the U.S. Army Special Forces. This project demonstrated the rapid development possibilities unlocked by starting with an existing government-owned code base, setting the stage for future collaborations.

After the vehicles were deployed to Afghanistan, SwRI began working with TARDEC to leverage the expanded DSAT capabilities to improve and integrate capabilities to other robotic ground vehicle programs. Renamed the Robotics Technology Kernel (RTK) in 2014, it has been expanded and exported to over 15 different Army programs. The SwRI team has been a major player throughout this program, working with Ground Vehicle Systems Center (GVSC) engineers and helping new users learn how to use and contribute to



SwRI's autonomy stack has been deployed in more than 20 research platforms from passenger vehicles to buses, shuttles, long-haul trucks, military combat vehicles and more.

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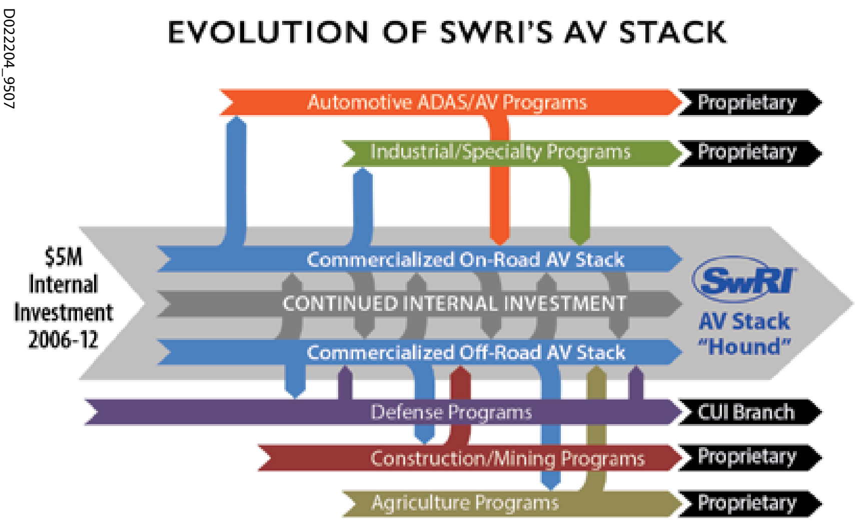


This graphic illustrates how the initial investment in MARTI has created a multipronged software stack that has DOD branches, commercial extensions, and agriculture and construction applications.

D026645

the RTK. Since the 2019 RTK core release, this base has grown to over 1.7 million lines of code. SwRI has been the primary contributor, but over 20% of the code has come from other organizations like GVSC, DCS and newer contributors like Carnegie Mellon University's National Robotics Engineering Center (NREC).

BACK ON COMMERCIAL TRACK

In addition to its federally funded autonomy work, SwRI is managing the Shell Eco-marathon Autonomous Programming Competition. Through this program, SwRI has developed an integrated platform that uses continuous integration, a robotic simulator, the Robot Operating System and a game engine to automatically build, test and analyze the performance of the simulated vehicles and contestants' algorithms. This simulation models the performance, behavior and sensors of the real-world vehicle platform used in other competition components. SwRI constructed a virtual representation of one of its automated driving test facilities for testing software performance and behavior in a simulated environment.

Once SwRI established its credibility in the ADS arena, teams performed a number of projects for Japanese OEM and Tier-1 suppliers. These projects ranged from staff training to developing black box functionality to deploying and testing technology. SwRI's stack is used in a variety of self-driving platforms from passenger vehicles to buses, shuttles, long-haul trucks, military combat vehicles and more. The staff continually upgrades and tests the technology and uses it to help clients in the commercial and military sectors to test and validate the safety and security of automated driving systems.

On the DOD front, the large defense contractors who initially flooded the space realized that production of automated driving fleets would be limited because the technology simply was not progressing fast enough. This situation enabled SwRI to become a major player in military autonomy because its role is in specific solutions, not in product sales, and it has been developing automated systems for the Army for the last 10 years. In fact, the Army's vehicle autonomy stack for all their ground vehicles is maintained by SwRI and includes part of the original MARTI code.

Over nearly two decades, SwRI has developed a range of autonomy solutions, including a stack known as Hound that features several layers of technology enabling advanced levels of automated driving. This groundbreaking progress in autonomy started with SwRI's $5 million internal research investment and has evolved into a diverse automated driving program with a multipronged software stack.

While the automated driving sector has advanced rapidly, it took years to get to this point, and SwRI continues to address many safety and security challenges. Looking back at SwRI's foray into automated driving, the team can see how much it has contributed to the sector. As autonomous robotic systems become increasingly complex, SwRI recognizes the opportunities to help industry and the public pave a way for safe, secure and reliable autonomy.

Questions about this story? Contact Dellenback at steve.dellenback@swri.org or 210-522-3914 or Lamm at ryan.lamm@swri.org or 210-522-5350.

D0253541_6961

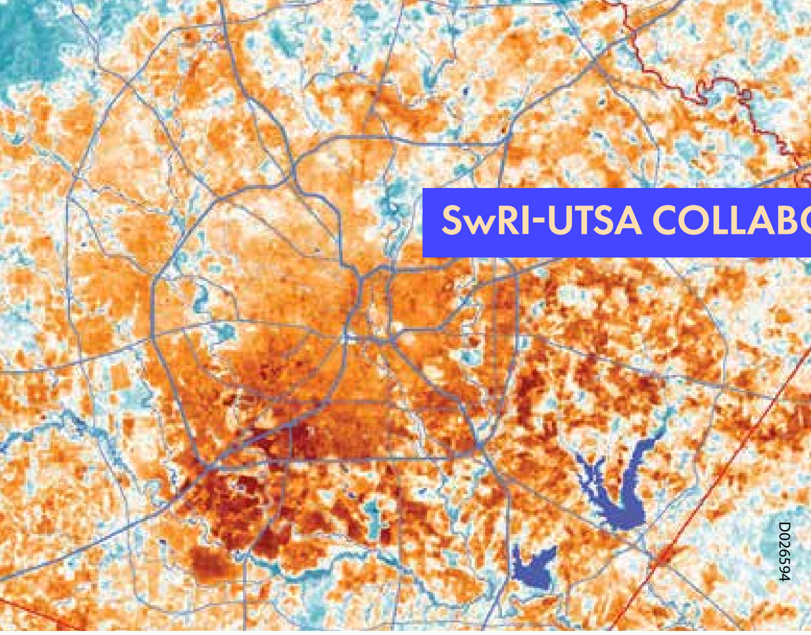
D025636

A key component of an ADS is the visualization technology that allows a vehicle to navigate while recognizing objects, traffic signs, pedestrians and other vehicles. The team continues to enhance and improve the capabilities of these systems using platforms such as an automated driving shuttle that runs regular routes around SwRI's 1,500-acre San Antonio campus.

ABOUT THE AUTHORS: **Dr. Steve Dellenback** is vice president of the Intelligent Systems Division, directing approximately 270 R&D staff. He served as a member of the ITS America Board for seven years and recently joined the U.S. Department of Transportation's Transforming Transportation Advisory Committee (TTAC). Executive Director **Ryan Lamm** has more than 25 years of experience in automated driving systems and enabling technologies. He is appointed to and leads the sensor team of a NATO research task group assessing mobility methods and tools for autonomous mobility ground systems. The authors are pictured next to SwRI's first automated driving platform, MARTI 1, on display at the San Antonio Museum of Science and Technology's Area 21™, which exhibits 21st century inventions.


D026549_0130

SwRI-UTSA COLLABORATIVE RESEARCH



Southwest Research Institute and The University of Texas at San Antonio (UTSA) are collaborating on two projects dealing with "felt heat" and traumatic brain injury (TBI) detection through the Connecting through Research Partnerships (Connect) Program. SwRI's Executive Office and UTSA's Office of the Vice President for Research, Economic Development, and Knowledge Enterprise sponsor the Connect program, which offers grant opportunities to enhance greater scientific collaboration between the two institutions.

Principal Scientist Dr. Stuart Stothoff of SwRI's Chemistry and Chemical Engineering Division is collaborating with Dr. Esteban Lopez Ochoa of the Margie and Bill Klesse College of Engineering and Integrated Design at UTSA to study the "felt heat" of San Antonio's historic West Side. The prevalence of paved surfaces creates an environment that feels considerably hotter than the rest of the city. Recent measurements by Lopez Ochoa showed temperatures as high as 154 F just above the pavement.

"We're working to precisely characterize what's going on in this unusually hot area of the city, so that eventually a solution can be found to alleviate it," Stothoff said.

SwRI and UTSA are installing sensors in representative locations around the West Side to measure air flow, wind speeds, relative humidity, air temperatures and dew points.

"The publicly available information about the heat measured on the West Side is satellite data, derived from visible or infrared wavelengths. While useful, it doesn't characterize the actual felt heat," Stothoff said. "Satellite data also doesn't allow you to see underneath the trees, in the shade. By placing our sensors in various key locations, we can measure the temperatures people actually feel."

Stothoff and Lopez are also considering putting sensors inside homes on the West Side and are working with the Historic Westside Neighborhood Association and the Esperanza Peace and Justice Center to connect with residents who might be willing to participate.

With the data in hand, SwRI will create an energy balance model to comprehensively evaluate the felt environment and adapt publicly available weather data to better represent ambient temperatures and overall thermal comfort on the West Side.

SwRI's Dr. Mark Libardoni is collaborating with UTSA's Dr. Marzieh Memar and Dr. Morteza Seidi to investigate using breath analysis to detect TBIs.

They are analyzing exhaled breath for specific biomarkers, such as metabolites, proteins and cytokines, which can be associated with diseases and human performance.

"Using breath analysis as a diagnostic tool is still fairly new," Libardoni said. "Recent advances in sampling methodologies, analytical hardware and advanced data processing programs have allowed breath analysis to become a more routine analytical tool for researchers."

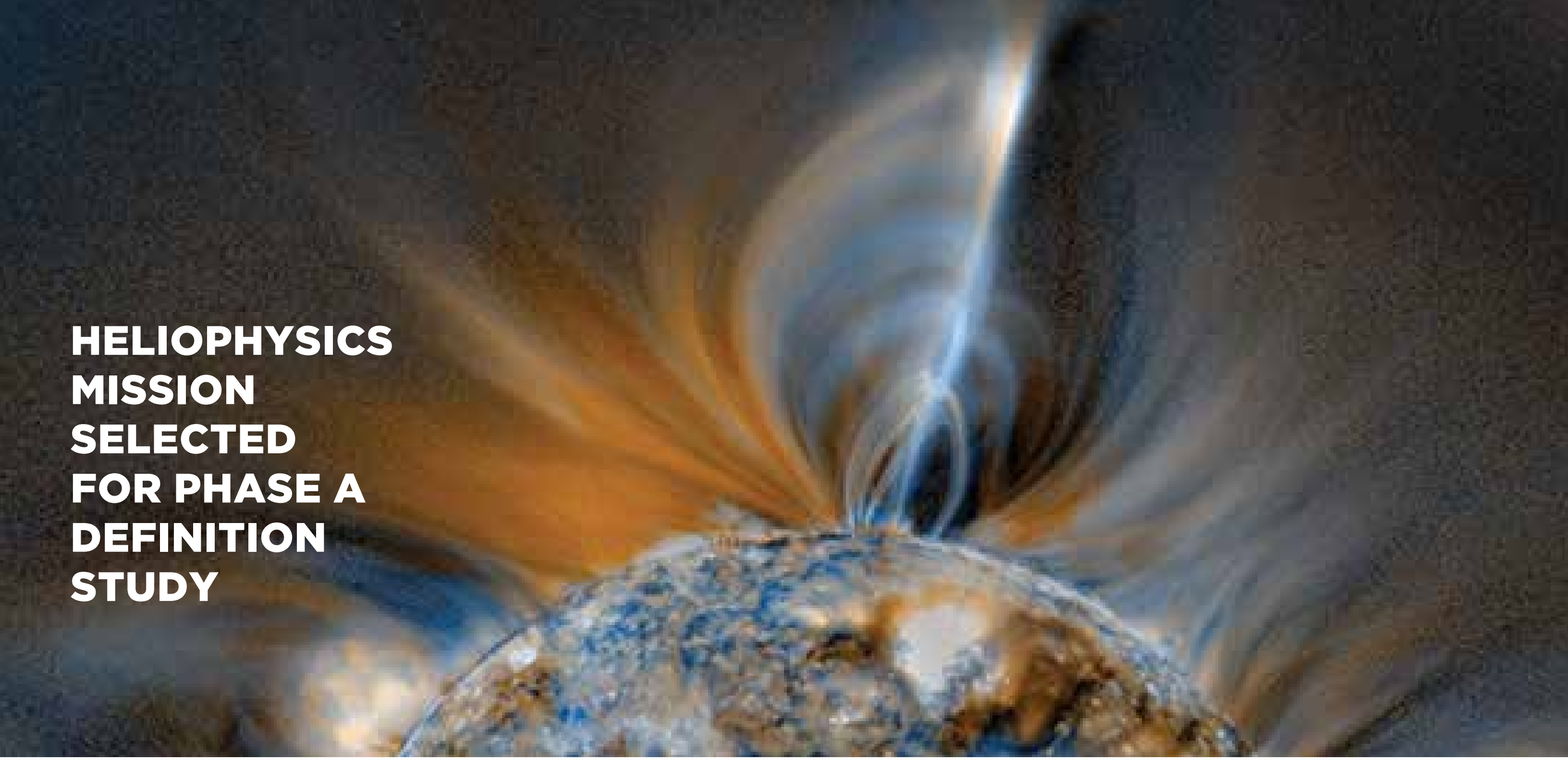
While breath analysis has been used to diagnose cancer, Alzheimer's disease and Parkinson's disease, it has not yet been explored as a noninvasive method of diagnosing TBI. Roughly 50 million cases of traumatic brain injury occur each year, which can affect human performance and quality of life, especially if left undiagnosed and untreated. Repeated subconcussive exposures, which are impacts that don't meet the threshold for a concussive impact, can be dangerous as well, leading to a higher risk of cognitive decline and neurogenerative diseases.

The project will use a gas sampling system that Libardoni developed for space research applications to collect and process the exhaled breath samples, isolating chemical metabolites for identification by a gas chromatograph coupled to a mass spectrometer.

Libardoni, Memar and Seidi believe their findings could ultimately be used in sports and military settings to immediately identify TBIs while reducing the growing burden of TBI diagnosis and management on the healthcare system.

IMAGE COURTESY SwRI/UTSA

SwRI and UTSA are exploring using breath analysis to detect traumatic brain injury. The noninvasive technique could potentially be deployed in sports and military settings.



HELIOPHYSICS MISSION SELECTED FOR PHASE A DEFINITION STUDY

IMAGE COURTESY DAN SEATON/SwRI/NOAA D026588_2

NASA has selected a new Southwest Research Institute-managed heliophysics mission focused on investigating the Sun's middle corona — an enigmatic region of the Sun's atmosphere driving solar activity — for a Phase A, mission definition study. SwRI's Dr. Dan Seaton is deputy principal investigator of the proposed small explorer mission, EUV CME and Coronal Connectivity Observatory (ECCCO), led by Dr. Kathy Reeves of the Center for Astrophysics | Harvard & Smithsonian (CfA).

The mission focuses on imaging and spectroscopy of the middle corona in extreme ultraviolet (EUV) wavelengths, tracking events like coronal mass ejections (CMEs) from their origins until they leave the Sun. CMEs are huge bursts of coronal plasma threaded with intense magnetic fields ejected from the Sun over the course of several hours. CMEs reaching Earth can generate geomagnetic storms and cause anomalies in and disruptions to modern conveniences such as electrical grids and GPS systems.

"We've explored the Sun itself extensively over the last few decades," said Seaton, a heliophysicist who specializes in imaging the Sun. "With SwRI's upcoming PUNCH mission, we'll explore the outer corona and heliosphere, but the middle corona remains a great mystery. ECCCO will finally reveal its secrets."

NASA's Polarimeter to Unify the Corona and Heliosphere (PUNCH) mission, scheduled to launch in 2025, is designed to better understand how the mass and energy of the Sun's corona become the solar wind that fills the solar system. The complementary ECCCO mission would detect, track and measure CME and solar wind outflows from, and study changes in the large-scale structure of, the corona on timescales ranging from minutes to months and years.

"ECCCO is a fascinating mission. The science is right at the center of solar physics right now, going after the 'middle corona' that regulates the structure of the corona and the solar wind. Its instruments and analysis build on decades of advances in data processing," said SwRI's Dr. Craig DeForest, principal investigator of the PUNCH mission and an ECCCO co-investigator. "We've had prototypes of this kind of spectral imaging data — 'overlappograms' — since Skylab in the 1970s. Only now do we have the technology to sort out all the information in them."

ECCCO's innovative high-sensitivity instruments, when trained on the middle corona, will return wide-field data that are critical to understanding eruptive events and solar wind streams. The ECCCO-I imager sees the full multi-thermal corona from the surface of the Sun out to three solar radii away from the star. The twin ECCCO-S spectrographs are designed to provide unprecedented temperature and density diagnostics from the solar disk to the middle corona.

CfA will lead the ECCCO science mission, SwRI will manage the project and its science and mission operations centers, and Ball Aerospace will build the spacecraft.

ECCCO

EUV CME and Coronal Connectivity Observatory

NASA recently selected ECCCO, a CFA-SwRI collaboration, for Phase A mission development. The image above shows a coronal mass ejection (CME) forming in the corona, highlighting how ECCCO's new, wide-field extreme-ultraviolet view of the corona will help better connect the sources of outflows from the solar corona, such as CMEs and the solar wind, to their origins near the Sun.

D026616_WHT

2014


D019366_8285

Dedicated EGR

Dedicated EGR is a novel engine architecture up to 15% more efficient than mainstream engines while simultaneously improving performance. It could allow manufacturers to cost-effectively address future, more aggressive fuel economy and exhaust emissions standards.

- 20 IRs from 2001–21
- 3 patents

2015

Cased Pipeline Corrosion Model (CAPCOM)

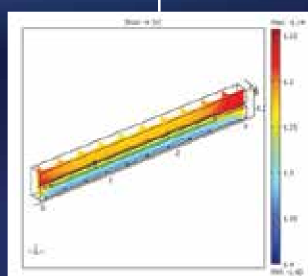
CAPCOM allows engineers to evaluate corrosion conditions of cased pipeline sections, where product-carrying pipes are encased within an outer shell of protective piping. The software also allows engineers to evaluate the effectiveness of cathodic protection systems in complex, sensitive environments.

- Q-LIR in 2014 contributed

Ranger

Ranger produces precise position and orientation measurements using a down-facing camera and novel localization algorithms. Ranger images the unique "fingerprint" of on/off road and off-planet surfaces, allowing precise automated driving, , precision rail and logistics applications within 1-2 centimeters, even where GPS has poor performance or fails.

- 6 IRs from 2011–19
- 1 patent
- SwRI Investment: $1.25M
- ROI: $6.8M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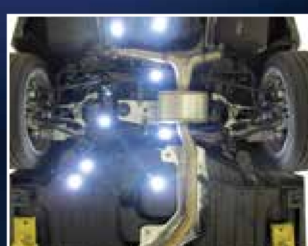
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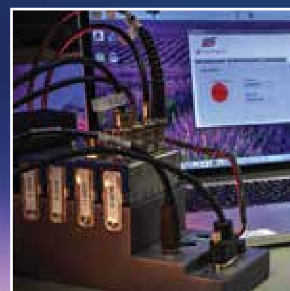
2016


D026638

Time REsilient System (TRES)

Using inexpensive hardware and sophisticated software, TRES was designed to safeguard critical infrastructure against GPS jamming and spoofing to maintain the precise time synchronization needed for energy infrastructure, financial and transportation applications.

- IR in 2013
- Patent # 10,310,091

2017

High Power Impulse Plasma Source (HiPIPS)

HiPIPS technology efficiently generates high-density, high-flux plasmas at low temperatures and atmospheric pressures. These plasmas are used to generate coatings and advanced materials as well as to augment processes for decarbonization, algae remediation and critical element recovery, among others.

- 2 IRs from 2012–2013
- 2013–2016 DARPA
- 7 follow-on contracts
- Patent # 10,440,808
- ROI: $6.8M

Smart LEak Detection (SLED)

The SLED system autonomously monitors pipelines and other facilities for methane and liquid hydrocarbon spills. Using algorithms to process sensor images, SLED can autonomously pinpoint small leaks before they become major problems, with minimal false alarms.

- IR in 2015
- Q-LIR 2018 SLED-Methane
- IR 2018 SLED-Methane
- Patent # 10,657,443


D022686_7671


D022179_8774

IR&D TO R&D 100 WINNER

Since 1971, Southwest Research Institute has earned 52 R&D 100 Awards. These SwRI developments were recognized by R&D World magazine as among the 100 most significant technical accomplishments in a year. Considering the last decade of awards, SwRI's Internal Research & Development program played a role in 14 of the 15 awards received in that period, illustrating the value of IR&D. These included special categories such as presidential discretionary internal research (PDIR), targeted (TIR), disruptive (DIR) and quick-look (Q-L) projects. Many of these programs resulted in follow-on contracts.

DM023699_1390

D024251

2019

AF-369 VHF/UHF Terrestrial Direction-Finding Antenna

The AF-369's sleeved electric dipole antenna boosts usable bandwidth by 80% over conventional dipoles, improving capability while reducing costs for the specialized terrestrial direction-finding antenna.

- IR in 2017
- 12 antennas deployed
- 10 pending orders

Lotus Superhydrophobic Compositions and Coating Process (LotusFlo™)

LotusFlo™ is a superhydrophobic coating process designed to prevent clogs in offshore drilling pipes by various substances present in crude oil and salty liquids. Applied to pipes under vacuum, the long-lasting coating repels liquids and is environmentally friendly.

- Q-LIR in 2010
- Related IR in 2019

Laser Coating Removal Robot (LCR)

SwRI developed the LCR robot to use environmentally friendly laser techniques to strip paint and coatings precisely and efficiently from a broad range of military and commercial aircraft, from fighter jets and helicopters to cargo aircraft.

- IRs from 2010–2013
- 6 patents

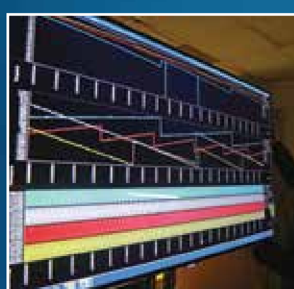
System Performance and Real Time Analysis (SPARTA)

SPARTA's advanced measurement and analysis software denies accurate targeting information to a combatant. SPARTA evaluates fighter aircraft defense systems, ensuring the correct countermeasure to a given radar "ding."

- PDIRs from 2012–19
- 8 different contract awards
- Supporting 4 different weapon systems

2020

D025427



D022710_6072

D026083

Cat-DEF

D024329_5611

2021

Eco-Mobility with Connected Powertrains

Connected and automated vehicle (CAV) technology helps passenger and fleet vehicles reduce energy consumption, providing 20% energy savings on a plug-in hybrid vehicle in real-world driving conditions by optimizing power management, routing and speed.

- 2 IRs from 2019–2021
- 4 external contracts

Catalyzed Diesel Exhaust Fluid, (Cat-DEF™)

Cat-DEF™ is a catalyst- and surfactant-modified diesel exhaust fluid solution that improves nitrous oxide and carbon dioxide emissions by reducing undesirable deposit formation in exhaust systems.

- IR in 2017

Floodlight™ Non-Targeted Analysis System

Floodlight™ software allows efficient discovery of vast numbers of chemicals present in various substances including food, air and consumer products. The cheminformatics machine learning tool provides deep analysis of two-dimensional gas chromatography mass spectrometry and metadata.

- PDIR in 2019
- Current version: Highlight
- 3 papers published
- 2 papers in progress

Wideband Conformal Continuous-Slot Antenna Array

SwRI's state-of-the-art Wideband Conformal Continuous-Slot Antenna Array technology provides naval ships with high-performance, high-frequency direction-finding (DF) and signal acquisition while conforming around shipboard-supporting mast structures.

- IR in 2019
- Array allowing a cost-effective retrofit of a class of naval ships
- Patent # 11,489,267

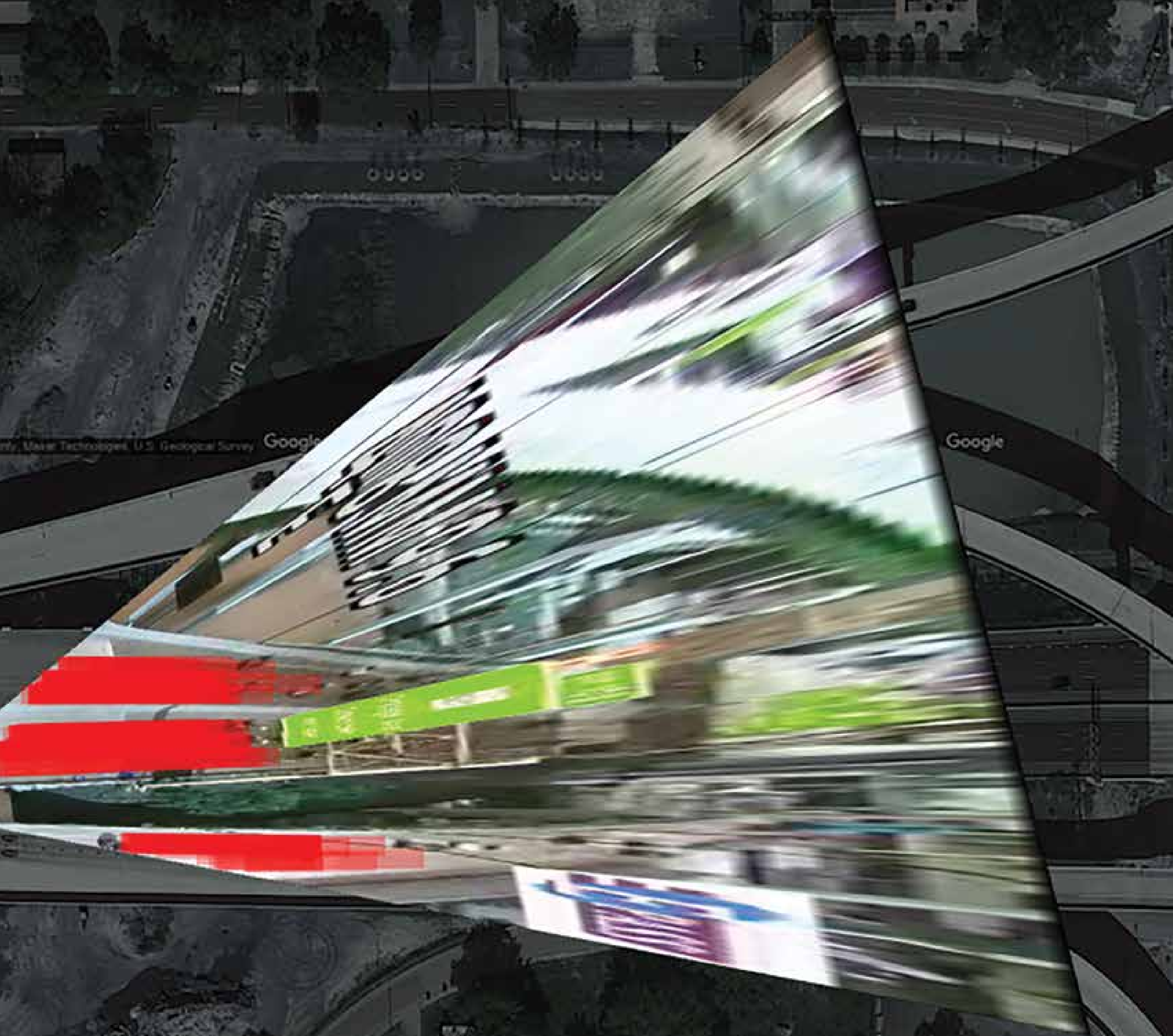
2023

D025611_8510

Active-Vision

COST-EFFECTIVE MOBILITY SOLUTIONS

By Clay Weston



Each year, tens of thousands of people die in traffic accidents in the United States. In 2022 alone, an estimated 42,975 people died in motor vehicle crashes.[1] While vehicle safety, roadside infrastructure and traveler information continue to improve, the stark reality remains that as long as there are vehicles, there will be accidents. While research tends to focus on mitigating or eliminating the causes of accidents, more research is needed to improve accident recognition and response.

[1]https://www.nhtsa.gov/press-releases/traffic-crash-death-estimates-2022#:~:text=The%20National%20Highway%20Traffic%20Safety,42%2C939%20fatalities%20reported%20for%202021

Department of Transportation (DOT) operators around the nation agree that accelerating response times will help save lives[2] and reduce congestion. One study found a nine-minute median response time across more than 2,000 counties[3]. Making it easier for people to report accidents or interfacing directly with emergency service computer-aided dispatch (CAD) systems could help, but using the ever-growing network of traffic cameras has produced the most promising results when successfully deployed.

Imagine you had thousands of employees, each monitoring the camera feed, counting each and every vehicle, recording their speeds and reporting any incidents or abnormalities. This would certainly help reduce incident response time but would come at an exorbitant cost that no state DOT can afford. However, computer-vision-based machine-learning (ML) techniques can achieve the same level of perception at a fraction of the cost. Using these systems, organizations with traffic cameras could constantly monitor their roadways, recognizing accidents, wrong-way drivers and more, while simultaneously notifying first responders with virtually zero delay.

With these goals in mind, Southwest Research Institute's intelligent transportation specialists developed the initial idea for the Active-Vision™ system. Through Internal Research and Development (IR&D) funding, engineers addressed these problems, developing an application to detect traffic anomalies such as accidents or wrong-way drivers. This application drew on years of machine vision and learning research, providing consistent, reliable anomaly detection at a cost that DOTs, cities and municipalities can afford.

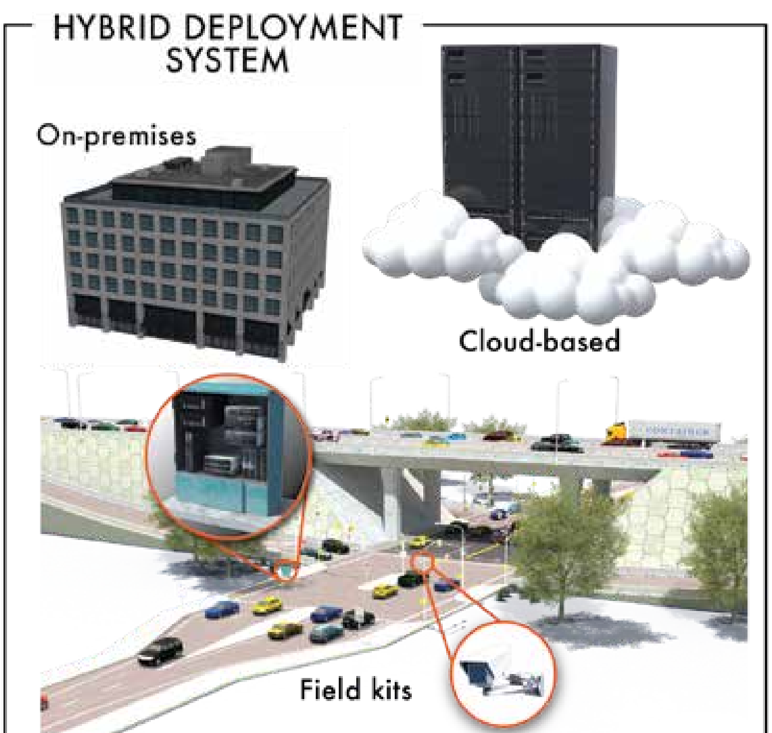
ACTIVE-VISION LAUNCH

The project first needed to develop algorithms that could identify a series of pixels across a two-dimensional screen as a vehicle. The first question was, how do people look at an image and know they are looking at a vehicle? For instance, at some point in my early childhood, my mom or dad showed me a toy car and said "car." Then, when I pointed at the dog and said "car," they gently corrected me by pointing out another car driving past. It turns out that teaching an ML algorithm is not terribly different. Without getting into the fuzzy logic details of the ML algorithms, you simply provide tons of data, and you label each proper area "car." When the algorithm incorrectly interprets something as a vehicle, you correct it. Over time, just like us, it gets better and better at determining what is, or is not, a car.

Once you can determine what a vehicle is, how do you know what that vehicle is doing? Did it stop? Is it going backwards? A video is just a series of images, so processing each individual

A geographic information system, or GIS, is a spatial system that creates, manages, analyzes and maps data.

DETAIL



Active-Vision deployment enables video feed processing using cloud-based, on-premises or edge deployments, with a hybrid of the three offering the maximum efficiency. Cloud-based models are low maintenance but require high-bandwidth connectivity. On-premises models deployed at traffic management centers require moderate maintenance. Edge or roadside deployments (field kits) process video feeds onsite, eliminating the need to stream video feeds over the field network, but are higher maintenance. Detections identified on-site then can be uploaded to the central field.

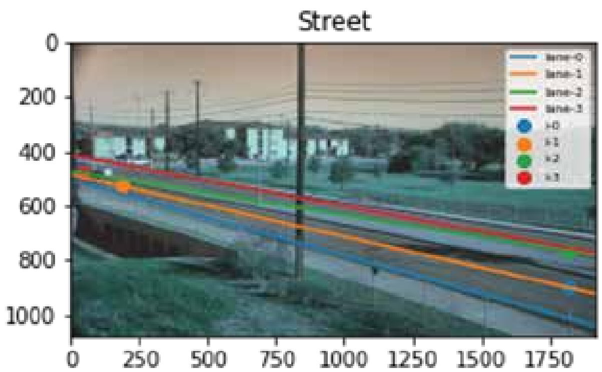
D026632_3

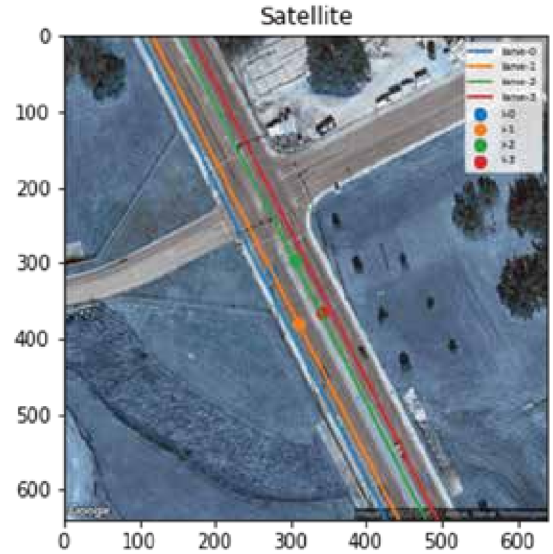
Ryan McBee is developing software to process feeds from traffic cameras deployed across highway systems to automatically detect traffic anomalies such as accidents or wrong-way drivers.

D026531_0213

[2] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6484802/
[3] https://pubmed.ncbi.nlm.nih.gov/30725080/

Central to Active-Vision vehicle detection is the process of building a homography or "mapping" between what the camera sees (near right) and a satellite perspective (far right).





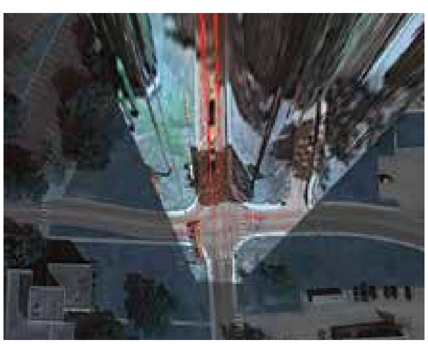
D026607

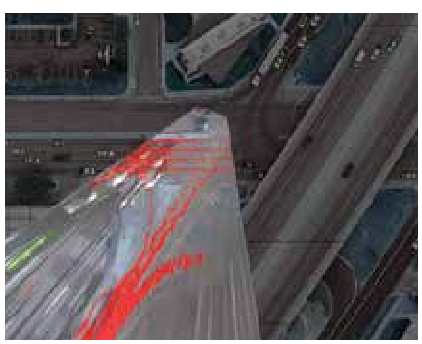
image allows you to determine each time what is and is not a vehicle. Now we're adding the ability to understand that a vehicle found in the previous image is also the same vehicle in the current image, and in subsequent images. From this, we can derive if, and how far, a vehicle moved, as well as its direction.

Determining the direction a vehicle is moving relative to the camera does not indicate where the vehicle actually is. It can be problematic and potentially dangerous if we think a vehicle is on the wrong side of the road or perhaps driving through a lake. We must determine the vehicle's position relative to the roadway it is traversing. To do this, Active-Vision does what computer vision software does well, using very complicated math to determine a visual perspective. In a process known as auto-homography, different images of the same planar surface, in this case a road, are stitched together to enable navigation, allowing the insertion of 3D models of objects, such as vehicles, into an image or video at the correct perspective. This process translates the view of a camera to a top-down placement of a vehicle on a GIS map, connecting data to a map, integrating location along with condition descriptions. This process allows the system to report precise latitude and longitude positions of the vehicles it detects. Combining this technology with free OpenStreetMap (OSM) data, the system can accurately determine where the vehicle is relative to the roadways it's traveling. But we still have a problem. As good as the auto-homography process is, it is not infallible and can, at times, suggest an incorrect configuration. To combat this, the system cleverly applies logic and simply watches where vehicles are actually traveling. Any time the camera view is moved or repositioned, before assuming that the homography is correct, the system "watches" where the vehicles are and determines if that matches the underlying roadway. If it matches, which happens most of the time, all is well. If not, it rebuilds the homography until it gets it right — just like you or I would do.

Once the system accurately and reliably detects traffic conditions and anomalies, the final piece of the puzzle is establishing when these things actually happen. Toward this goal, Active-Vision shares data through an application programming interface (API), allowing external systems to collect data. The Active-Vision API is specifically written to interface with ActiveITS™, the SwRI-built traffic management software that notifies ATMS operators when abnormal conditions occur.

D026636





D026611

OpenStreetMap is a free, open geographic database updated and maintained by a community of volunteers.

DETAIL

D026600

A new "auto-homography" tool automatically assigns a vehicle's GPS location based on its proximity to a traffic camera, instead of requiring a human to manually match points between a traffic camera and satellite image.

An application programming interface, or API, is a set of rules allowing different applications to communicate, acting as an intermediary layer, processing data transfers between systems.

DETAIL

D026531_0174

ABOUT THE AUTHOR: Clay Weston is assistant director of the Intelligent Transportation Systems (ITS) Department, responsible for leading a team of ITS specialists developing innovations in the mobility domain. The team develops software to support existing client systems and identify tomorrow's mobility challenges.

ACTIVE-VISION TODAY

Today, Active-Vision can reliably detect vehicle counts and speeds, wrong-way drivers, and stalled or disabled vehicles and report that information to first responders to reduce response times. However, SwRI is continuing scale-up activities. The system can currently process over 50 camera feeds on a single server but will eventually need to be distributed across multiple servers to handle thousands of feeds.

The City of San Antonio ran the first Active-Vision pilot program, and the Central Florida Expressway Authority is currently conducting a second deployment and evaluation. Additional DOTs across the nation have expressed interest in Active-Vision based on these demonstrations and its reasonable cost.

Additional internally funded research continues to hone the accuracy of the algorithms, aiming to deliver sub-meter-level accuracy to provide lane-level reporting and simulated connected vehicle information. This information mimics the data that current connected vehicles send, enabling fine-grained analysis to characterize how vehicles move and react to different conditions. For instance, perhaps a curve in the roadway is a little too sharp, causing hard braking events, or an exit ramp is not long enough, causing backups onto the main roadway. This research, and the research that follows, will enable future systems to detect more than ever.

ACTIVE-VISION TOMORROW

As a stable, deliverable platform that can accurately detect and place vehicles, Active-Vision can provide meaningful results, mitigate congestion and, above all, save lives. However, we are not done yet. The software shows promise for additional capabilities to improve safety and mobility, such as detecting weather, including rain, snow or dust. Additional capabilities could identify pedestrians, animals or debris on roadways or shoulders. The system could be trained to find ramp backups, lane departures or the precise location of congestion. Active-Vision could classify vehicles — truck, car, motorcycle, bicycle, etc. — or the severity of accidents. The system could be trained to identify and provide alerts for distracted or drunk drivers. SwRI is considering developing these capabilities, all realistic candidates based on the current architecture of the system.

IR&D

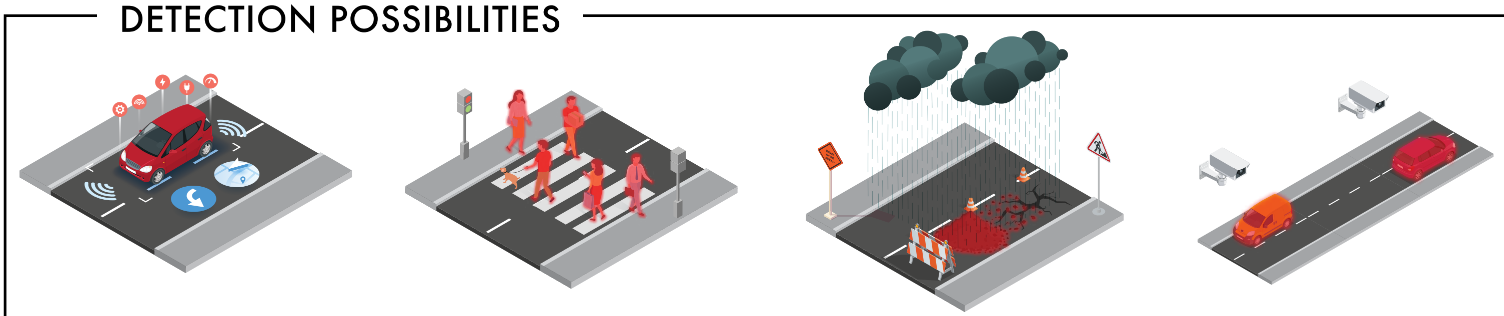
SwRI's Internal Research and Development program has helped to create this and many more successful projects that advance science and technology while providing real-world benefits. This work builds on previous research in intelligent transportation and automated vehicles, using the skills and expertise gained in computer vision and machine learning and applying it to a different, but related, problem set. While the primary benefits of internal research projects are specific technology advancements, these projects help enhance staff skillsets to create experts in cutting-edge technologies.

As we move to expand Active-Vision capabilities, the technology and skills gained will undoubtedly continue to help fulfill SwRI's mission statement of benefiting government, industry and the public through innovative science and technology.

Questions about this story? Contact Weston at clay.weston@swri.org or (210) 522-2954.

D026637

DETECTION POSSIBILITIES



Vehicle Detection/Tracking | **Pedestrian Detection/Tracking** | **Environmental Detection** | **Advanced Detection/Tracking**

With the Sun at such a low angle with respect to the Moon's poles, sunlight never reaches the floors of some deep craters. These permanently shaded regions are some of the coldest spots in the solar system, capable of trapping volatile chemicals including water ice. New research indicates these regions are not as old as originally thought, so current estimates of water ice on the Moon may be too high.

D026596

MOON MAY BE DRYER THAN EXPECTED

A team including Southwest Research Institute's Dr. Raluca Rufu recently calculated that most of the Moon's oldest permanently shadowed regions, or PSRs, are at most around 3.4 billion years old and contain relatively young deposits of water ice. Water resources are considered key for sustainable exploration of the Moon and beyond, but these findings suggest that current estimates for cold-trapped ices are too high.

"We think the Earth-Moon system formed following a giant impact between early Earth and another protoplanet," said Rufu, a Sagan Fellow who is the second author of a Science Advances paper about this research. "The Moon formed from the impact-generated debris disk, migrating away from Earth over time."

Around 4.1 billion years ago, a major spin axis reorientation decreased the amount of sunlight reaching the poles, particularly in deep craters. The team used AstroGeo22, a new Earth-Moon evolution simulation tool, to calculate the Moon's axial tilt over time. Together with surface height measurements from the Lunar Orbital Altimeter Laser data, the team estimated the evolution of the shadowed areas over time.

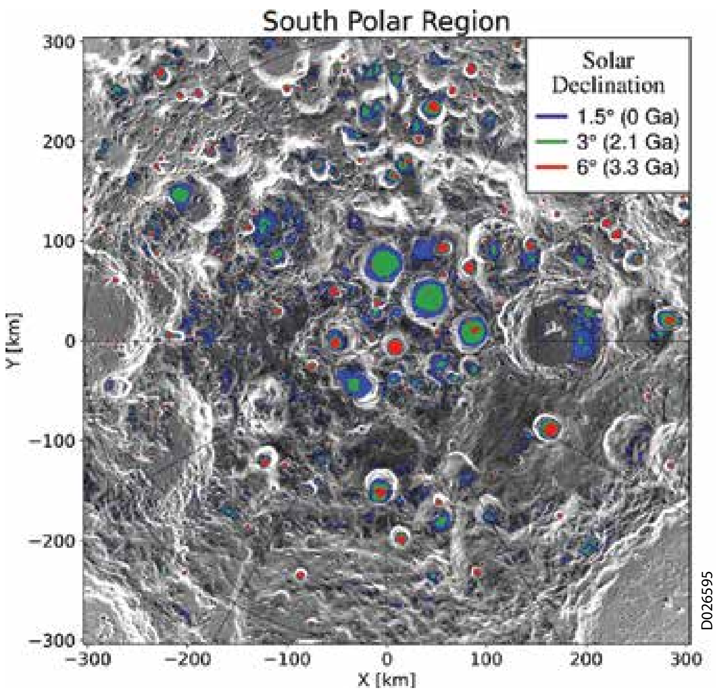
PSRs are some of the coldest places in the solar system, allowing them to trap volatile chemicals like water in the form of ice. Water ice anywhere outside of the Moon's PSRs would immediately transform from solid to gas in the harsh, airless sunshine that falls on most of the lunar surface.

In 2009, NASA crashed the two-ton Atlas Centaur rocket body, part of the Lunar Crater Observation and Sensing Satellite (LCROSS), near the south pole of the Moon. It struck the floor of Cabeus crater, creating a plume of debris examined for the presence of water and other chemicals in the lunar regolith. A shepherding satellite traveling four minutes behind the Centaur and several Earth-orbiting satellites, including the Hubble Space Telescope, monitored the impact, detecting water ice, ammonia and methane.

The work suggests that Cabeus crater became a PSR less than a billion years ago. The various volatiles detected in the plume created by LCROSS indicate that ice-trapping continued into relatively recent times.

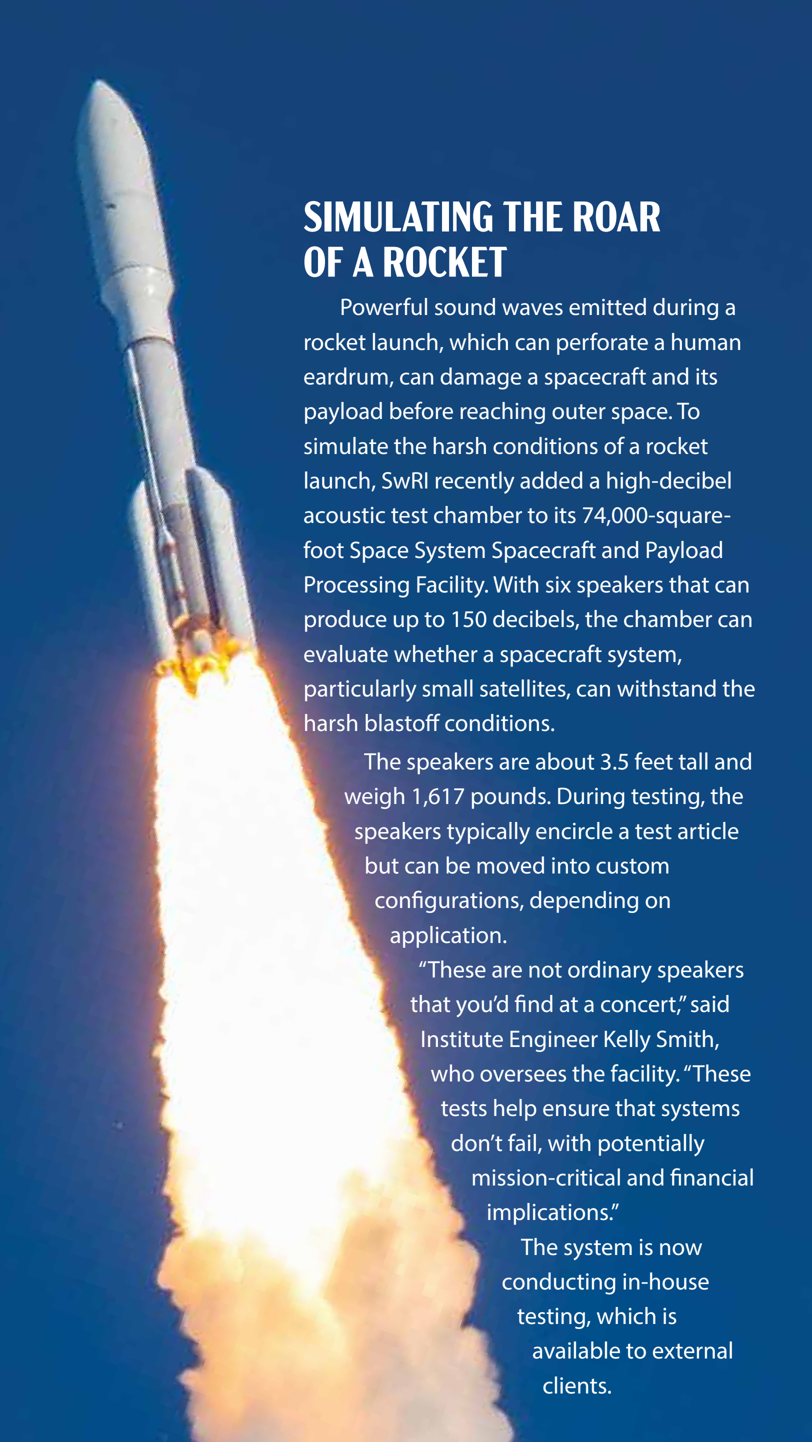
Water is a key resource that can be used to create air and rocket fuel to sustain human habitation on the Moon. However, the findings published in Science Advances suggest estimates for cold-trapped lunar ice may be too high. NASA and other entities plan to send rovers and humans to characterize the water ice within PSRs over the next few years.

IMAGES COURTESY SCHÖRGHOFER/RUFU



D026595

SwRI's Dr. Raluca Rufu collaborated with Norbert Schörghofer of the Planetary Science Institute in Honolulu, Hawaii, to calculate the age of the Moon's permanently shadowed regions near its poles. Water resources are considered key for sustainable exploration of the Moon and beyond, but these findings suggest that current estimates for cold-trapped ices are too high. Colored deposits show the extent of PSRs 3.3 billion years ago (red), 2.1 billion years ago (green) and close to present-day (blue) with current topography.



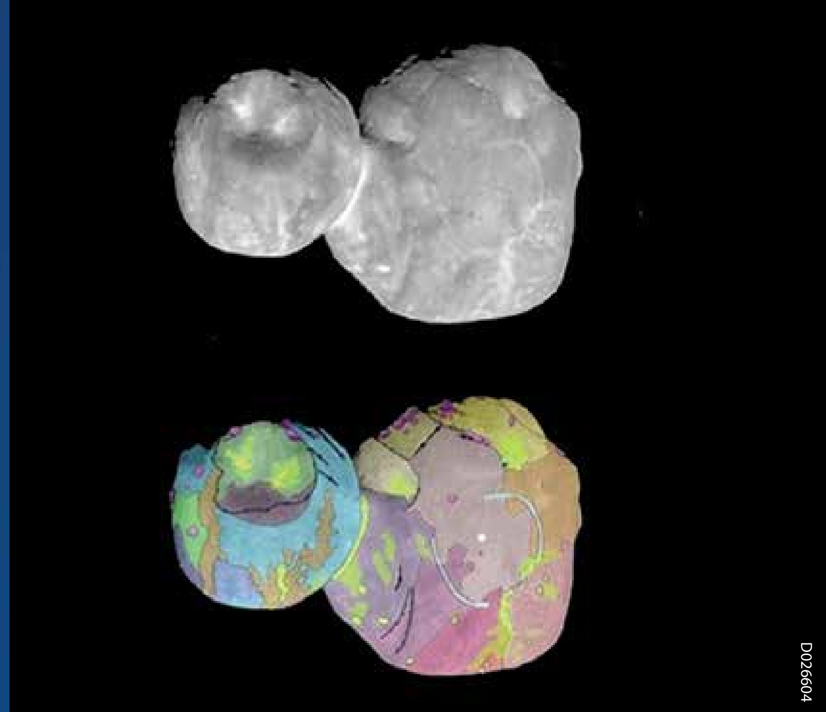
SIMULATING THE ROAR OF A ROCKET

Powerful sound waves emitted during a rocket launch, which can perforate a human eardrum, can damage a spacecraft and its payload before reaching outer space. To simulate the harsh conditions of a rocket launch, SwRI recently added a high-decibel acoustic test chamber to its 74,000-square-foot Space System Spacecraft and Payload Processing Facility. With six speakers that can produce up to 150 decibels, the chamber can evaluate whether a spacecraft system, particularly small satellites, can withstand the harsh blastoff conditions.

The speakers are about 3.5 feet tall and weigh 1,617 pounds. During testing, the speakers typically encircle a test article but can be moved into custom configurations, depending on application.

"These are not ordinary speakers that you'd find at a concert," said Institute Engineer Kelly Smith, who oversees the facility. "These tests help ensure that systems don't fail, with potentially mission-critical and financial implications."

The system is now conducting in-house testing, which is available to external clients.



A new SwRI-led study asserts that large mound structures dominating one of the lobes of the Kuiper Belt object Arrokoth are similar enough to suggest a common origin.

Study Points to Building Block Formation Model in Kuiper Belt

An SwRI-led study posits that 5-kilometer-long mounds dominating the larger lobe of the pristine Kuiper Belt object Arrokoth are similar enough to suggest a common origin. These "building blocks" will guide further work on planetesimal formational models.

Using data from NASA's New Horizons spacecraft flyby of Arrokoth in 2019, scientists identified 12 mounds on Arrokoth's larger lobe, Wenu, that are almost the same shape, size, color and reflectivity. The results now published in the peer-reviewed Planetary Science Journal also tentatively identified three more mounds on the object's smaller lobe, Weeyo.

"Similarities including in sizes and other properties of Arrokoth's mound structures suggest new insights into its formation," said Dr. Alan Stern, lead author and principal investigator of NASA's New Horizons mission. "If the mounds are indeed representative of the building blocks of ancient planetesimals like Arrokoth, then formation models will need to explain the preferred size for these building blocks."

Arrokoth's geology supports the streaming instability model of planetesimal formation where collisions made at a few miles per hour allowed objects to gently accumulate and build objects in a local area of the solar nebula undergoing gravitational collapse.

Scientists anticipate that flyby targets for NASA's Lucy mission to Jupiter's Trojan asteroids and ESA's comet interceptor will encounter other pristine objects. The observation will provide additional insight into the accretion of planetesimals in the ancient solar system for comparison to processes New Horizons found in the Kuiper Belt.

"It will be important to search for mound-like structures on the planetesimals these missions observe to see how common this phenomenon is, as a further guide to planetesimal formation theories," Stern said.

A STEP Forward for Supercritical Carbon Dioxide Power Generation

The Supercritical Transformational Electric Power (STEP) Demo pilot plant, one of the largest demonstration facilities for supercritical carbon dioxide (sCO_2) technology in the world, achieved an industry first by firing its natural gas heater and operating its turbine at 18,000 rpm.

"This is an important step for our sCO_2 demonstration plant," said SwRI Project Manager Dr. Jeff Moore. "The STEP Demo team is thrilled to have achieved this significant milestone of integrated plant operation."

Completed in 2023 on the SwRI campus, the $169 million, 10-megawatt facility will demonstrate and evaluate sCO_2 power generation technology, which is about one-tenth of the size of conventional equipment and can increase efficiency by 10%. The STEP Demo project was built in collaboration with SwRI, GTI Energy, GE Vernova, the U.S. Department of Energy/National Energy Technology Laboratory and several industry participants.

Carbon dioxide is nontoxic and nonflammable, and when it is held above a critical temperature and pressure, it can act like a gas while having the density near that of a liquid. System commissioning for the STEP Demo pilot plant will continue in 2024. The plant's turbine speeds will eventually reach 27,000 rpm at operating temperatures of 715 C to achieve full 10 MWe output.

MONITORING THE MASSIVE C-5

SwRI has begun outfitting five C-5 Aircraft with Loads/Environment Spectra Survey (L/ESS) systems to capture precise aircraft usage data that would otherwise require manual input from a crew member.

The updates are a part of a five-year, $4.5 million contract with the U.S. Air Force Academy's Center for Aircraft Structural Life Extension (CAStLE). Once installation is complete, the Institute will perform component, subsystem and system-level testing to ensure functionality. Introduced in 1969, the large military cargo carriers were designed to transport sizable freight, including other aircraft. With a 222-foot wingspan, the 247-foot-long C-5 is among the largest aircraft in the world.

"The system will support fleet management, monitoring the aircraft usage and updating inspection intervals as needed to increase aircraft availability and reduce maintenance costs in the long term," said SwRI Senior Research Engineer Richard Lammons.

The U.S. Air Force is required to monitor usage on 20% of the C-5 fleet to assess structural health and establish usage projections, among other things. SwRI's structural integrity work for the U.S. Air Force began in the early 1970s. Since then, the Institute has managed and developed tools such as NASGRO®, a collaboration with NASA that can analyze fracture and fatigue crack growth in structures and mechanical components.

Already installed on T-38 and A-10 aircraft, SwRI-developed flight data recording systems help engineers understand the structural stresses associated with various flight maneuvers. SwRI has also developed specialized inspection probes including technology to inspect under bushings, a type of sleeve bearing or metal encasement used with rotating or sliding parts. The SwRI-patented magnetostrictive sensors also provide ongoing structural health monitoring for the A-10 aircraft.

D025023_8438

'BREAKTHROUGH' METHOD FOR SYNTHESIZING NERVE AGENT ANTIDOTES

SwRI has developed unique technology, enabling the safe and efficient synthesis of organophosphorus nerve agent (OPNA) oxime antidotes. SwRI's new development integrates new purification methods while circumventing the need for dangerous ingredients traditionally associated with the development process. SwRI scientists can now successfully synthesize currently known and highly effective nerve agent countermeasures and effectively develop promising new drug candidates to treat nerve agent exposure.

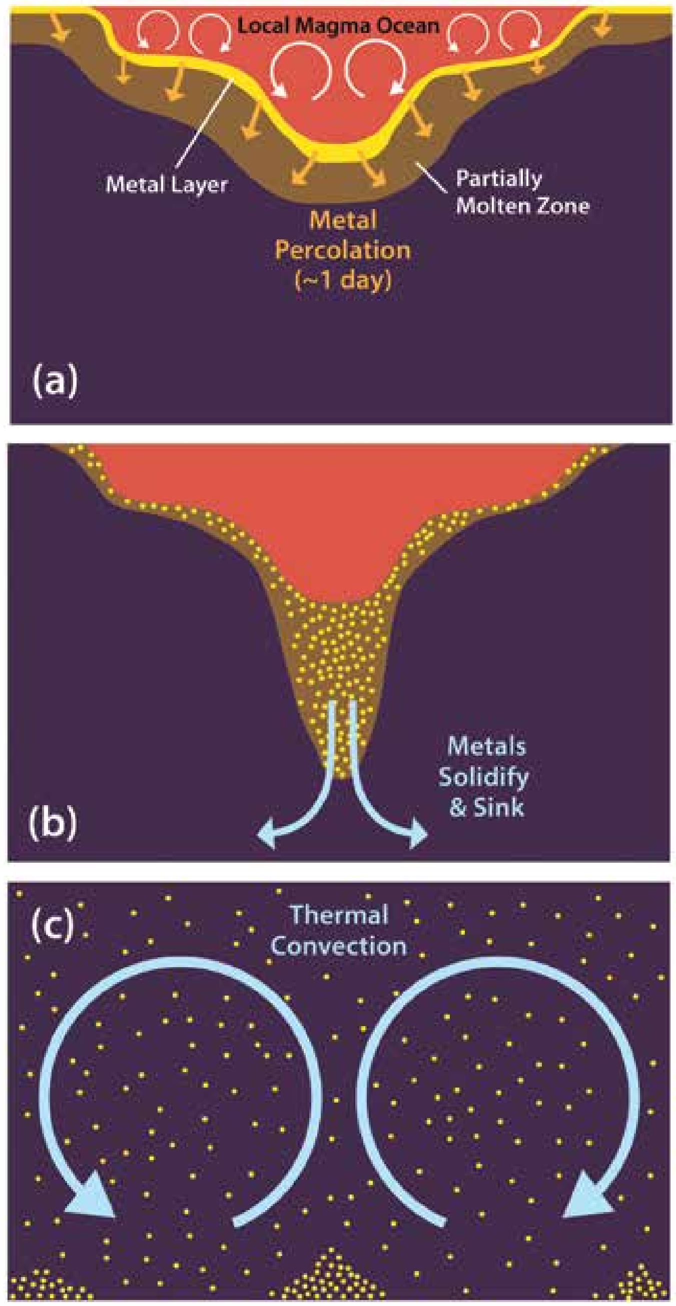
A significant threat to both military and civilian populations worldwide, OPNA exposure causes an estimated 300,000 deaths each year. OPNAs are odorless, colorless chemicals found in pesticides and chemical weapons, which affect the central nervous system by interrupting signals between nerve cells. Moderate exposure can cause nausea, vomiting and abdominal cramps while severe exposure can cause arrhythmias, loss of consciousness and, if not properly treated, even death.

"Overcoming the difficulties with synthesizing medical counter measures is a longstanding challenge that SwRI has been pursuing since the early 1990s," said SwRI's Dr. Shawn Blumberg, a lead scientist in SwRI's Pharmaceutical and Bioengineering Department. "We recently had a breakthrough, developing an innovative manufacturing process that allowed us to develop two highly sought-after antidotes."

SwRI is one of more than 300 industry, government and nonprofit organizations supporting the medical countermeasures sector in the Medical CBRN Defense Consortium. This sector was founded to support U.S. Department of Defense needs in areas of infectious diseases, chemical threats and other medical countermeasures for military personnel.

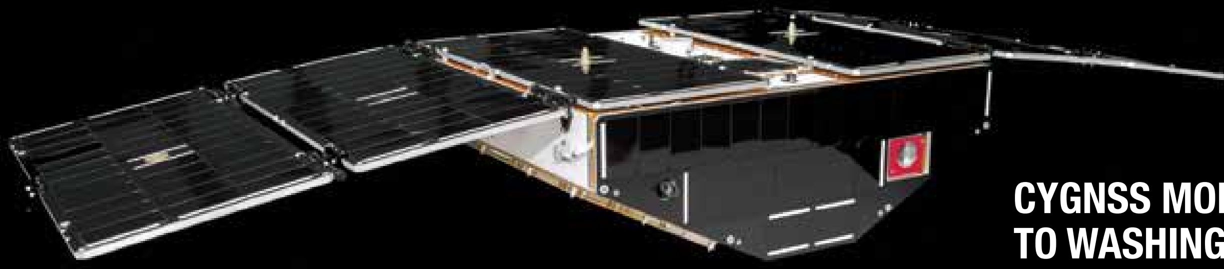
SwRI's Chemistry and Chemical Engineering Division is ISO 9001:2015 certified, meeting international quality standards for product development from initial design through production and service. SwRI scientists support drug development from discovery to clinical trials in FDA-inspected Current Good Manufacturing Practice facilities.

EXPLAINING PRECIOUS METALS IN EARTH'S MANTLE



D026605

SwRI Institute Scientist Dr. Simone Marchi collaborated on a new study finding the first geophysically plausible scenario to explain the abundance of certain precious metals — including gold and platinum — in the Earth's mantle. Based on the simulations, scientists found an impact-driven mixing of mantle materials scenario that could prevent the metals delivered by impactors from completely sinking into the Earth's core during the long period of bombardment.
(a) Liquid metals would sink in the locally produced impact-generated magma ocean before percolating through the partially molten zone beneath.
(b) Compression causes the metals in the molten zone to solidify and sink.
(c) The thermal convection mixes and redistributes the metal-impregnated mantle components over long geologic time frames.



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CYGNSS MODEL GOES TO WASHINGTON

A model of the Cyclone Global Navigation Satellite System (CYGNSS) microsatellite arrived at its new home at the Smithsonian National Air and Space Museum in Washington, D.C., earlier this year. CYGNSS was NASA's first small satellite mission to remotely measure ocean surface winds and monitor the location, intensity, size and development of tropical storms to improve typhoon, cyclone and hurricane forecasting. SwRI designed, built and currently operates the constellation of eight microsatellites for the University of Michigan.

"CYGNSS was at the forefront of the SmallSat revolution," said Institute Engineer Randy Rose. "Our efforts were a significant catalyst for the SmallSat market that is forecast to reach $8.2 billion by 2026. We literally showed the world that SmallSats could be more than the educational curiosities that existed prior to CYGNSS."

CYGNSS science data has made a significant impact on the improved accuracy of tropical storm, cyclone and hurricane forecasting. Before CYGNSS, false alarms affected the public response to warnings. CYGNSS is saving lives by enabling better storm preparedness. And the work continues. After deeming the CYGNSS satellites healthy in 2020, NASA extended the mission into 2026.

SwRI built the microsatellite model using leftover parts from the original CYGNSS spacecraft as well as engineering model components. It is expected to go on permanent display to the public sometime in 2026, following ongoing museum renovations. It will be part of the "RTX Living in the Space Age" exhibition highlighting space technology that has had a profound impact on the daily lives of people around the world yet is often relatively unknown.

D024106_3000

ASSESSING HOW BLENDED GASES AFFECT INFRASTRUCTURE

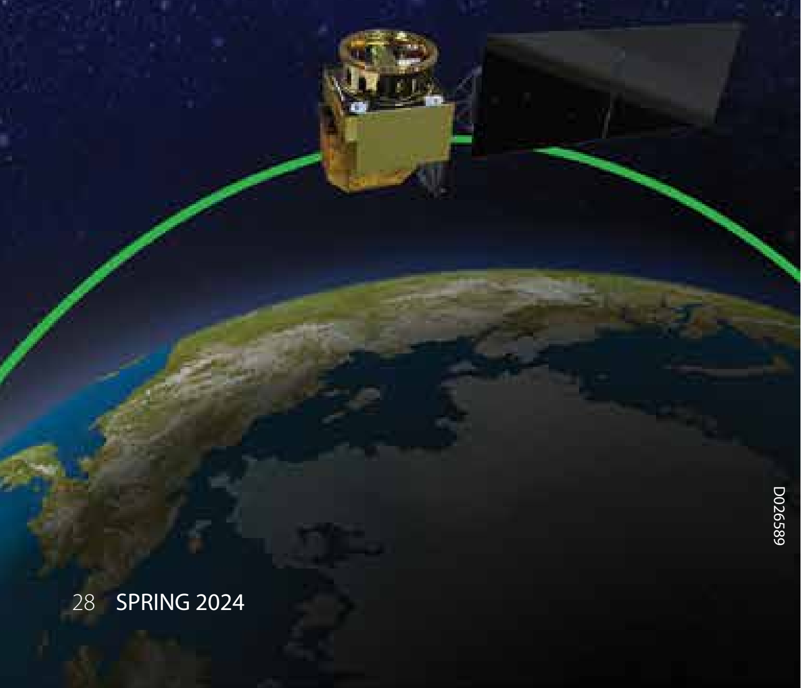
Using its onsite full-scale reciprocating compressor loop, SwRI is evaluating the safety and efficiency of using a full-scale compressor system for hydrogen-natural gas blends with up to 20% hydrogen by volume. Senior Research Analyst Sarah Simons leads this $1.5 million Department of Energy project conducted in collaboration with the Gas Machinery Research Council.

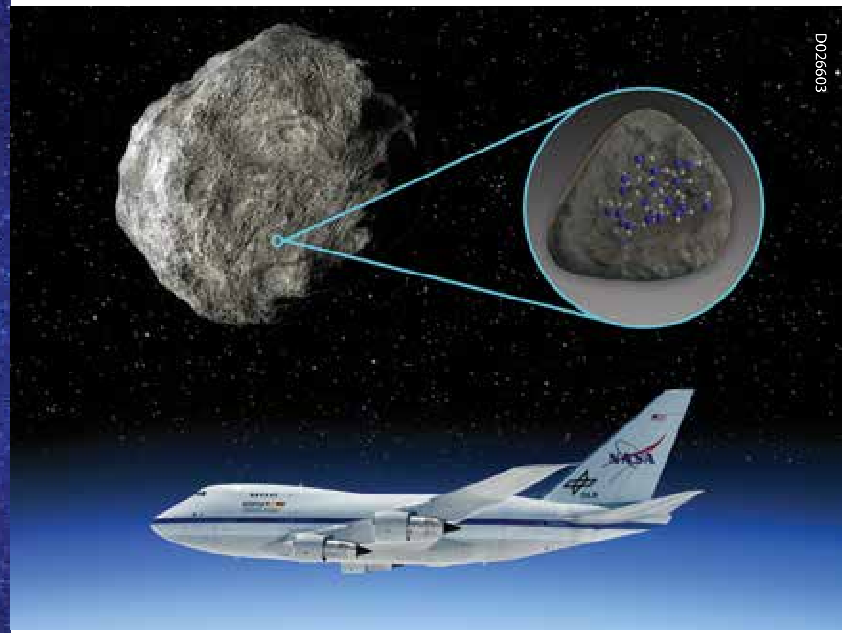
QUICKSOUNDER SATELLITE TO ADVANCE WEATHER FORECASTING

NASA and NOAA have selected SwRI to develop QuickSounder, a pathfinder for a new generation of NOAA Low Earth Orbit (LEO) environmental satellites. From LEO, microwave (MW) and infrared (IR) soundings offer higher resolution for short- and long-term weather forecasts, hyperspectral ocean imagery (e.g., harmful algal blooms) and enhanced measurements of atmospheric chemistry. Under the $47 million contract, SwRI will design, build and operate the satellite through 2029 to significantly improve NOAA's weather forecasting abilities by delivering 99% of data within 50 minutes of collection.

At 2.8 feet (87 cm) wide and 4.1 feet (125 cm) long, QuickSounder is slightly larger than a typical washing machine. The satellite will weigh about 750 pounds (340 kg), including its ion thrusters and xenon propellant. All spacecraft design, fabrication and testing will occur within the 74,000-square-foot Space System Integration Facility at SwRI's San Antonio headquarters. Once complete, QuickSounder will ship to Vandenberg Space Force Base to undergo launch vehicle integration ahead of its scheduled 2026 launch. The Institute's Mission Operations Center in Boulder, Colorado, will operate the satellite.

Developing and launching environmental satellites has typically taken a decade or more. With QuickSounder, SwRI will cut the process down to just over two years while also integrating the latest commercial-off-the-shelf "new space" technology. QuickSounder will precede and inform the Near Earth Orbit Network (NEON) program, where NASA will manage the development and launch of the next generation of MW and IR payloads. Then NOAA will take over, operating the on-orbit satellites and delivering data to users worldwide to support weather forecasting, climate monitoring and environmental observations.





SwRI DISCOVERS WATER ON TWO ASTEROIDS

Using data from the retired Stratospheric Observatory for Infrared Astronomy (SOFIA) — a joint project of NASA and the German Space Agency at DLR — Southwest Research Institute scientists have discovered, for the first time, water molecules on the surface of an asteroid.

"We detected a feature that is unambiguously attributed to molecular water on the asteroids Iris and Massalia," said SwRI's Dr. Anicia Arredondo, lead author of a Planetary Science Journal paper about the discovery. "We based our research on the success of the team that found molecular water on the sunlit surface of the Moon. We thought we could use SOFIA to find this spectral signature on other bodies."

Previous observations of both the Moon and asteroids have detected some form of hydrogen but could not distinguish between water and its close chemical relative, hydroxyl. Scientists looked at four silicate-rich asteroids using SOFIA's FORCAST instrument and identified the mid-infrared spectral signature indicative of molecular water on two of them.

Data from Parthenope and Melpomene, two other asteroids, proved too noisy and inconclusive. However, the team took initial measurements for two more asteroids with the precise optics and superior signal-to-noise ratio of NASA's James Webb Space Telescope. Arredondo says the team has submitted another proposal to investigate 30 more targets using JWST in the next cycle.

"Asteroids are leftovers from the planetary formation process, so their compositions vary depending on where they formed in the solar nebula," Arredondo said.

Anhydrous, or dry, silicate asteroids form close to the Sun while icy materials coalesce farther out. Understanding the location and composition of asteroids can tell us how materials in the solar nebula were distributed and evolved. The distribution of water in our solar system may shed light on the distribution of water in other solar systems and will help drive the search for potential life, both in our solar system and beyond.

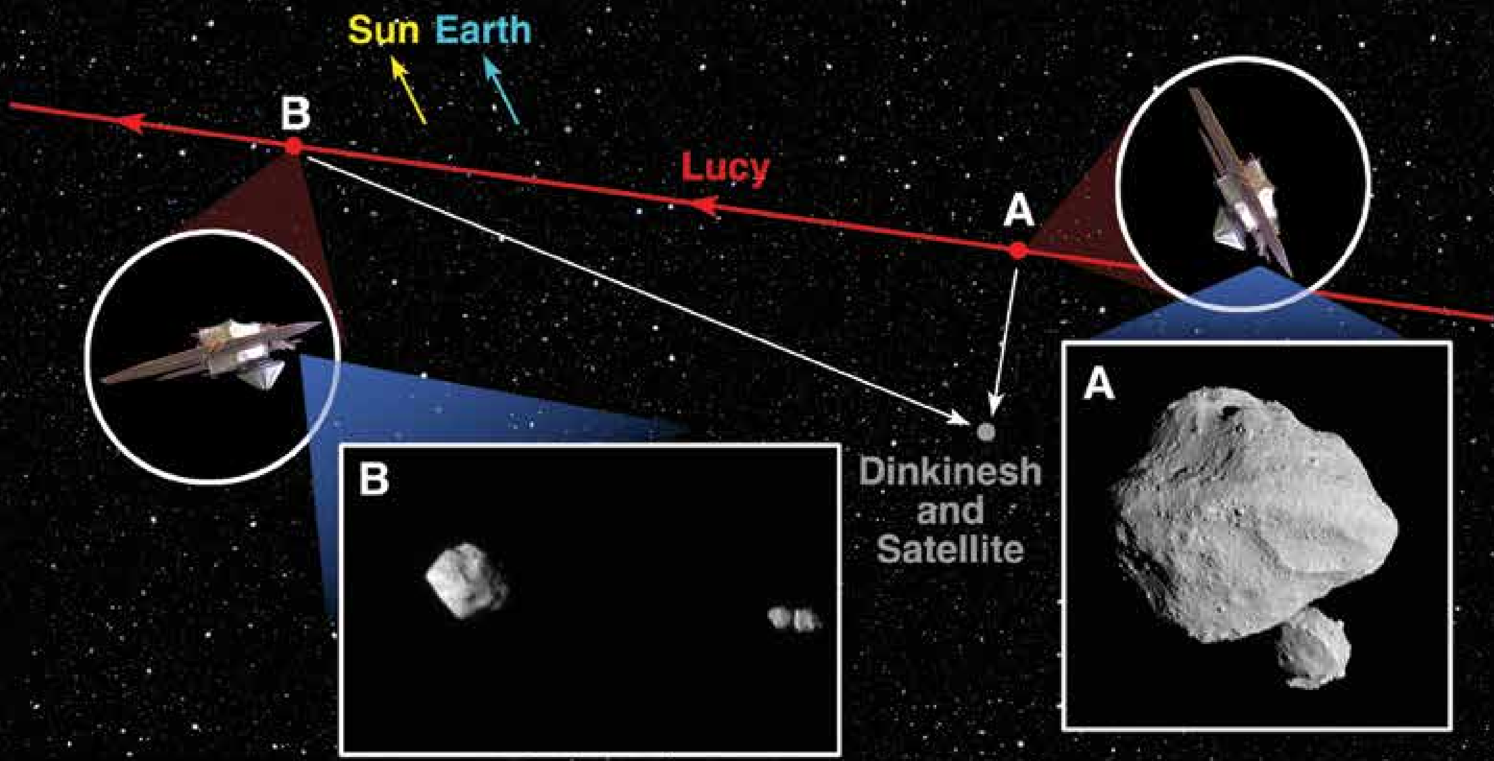


IMAGE COURTESY NASA/GODDARD/SwRI/JOHNS HOPKINS APL/NOIRLAB

D026592

LUCY DISCOVERS DINKY'S DOUBLE MOON

On Nov. 1, 2023, the SwRI-led Lucy mission flew past the asteroid Dinkinesh, discovering that it hosted a satellite. As NASA's Lucy spacecraft continued to return data acquired during its first asteroid encounter, the team discovered that Dinkinesh's surprise satellite is itself a contact binary, two smaller objects touching each other.

"Contact binaries seem to be fairly common in the solar system," said SwRI's John Spencer, a Lucy deputy project scientist. "We haven't seen many up close, and we've never seen one orbiting another asteroid. Variations in Dinkinesh's brightness seen on approach hinted that 'Dinky' might have a moon of some sort, but we never suspected anything so bizarre!"

Lucy's primary goal is to survey the never-before-visited Jupiter Trojan asteroids. The mission team added the first encounter with this small, main-belt asteroid in January 2023. The Dinkinesh encounter served as an in-flight test of the spacecraft's novel terminal tracking system, which keeps tabs on the target as the spacecraft buzzes past.

The system's excellent performance allowed the team to capture multiple perspectives of the Dinkinesh system. At closest approach, the two lobes of the contact binary lined up, one behind the other, appearing as one body from Lucy's point of view. Additional images captured after the closest encounter revealed that Dinkenesh has a double moonlet, now named Selam.

"I would have never expected a system that looks like this," said SwRI's Hal Levison, Lucy principal investigator. "Understanding why the two components of the satellite have similar sizes is going to be fun for the scientific community to figure out."

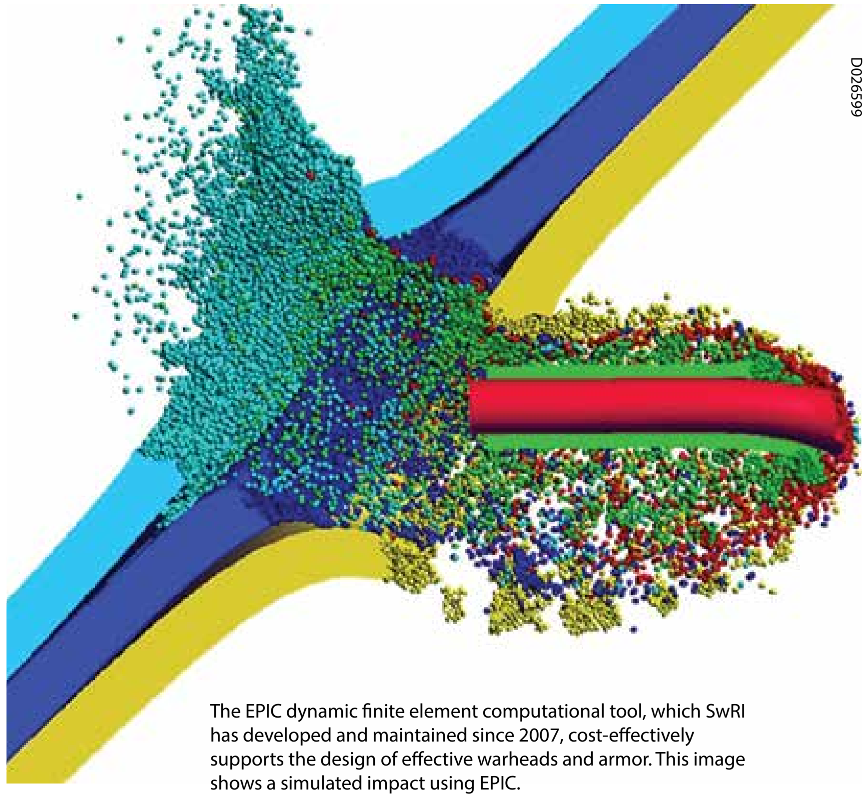
Over Lucy's 12-year journey, the spacecraft will fly by eight target asteroids with three known satellites among them, including the newly discovered contact binary. The next target is another main belt asteroid in 2025 before the spacecraft continues its journey to reach the Trojan asteroids in 2027.

EPIC ADVANCEMENTS

An SwRI team is working to improve and update the Elastic-Plastic Impact Computations (EPIC) code. First developed in the 1970s, EPIC offers a cost-effective tool to design and model the interactions of warheads, body armor and armored vehicles. The U.S. Army Corps of Engineers has funded $500,000 for the first year of an EPIC development project, with up to $3.5 million available if the project is extended for three additional years.

"EPIC uses finite element and particle methods to simulate complex impact and explosion scenarios," said SwRI Staff Engineer Dr. Stephen Beissel, who leads the EPIC project and has been involved in EPIC's development since the mid-1990s. "The numerical algorithms and the material models allow EPIC to handle highly dynamic and energetic events. Through simulations with the EPIC code, engineers can perform analyses of how a particular design for a ground vehicle, ship or aircraft component would react under stress in real-world conditions."

In 2007, SwRI took over maintenance and development of the project, opening an office in Minneapolis where EPIC's development team joined forces with Institute staff. The current objective is to improve EPIC's accuracy, expand the types of problems and scenarios it can address, and increase its computational efficiency when used on supercomputers and graphics processing clusters.



D026599

The EPIC dynamic finite element computational tool, which SwRI has developed and maintained since 2007, cost-effectively supports the design of effective warheads and armor. This image shows a simulated impact using EPIC.

SwRI CELEBRATES FIRST ASTRONAUT

IMAGE COURTESY VIRGIN GALACTIC D026591

Dr. Alan Stern, an associate vice president in SwRI's Space Sector, conducted internally funded suborbital research aboard the Virgin Galactic commercial spaceship Unity on Nov. 2, 2023. During the roughly 75-minute mission, first mated to its carrier aircraft VMS Eve and then horizontally launched into space, Stern tested equipment and trained for a future suborbital flight where he will conduct two NASA experiments in space.

"Dr. Stern's flight is a first for SwRI scientists," said SwRI President and CEO Adam L. Hamilton, P.E. "This is an important step in preparing additional SwRI scientists and engineers for space-based research in the future."

Stern traveled 54.2 miles above the Earth, roughly 10 times higher than the cruising altitude of most commercial airliners, reaching a top speed approaching Mach 3.

During the flight, he evaluated equipment monitoring his vital signs and conducted training and risk-reduction activities in preparation for his NASA spaceflight, evaluating the spacecraft's suitability for making astronomy observations in space. For that experiment, Stern will use the Southwest Ultraviolet Imaging System (SWUIS), an innovative, wide-field, visible and ultraviolet imager, which has flown on two Space Shuttle missions. Stern led the development of SWUIS at SwRI as its principal investigator.

SwRI's Internal Research and Development program funded Stern's suborbital journey, investing in his ticket to space two decades ago, and in numerous high-performance NASA F-18s operated by Stern and Principal Scientist Dr. Dan Durda.

"This first human spaceflight by a SwRI staff member was a thrilling and truly unforgettable experience, and I'm already excited about my next trip for NASA," Stern said. "What I find even more exciting is the idea that this is the beginning of a new era for SwRI space scientists, when we can conduct research in space ourselves. I believe this is the beginning of something pivotal."

Stern trained on numerous fighter aircraft, in a human centrifuge and on over 20 parabolic flights, and underwent intensive training at Spaceport America in preparation for his flight.

CHEDE-9 EXPANDS SCOPE, PRIORITIZES DECARBONIZATION

D026601/02

SwRI recently launched the latest phase of the transportation industry's longest running commercial vehicle research consortium. Building on more than 33 years of research and development, SwRI's Clean Highly Efficient Decarbonized Engines 9 (CHEDE-9) consortium expands its scope from diesel-engine-focused research to a range of internal combustion engines and hybrid solutions.

Formerly known as the Clean High-Efficiency Diesel Engine consortium, CHEDE-9 focuses on research of low- and net-zero carbon dioxide (CO_2) transportation technologies for light-duty passenger vehicles, heavy-duty commercial vehicles and large power systems. CHEDE-9 will explore decarbonization technologies combining past and future research efforts with low-carbon fuels, advanced engine and powertrain systems, and life-cycle analyses.

"The future of mobility is through decarbonization," said Chris Bitsis, an assistant director in SwRI's Powertrain Engineering Division. "Those efforts will include advancing hybrid-electric vehicles and innovations to internal combustion using hydrogen and other fuel sources."

CHEDE-9 leverages the most recent research from CHEDE-8 and other SwRI-led research programs, including the High-Efficiency, Dilute Gasoline Engine (HEDGE-V) and Hydrogen Internal Combustion Engine (H_2-ICE) programs. Members include major engine and vehicle manufacturers along with companies specializing in fuels and lubricants and other suppliers. Consortium members share costs and provide access to more research than possible with funding from a single organization.

SwRI is home to several automotive consortia, such as the Advanced Fluids for Electrified Vehicles (AFEV) consortium, which seeks to advance industry understanding of electric and hybrid vehicle fluids, and the Electrified Vehicle and Energy Storage Evaluation (EVESE) program, which provides test data for member-selected sets of battery cells, among others.

IMAGE COURTESY SwRI D025805

NEW MILESTONE FOR SwRI-LED SOLAR MISSION

The SwRI-led Polarimeter to UNify the Corona and Heliosphere (PUNCH) mission passed an internal system integration review, clearing the way for a pre-environmental review ahead of its planned launch in 2025. Three of the four PUNCH spacecraft will include SwRI-developed Wide Field Imagers (pictured) optimized to image the solar wind. The dark baffles in the top recess allow the instrument to image objects over a thousand times fainter than the Milky Way.

UPCOMING

WEBINARS, WORKSHOPS and TRAINING COURSES HOSTED by SwRI:

Tolerance Stack Analysis Webinar, June 26, 2024, virtual.

Turbomachinery Design Training Week, September 9-13, 2024, in-person.

Lean Manufacturing Certification Program, October 2024, in-person.

Geothermal Energy Machinery and Systems (GEMS) Workshop, November 19-20, 2024, in-person.

TRADESHOWS:

Advanced Clean Transportation Expo, Las Vegas, May 20, 2024, Booth No. 1655.

ARPA-E Energy Innovation Summit, Dallas, May 22, 2024, Booth No. 1336.

Carbon Capture & Storage Summit/Biodiesel Summit, Minneapolis, June 10, 2024, Booth No. 509.

American Society for Microbiology (ASM) Microbe, Atlanta, June 13, 2024, Booth No. 1522.

Eurosatory, Paris, France, June 17, 2024, Booth No. C268.

EPRI Nondestructive Evaluation (NDE) Technology Week, Hilton Head, South Carolina, June 17, 2024.

NSMMS and CRASTE Joint Symposia, Madison, Wisconsin, June 24, 2024, Booth No. 62.

Hydrogen Technology Expo North America, Houston, June 26, 2024, Booth No. i90.

Controlled Release Society Annual Meeting, Bologna, Italy, July 8, 2024, Booth No. 63.

Institute of Food Technologists (IFT) First Conference, Chicago, July 14, 2024, Booth No. 3428.

International Society of Biomechanics in Sports, Salzburg, Austria, July 15, 2024.

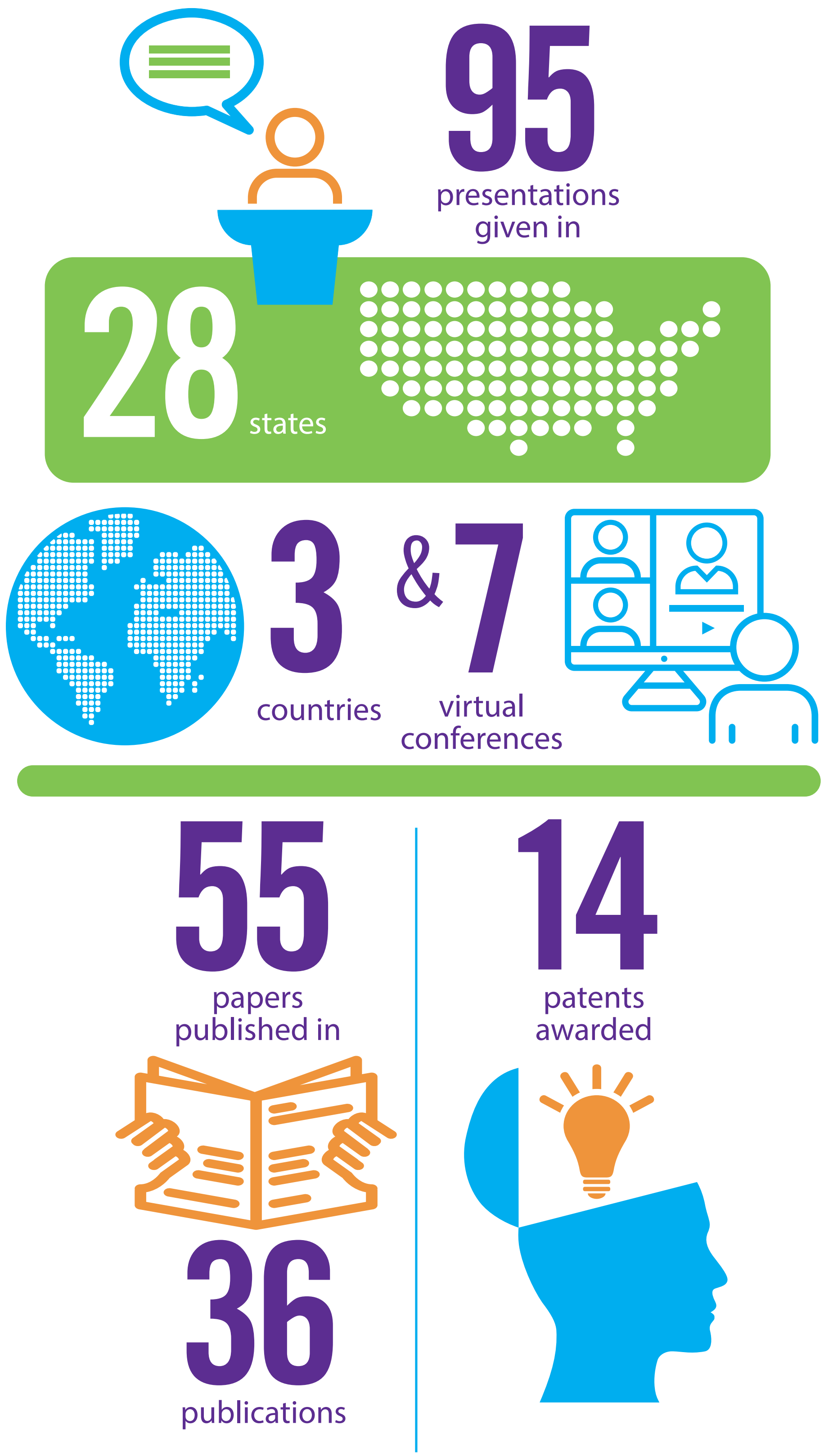
Microencapsulation Industrial Convention, Frankfurt, Germany, July 22, 2024.

Life Cycle Industry Days (LCID) & Wright Dialogue with Industry (WDI), Dayton, Ohio, July 29, 2024, Booth No. 317/319.

For more information on upcoming events visit newsroom.swri.org.

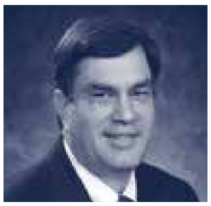
BY THE NUMBERS

Fall 2023–Spring 2024




D022877

David Brown has been selected to serve as a 2024-2026 Distinguished Lecturer by the IEEE Systems Council. With more than 30 years of experience in the defense industry, Brown is a staff engineer in the advanced electronic warfare department operating out of the Institute's Warner Robins, Georgia, office. Brown is one of just eight distinguished lecturers selected.


D026614

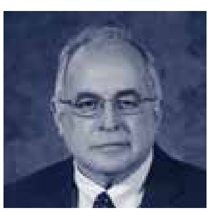
Dr. Steve Dellenback, vice president of SwRI's Intelligent Systems Division, will join the U.S. Department of Transportation's Transforming Transportation Advisory Committee (TTAC). The 27 committee members represent diverse perspectives from academia, the public sector, labor and industry, offering insight in automation, cybersecurity, safety, entrepreneurship and more.


D026626

SwRI's Lead Safety Engineer **Matthew Herron**, M.S., P.E., CSP, CPE, has been named the American Society of Safety Professionals (ASSP) Council on Practices and Standards 2023 Safety Professional of the Year. The award recognizes Herron's outstanding achievements and contributions to ASSP's practice specialty and common interest group communities.


D026622

Dr. Nicholas Mueschke has been named an Associate Fellow of the American Institute of Aeronautics and Astronautics. AIAA selected Mueschke for "significant contributions in developing leading-edge testing capabilities for hypersonics research, development, testing and evaluation efforts leveraging SwRI's ballistic facilities."


D026623

Jose Navarro has been named vice president of SwRI's Applied Physics Division. He previously served as acting vice president of the division. As vice president, Navarro will oversee a staff of nearly 100, working in two departments. Since 1984, he has been involved in numerous efforts incorporating analog, digital, radio frequency/microwave, magnetics, fiber optics and embedded microprocessors.


D026615

Kevin Shannon, a manager in SwRI's Fuels and Lubricants Research Division, has been awarded ASTM's prestigious Daniel H. Green Award. The award, presented annually by the ASTM International Committee on Engine Coolants, recognized his role in developing standards for the engine coolants industry, addressing a wide range of technical challenges.


D026613

Dr. Alan Stern, associate vice president of SwRI's Space Sector, has been named a Fellow of the American Institute of Aeronautics and Astronautics. Fellows have made notable, valuable contributions to the arts, sciences or technology of aeronautics and astronautics, and Stern was cited for his role in the exploration of the solar system and the development of commercial spaceflight.

TECHNOLOGY
TODAY

Director of Communications
Maria Stothoff

Editor
Deb Schmid

Assistant Editor
Lisa Peña

Contributors
Jesús Chávez
Robert Crowe
Joanna Quintanilla
Maria Stothoff
Tracey Whelan

Design
Jessica Vidal

Illustration
Isaac Herrera
Bill Livermore

Photography
Ian McKinney
William Luther

Circulation
Cecilia Novak

Address correspondence to the Editor, Communications Department, Southwest Research Institute, 6220 Culebra Road San Antonio, Texas 78238-5166, or e-mail **dschmid@swri.org**.
To be placed on the mailing list or to make address changes, call 210.522.2257 or visit **update.swri.org**.

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Southwest Research Institute® (SwRI®) is a premier independent, nonprofit research and development organization. With eleven technical divisions, we offer multidisciplinary services leveraging advanced science and applied technologies. Since 1947, we have provided solutions for some of the world's most challenging scientific and engineering problems.

Technology Today® (ISSN 1528-431X) is published three times each year and distributed free of charge. The publication discusses some of the more than 4,000 research and development projects under way at SwRI.

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