
SwRI®
ANNUAL REPORT 2023

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FROM THE PRESIDENT

Southwest Research Institute drives science and technology into new territory with bold exploration, inspiring ideas and novel discoveries. SwRI is a research and development leader, forging ahead through the unknown to uncover creative solutions to the world's most challenging technical problems. And while our expertise transforms the science and engineering landscape, SwRI's guiding principles remain unchanged.

For 76 years, we have been dedicated to fulfilling our mission of conducting unbiased, independent research and development to benefit humankind. Then and now, we are committed to operating with the highest ethical standards. As an organization and as individual problem-solvers, we strive for excellence in all that we do, which is key to successfully serving our clients. With these fundamental values, we achieved remarkable things in 2023.

This year, the Institute won its 52nd R&D 100 award with the Wideband Conformal Continuous-Slot Antenna Array, a compact shipboard system designed with SwRI Internal Research & Development (IR&D) funds. The R&D 100 award program, by R&D World Magazine, is known as the "Oscars of Innovation" and recognizes the 100 most significant new technologies of the year.

The Space Foundation inducted the NASGRO® fracture control software, a past R&D 100 award winner, and the leaders of its development team into the Space Technology Hall of Fame®. The Hall of Fame recognizes technologies that began as space programs and have since been adapted to improve the quality of life for all of humanity. Initially developed to support NASA's Space Shuttle program, the software is now used by companies worldwide to analyze spacecraft, aircraft and structures for fractures and fatigue. NASGRO collects data to determine the potential for growth of a small crack, which can prevent a catastrophic failure.

We continue to champion programs from Deep Sea to Deep Space®. In 2023, we used internal research and capital equipment funding to complete a new 30-inch-diameter deep sea simulation chamber for evaluating the quality and operation of components for oil producers, pipeline and subsea parts manufacturers, and the U.S. Navy.

And in space, SwRI pioneered a new era of space research. For the first time in our history, our IR&D program funded a scientist's flight to space, using a seat reserved more than a dozen years ago with an emerging commercial space enterprise. SwRI planetary scientist Dr. Alan Stern conducted suborbital research and training exercises aboard Virgin Galactic's VSS Unity, traveling over 50 miles above the surface of the Earth. The mission allowed him to collect valuable data firsthand in preparation for an upcoming NASA-funded flight.

Who we are as an organization is just as important as our work at SwRI. Guided by our steadfast principles, we uphold a diverse and inclusive work culture, where our staff is our greatest asset. SwRI thrives at the forefront of progress, looking toward what could be and how to make it happen.

The 2023 Annual Report offers a snapshot of additional recent SwRI accomplishments and many notable moments. Please take some time to peruse the document to learn more about the Institute's research programs, financial highlights and community contributions.

Adam L. Hamilton, P.E.
President & CEO

IR&D 2023

As a nonprofit research and development organization, SwRI invests in innovation, using our robust internal research and development (IR&D) program to expand and enhance our expertise and encourage our staff's professional growth. In 2023, SwRI initiated 103 IR&D new projects, investing more than $9.3 million in internal research, including quick-look and focused research programs. IR&D fulfills the Institute's objective of conducting innovative activities for the benefit of industry, the government and humankind.

Through internal research, we increase our technical capabilities, expand our reputation as a leader in science, and technology and invest in technology our clients may need in the future. 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, new clients and completely new research arenas within the Institute.

IMAGE COURTESY VIRGIN GALACTIC D026429

Funded by SwRI's longest running internal research program, SwRI's Dr. Alan Stern became the Institute's first astronaut, conducting preliminary research at zero gravity to support an upcoming NASA-funded flight to suborbital space aboard Virgin Galactic's VSS Unity.

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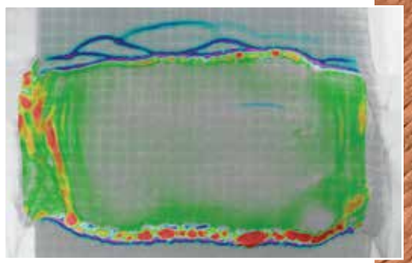

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Using internal research funding, SwRI scientists integrated our in-house expertise in digital photogrammetry and physical analog models to better simulate and quantify complex geologic processes on Earth and other planetary bodies.

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ON THE COVER:

The Sun's corona, its outermost atmosphere, is typically only visible to the naked eye during a total solar eclipse. The SwRI-led Citizen Continental-America Telescopic Eclipse (CATE) 2024 project evaluated special cameras to measure the polarization of coronal light during the April 2023 total solar eclipse in Exmouth, Western Australia. In this image, the colors indicate the polarization or orientation of the light. The white features, called prominences, have no polarization. For the Citizen CATE 2024 project, 35 teams of community volunteers will observe the path of totality for the April 8, 2024, total solar eclipse to make an hour-long movie of the polarized light from the Sun's corona.

D026451

D025779_3134

The $155 million, 10-megawatt supercritical carbon dioxide (sCO_2) STEP Demo pilot plant will demonstrate the next generation of higher-efficiency, lower-cost electric power technology.

D026441

Officials gathered for a ribbon cutting for the Supercritical Transformational Electric Power (STEP) test facility at Southwest Research Institute.

D026438

In 2023, Southwest Research Institute, GTI Energy, GE Vernova (GE) and the U.S. Department of Energy celebrated the ribbon-cutting of the Supercritical Transformational Electric Power (STEP) Demo pilot plant. The $155 million, 10-megawatt supercritical carbon dioxide (sCO_2) test facility at SwRI's headquarters in San Antonio will demonstrate a revolutionary new method of higher-efficiency, lower-cost electric power generation.

The STEP Demo pilot plant represents a shift toward more sustainable and efficient power generation and operated its main compressor with CO_2 at supercritical fluid conditions for the first time in 2023.

Conventional power plants heat water to create steam that drives electricity-generating turbines. In contrast, the STEP pilot plant is designed to use high-temperature sCO_2, which increases efficiency by as much as 10% due to its favorable thermodynamic properties. Carbon dioxide is nontoxic and nonflammable, and when CO_2 is held above a critical temperature and pressure, or in a supercritical state, it can act like a gas while having a density near that of a liquid. The sCO_2 power cycle technology can generate electricity from many heat sources including concentrating solar, geothermal, nuclear, and industrial waste heat. Supercritical CO_2 systems are also being developed as industrial heat pumps.

Another advantage to using sCO_2 as a working fluid is that STEP Demo's turbomachinery is approximately one-tenth the size of conventional power plant components, making it possible to shrink the footprint and construction cost of any new facilities. For example, STEP Demo's desk-sized sCO_2 turbine could power up to 10,000 homes.

The STEP Demo pilot plant is one of the largest demonstration facilities in the world for sCO_2 technology. The project's central goal is to dramatically improve the efficiency, economics, operational flexibility, space requirements and environmental performance of this new technology. SwRI, GTI Energy, and GE collaborated on the plant design, which was developed to evolve over time to keep pace with industry advancements. The facility's skid-mounted components provide flexibility and a unique, reconfigurable design.

SwRI is an industry leader in the development of sCO_2 power cycles. Staff members have conducted numerous DOE projects advancing the efficiency, reliability and commercial readiness of sCO_2 power cycle turbomachinery, heat exchangers, cycles and systems. The team brings extensive experience with sCO_2 technology and the key building blocks to make the STEP Demo project a success and a landmark demonstration.

STEP DEMO

STEP Demo's desk-sized sCO_2 turbine could power up to 10,000 homes.

D025779_3203

SwRI installed a gearbox connection driving the STEP main compressor at speeds up to 27,000 rpm.

D025037_8662

MILESTONES 2023

D026455/ D026452

The first images returned by NASA's Lucy spacecraft flyby of a small main belt asteroid showed that Dinkinesh has a moon. The inset image shows the "moonrise" of Dinkinesh's satellite at the point of closest approach. However, as more data was returned, a different perspective revealed that the satellite is a contact binary, made of two smaller objects touching each other, shown in the background "family portrait." Over Lucy's 12-year journey, the spacecraft will fly by eight target asteroids with three known satellites.

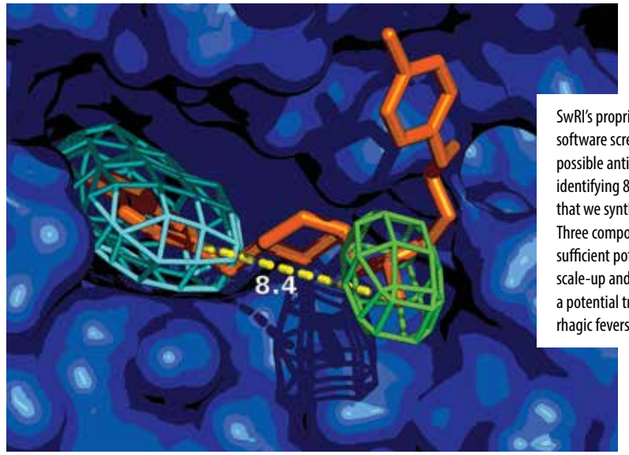
IMAGE COURTESY NASA/GODDARD/SWRI/JOHNS HOPKINS APL

PATENTS & inventions

42 U.S. PATENTS awarded

U.S. PATENT applications filed **34**

36 INVENTION disclosures submitted



D026445

SwRI's proprietary Rhodium™ software screened millions of possible antiviral compounds, identifying 88 viable candidates that we synthesized for testing. Three compounds exhibited sufficient potency to warrant scale-up and further evaluation as a potential treatment for hemorrhagic fevers, such as Ebola.

AWARDS

Dr. Frederic Allegrini: Professor Heinrich Greinacher Foundation Greinacher Prize
Dr. Tracy Becker: American Astronomical Society's Division for Planetary Sciences Carl Sagan Medal
Dr. David Ferrill: Gordon Atwater Best Professional Poster Award from the Gulf Coast Association of Geological Societies
Matthew Herron: 2023 Safety Professional of the Year by the American Society of Safety Professionals
Thomas Leone: Edward N. Cole Award from the Society of Automotive Engineers
Dr. Sarah Shaffer: 2023 James M. Wilson Award for Outstanding Equine Research Publication

517 PAPERS PUBLISHED

PODCASTS **15**

41 WEBINARS

PRESENTATIONS GIVEN **577**

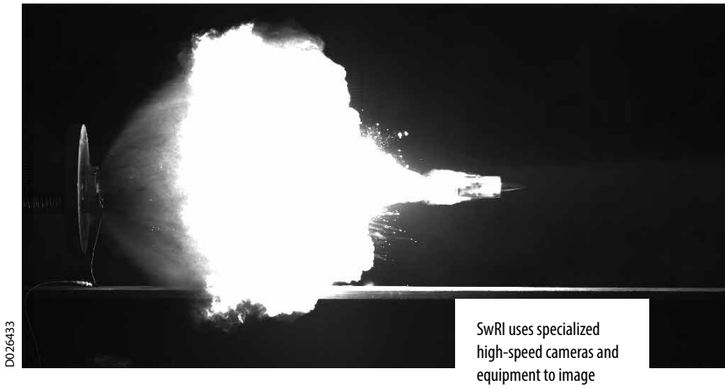
25 STREAMING MEDIA

HONORS

Dr. Robin Canup: appointed to National Academy of Sciences (NAS) Space Studies Board
Joseph Cardinal: inducted into 2023 class of Space Technology Hall of Fame with NASGRO®
Dr. Peter Lee: elected Fellow of the Society of Tribologists and Lubrication Engineers
Dr. Craig McClung: inducted into 2023 class of Space Technology Hall of Fame with NASGRO®
Dr. John Stamatakos: member of the NAS Committee on Geological and Geotechnical Engineering
Dr. Danielle Wyrick: elected Fellow of the Geological Society of America

3,129 EMPLOYEES

315 DOCTORATES
612 MASTERS
972 BACHELORS
223 ASSOCIATES



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SwRI uses specialized high-speed cameras and equipment to image hypersonic projectiles in flight, capturing and visualizing invisible features such as shock waves and turbulence, as this projectile launches at four times the speed of sound.

2023 R&D 100 WINNER

SwRI received a 2023 R&D 100 award recognizing the Wideband Conformal Continuous-Slot Antenna Array that collects signals to determine enemy locations as one of the top 100 inventions of the year. The innovative, compact antenna array — part of SwRI's AS-750 family of advanced antennas — operates in the super-high and ultra-high frequency bands of the electromagnetic spectrum. Measuring just seven inches in height (not shown to scale), this novel system can operate from a lower position on a ship mast, freeing up valuable space for higher-priority communications systems — a distinct advantage over comparable antenna technology.

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AUTOMOTIVE & TRANSPORTATION

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For over 40 years, SwRI has conducted extensive fuel surveys, procuring and analyzing samples from service stations across the nation. In 2023, the team conducted over 200,000 analyses of nearly 43,000 fuel samples.

For more than 75 years, Southwest Research Institute has been involved in nearly every facet of automotive and transportation research from powertrains to fuels and lubricants to intelligent highways and connected and automated vehicles. In 2023, many of these programs focused on sustainable mobility and transportation to lower greenhouse gas emissions. SwRI continued existing programs and launched new ones aimed at safe, low- and zero-emission, energy-efficient and affordable modes of transport, including electrified powertrains and alternative fuels. Connecting vehicles and intelligent infrastructure also offers solutions to mobility and safety on the road. SwRI develops a broad spectrum of automated driving systems with autonomy solutions for vehicles designed to traverse urban roadways, off-road environments and military battlefields.

AUTOMOTIVE

SwRI is investing in and expanding its research into hydrogen, a simple, carbon-free molecule that can fuel rockets and automobiles and store energy. We recently installed a 17,000-gallon liquid hydrogen tank on our main campus to provide a cost-effective, reliable supply of hydrogen to support a range of initiatives with this carbon-free energy source. For example, SwRI is leading a joint industry program to demonstrate the potential to replace heavy-duty diesels with hydrogen-fueled internal combustion engines as a pathway to eliminate greenhouse gas emissions in the transportation industry. Paired with SwRI's aftertreatment hardware and control strategies, this engine will produce only trace amounts of nitrogen oxide (NOx) and CO_2 emissions, offering an additional technology solution along with battery electric and fuel cell vehicles in the fight against climate change. SwRI also developed hydrogen powertrain and fuel cell research facilities to help the transportation industry develop new fuel cell technologies and improve the durability, reliability and performance of current fuel cell systems.

D026220_4085

SwRI offers several new, state-of-the-art emissions carts to enhance its emissions measurement and analysis capabilities.

Engineers demonstrate SwRI's new bench-scale test rig for fluids formulated for electric vehicles. The Institute specializes in creating custom tribology rigs and testing capabilities to allow industry to efficiently evaluate multiple lubricant formulations, without requiring full-scale testing.

D026432

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. Developed using internal research funding, 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.

An SwRI project funded by DOE demonstrated an average of 15% energy savings when connected and automated vehicles (CAVs) are integrated into traffic. The project used actual traffic data, specialized testing equipment and computer modeling to quantify the benefits of incorporating SwRI's eco-driving framework into different types of vehicles, studying how those vehicles affected traffic flow. According to the researchers, as more CAVs are introduced into traffic, roadway efficiency improves enough to, under the right conditions, reduce overall energy consumption by 15% without affecting trip time and traffic flow. The program built upon SwRI research funded by DOE's NEXTCAR program.

SwRI completed a nearly 10-year, comprehensive initiative to reduce NOx by 90% in future heavy-duty diesel trucks for the California Air Resources Board, the EPA and heavy-duty truck OEMs. The engine achieved this significant NOx reduction without increasing fuel consumption or carbon dioxide production. Datasets from this program will inform technology standards for the upcoming 2027 EPA emissions requirements.

To help the heavy machinery industry meet net-zero emissions goals, SwRI engineers are studying how to cost-effectively electrify mine hauling trucks, which can measure up to 65 feet long and weigh roughly 500 tons. Using internal research funding, researchers developed rigorous test setups to evaluate and characterize mechanical, electrical and thermal abuse for battery technology designed to power massive mine hauling trucks. SwRI developed tests to simulate the environments, altitudes, shock and vibration scenarios, crush potentials and fire safety issues that a mine hauling truck might face during continuous, 24-hour operations.

As the automotive and transportation industry transitions from internal combustion engines toward electric and hybrid-electric powertrains, SwRI is studying fuels and lubricants to ensure they are optimized and adapted to these new environments. With more than 70 years of experience working with engines, fuels and lubricants for traditional drivetrains, SwRI is well-positioned to study how fluids perform in electrified drivetrains through internally funded projects and industry collaboration.

In 2020, SwRI launched the Advanced Fluids for Electrified Vehicles (AFEV) consortium to help industry develop and optimize EV fluids and advance the design of EV powertrains. This year, AFEV grew and evolved to meet specific industry needs. SwRI is leading two complementary, internally funded projects to characterize the real-world stresses to fluids in electric or hybrid-electric vehicles and assess a "failed" fluid at the end of its life. The two programs involve running a battery electric vehicle and plug-in hybrid for the equivalent of 100,000 miles on SwRI's mileage accumulation dynamometers. Researchers take periodic fluid samples from these vehicles to understand how electrification affects fluid degradation and breakdown over time.

SwRI is also studying how the electric currents and magnetic fields produced by EVs influence fluid environments, leading EV lubricant aeration testing with a new custom test stand. Researchers recently modified commercial tribology testing devices to accurately test friction and wear associated with fluids operating in electrified environments.

SwRI chemists have launched a study to better understand the fluid chemistry involved in heat oxidation of vehicle catalyst systems. A team of SwRI fluid and lubricant researchers are examining how proposed next-generation, carbon-reducing technologies might affect fluids and how variables — such as the addition of hydrogen, nitrogen and ammonia to engines as well as stray voltages from electric drivetrains, etc. — might affect vehicle system longevity. Through this internally funded program, SwRI will be prepared to address future client challenges.

D026439

SwRI evaluated eco-driving-enabled vehicles using modeling, test tracks and dynamometers, finding that, as connected and automated vehicles are introduced in traffic, overall roadway efficiency improves, decreasing energy consumption by 15% without affecting trip time and traffic flow.

D026440

D026450

SwRI exposed a cryogenic storage tank filled with liquid natural gas to a pool fire, demonstrating that its pressure release system performed as designed, maintaining tank integrity.

To support SwRI sustainability goals, engineers outfitted several test cells with regenerating drives to absorb engine power, converting up to 90% into electricity to offset power consumption or feed into the grid.

D026220_4688

SwRI paired this hydrogen demonstration engine with low-NOx aftertreatment and control strategies, paving the way for future heavy-duty trucks that produce only trace amounts of NOx and CO_2.

D026220_4131

The Institute's cost-effective bench-scale testing capabilities allow clients to test multiple lubricant formulations efficiently, accelerating lubricant optimization, improving hardware durability and increasing vehicle range through reduced friction. Similar benchtop efforts are ongoing, with SwRI engineers working to modify an industry standard oxidation test to include testing for oxidation in an electrified environment.

For over 40 years, SwRI has conducted major national fuel surveys evaluating fuel samples collected from retail service stations across the nation. Over the years, SwRI has developed a network of independent contractors to collect pump nozzle samples and prepare them for shipment to SwRI for testing. In 2023, SwRI received nearly 43,000 samples and conducted over 200,000 analyses on these samples.

SwRI launched an extensive two-year effort to update its powertrain engineering testing capabilities, including 30 engine test cells that often operate 24 hours a day, seven days a week, 365 days a year. We are upgrading four of these cells with state-of-the-art dynamometers, emissions measurement technology and associated infrastructure to support longer, more robust testing.

To update fuels and lubricants test facilities and automotive infrastructure in preparation for new testing categories and an overall expansion of project scope, SwRI added new cooling towers, updated high-voltage and high-amperage electrical breakers, and installed regenerating drives, allowing dynamometers to recover energy and offset power consumption or feed into the grid.

Developed using internal research funding, this patented ECTO-Lab™ burner technology ages catalyst systems 10 times faster than traditional techniques, evaluating the systems' life cycles more efficiently.

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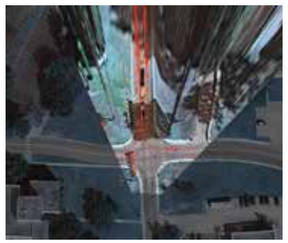

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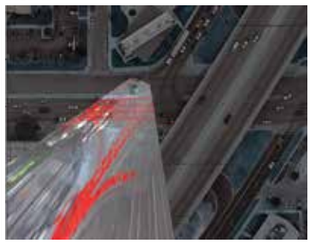

Using SwRI's Active-Vision software, a new tool automatically assigns a vehicle's GPS location based on its proximity to a traffic camera. This technology will allow clients to position traffic cameras wherever desired, providing opportunities for new metrics.

D026427

TRANSPORTATION

SwRI is a leader in intelligent transportation technology, developing traffic management systems used by a growing number of organizations and agencies to improve traffic flows on increasingly congested roadways. We are improving integration of state and local systems with new data streams to enhance mobility and safety with machine learning, networks and cloud-based solutions.

A quarter of the United States' population travels roads supported by SwRI-developed Intelligent Transportation Systems (ITS) deployed by state and local transportation agencies. In 2023, SwRI added two new states to its ActiveITS™ advanced traffic management system deployments. Puerto Rico, Oregon, California, Utah, New Mexico, Texas, Kansas, Arkansas, Tennessee, Kentucky, Florida, Pennsylvania, Maryland, Vermont, New Hampshire and Maine all use ActiveITS to manage their roads. We are developing a browser-based client interface to improve accessibility.

We are developing and deploying a data exchange system for the Florida Department of Transportation that will also be adapted

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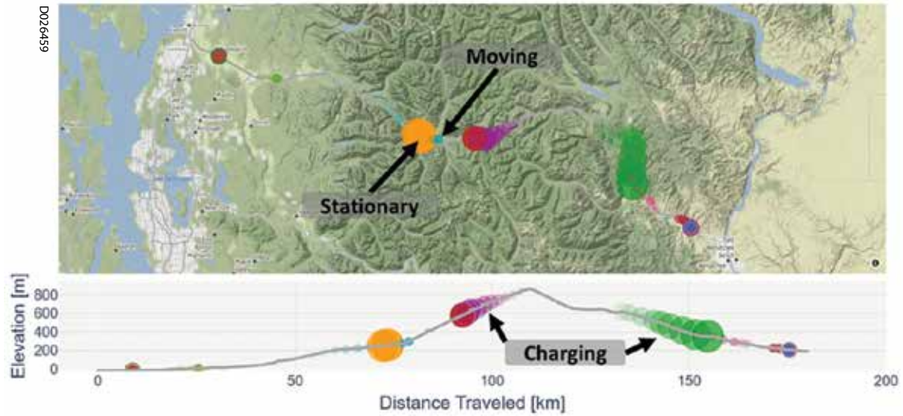


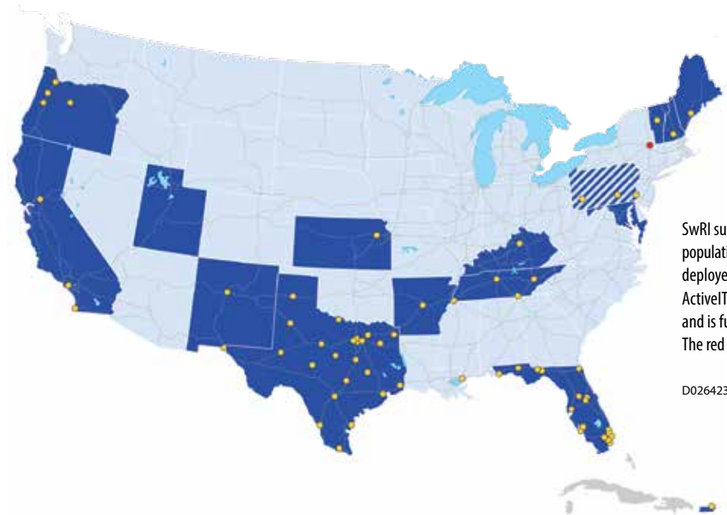
ALTRIOS software simulated a route through the Cascade Mountains in Washington state, showing a battery-electric locomotive's state of charge (indicated by the dot size). ALTRIOS accounts for trains stopping to allow others to pass (orange), battery usage as trains climb mountains (red) and regenerative battery charging as trains descend the mountain (green).

for use by the Pennsylvania Department of Transportation. The system integrates high volumes of information from connected vehicles and other transportation data sources, processing data in real time to detect and address actionable roadway conditions. It also archives vast quantities of data for research and analytics to aid in transportation planning, roadway safety improvements and other advances.

The Tennessee Department of Transportation recently went live with the Interstate-24 Smart Corridor system using the SwRI-built SmartWay Central Software platform. Initially focusing on lane control signs and variable speed limits, the corridor has already reduced accidents by 20–40%. An artificial-intelligence-based decision support system developed by Vanderbilt University will be integrated by SwRI to further reduce accidents and decrease the propagation of traffic slowdowns. Additional development will manage the arterial diversion of traffic during major incidents to enhance throughput and mitigate roadway congestion.

SwRI created a computer vision system that assigns a real-time GPS location to vehicles based on its proximity to a traffic camera. The auto-localization capability featured in SwRI's Active-Vision software can recalibrate the localizing system in a robust, accurate way. This technology will allow our clients to expand beyond a handful of preset configurations and let them position traffic cameras wherever desired, enabling speed detection and traffic volume measurements while also detecting incidents like stalled vehicles and wrong-way drivers.

SwRI is also helping the freight rail industry assess decarbonization technologies with an open-source modeling and simulation software. ALTRIOS — the Advanced Locomotive Technology and Rail Infrastructure Optimization System — simulates the real-world impacts and expenses related to adopting alternative energy locomotive technologies and expanding associated infrastructure. SwRI's Locomotive Technology Center shared its modeling and locomotive expertise with the National Renewable Energy Laboratory (NREL), the University of Texas at Austin, the University of Illinois Rail Transportation and Engineering Center and BNSF Railway. The project was funded by the U.S. Department of Energy Advanced Research Projects Agency–Energy. ALTRIOS is available for download at the NREL website.



SwRI supports over a quarter of the United States population with Intelligent Transportation Systems (ITS) deployed by state and local transportation agencies. ActiveITS is fully deployed statewide in dark blue states and is fully deployed in cities indicated by yellow dots. The red dot indicates a pilot program city.

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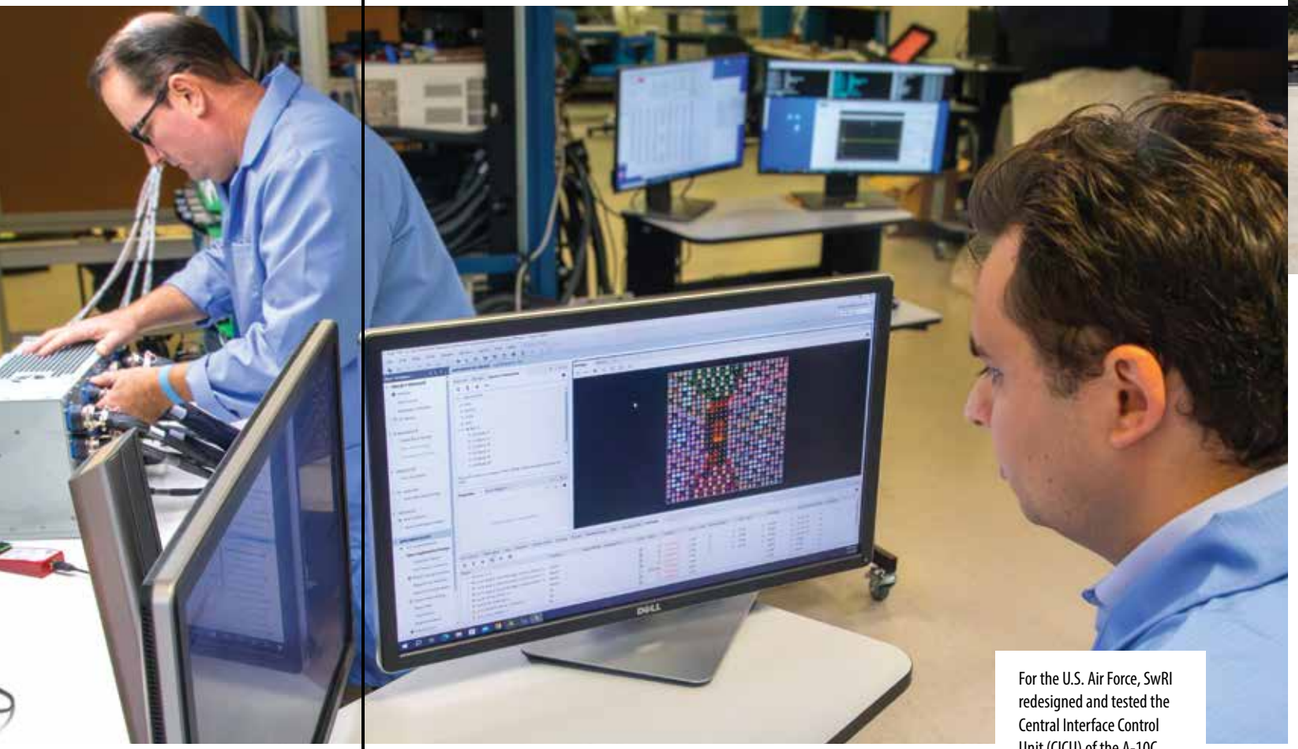
DEFENSE & SECURITY



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For the U.S. Air Force, SwRI redesigned and tested the Central Interface Control Unit (CICU) of the A-10C Thunderbolt II. The CICU serves as the aircraft's main mission processor controlling data to guide the pilot.

Southwest Research Institute is on the forefront of radiofrequency solutions and cybersecurity defenses. With more than 70 years of research and development in communications intelligence (COMINT), signals intelligence (SIGINT) and electronic intelligence (ELINT), SwRI advances existing technologies and breaks ground to deliver the next era of COMINT, SIGINT and ELINT solutions. SwRI signal acquisition and analysis technology, tools and techniques detect, intercept and interrupt a range of radiofrequency signals to support air-, sea- and ground-based operations. These activities provide direction finding, geolocation, situational awareness, tracking, and search and rescue, supporting efforts to thwart adversaries.

D026184_6840

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SwRI helped the U.S. military develop, integrate and test robotics systems on ground vehicles ranging from ATVs to trucks and vehicles that transport heavy equipment. This work included autonomy, cybersecurity, and systems modeling and simulation R&D.

SwRI's powerful electronic warfare (EW) technology detects and defeats enemy signals on the electromagnetic spectrum to protect U.S. and allied forces. As enemy signals continually evolve and change, SwRI stays ahead of emerging threats, providing unmatched EW solutions and enhancing safety and security for military assets. New technology is designed for interoperability, allowing quick and efficient component updates without a total system replacement or redesign.

Institute initiatives support an intelligence accord between the U.S., Australia, Canada, New Zealand and the United Kingdom for technology and data sharing. SwRI's most recent work for the Royal Australian Navy includes designing, building and delivering maritime communications electronic support equipment. SwRI is providing shipboard antennas for data collection and below-deck equipment. These include SwRI-developed algorithms that process signals, allowing operators to make immediate data-based decisions.

The Defense Advanced Research Projects Agency (DARPA) selected SwRI to develop small, light, inexpensive low-power distributable nodes to monitor high-frequency (HF) radio signals. The nodes will provide scalable and secure communications, to improve warfighter situational awareness and support devices deployed more than 1,000 kilometers apart. As part of DARPA's Cancun Program, the nodes will record and relay portions of the HF radio band for analysis. SwRI will complete the first phase of the program in December 2024.

For decades, SwRI has been involved in form, fit, function and replacement activities to modernize the U.S. Air Force's aging fleet of aircraft. The B-1B Lancer is a long-range, supersonic bomber, which has served the Air Force since 1986. In 2023, SwRI engineers redesigned the B-1B's Fuel Center of Gravity Management System (FCGMS), which tracks fuel usage and controls fuel transfer to the aircraft's four turbine engines, while calculating corrections to the bomber's center of gravity as fuel is depleted. The FCGMS update extends the B-1B's service life, ensuring the system can support the aircraft's next phase of service.

D026201_4277

In 2023, SwRI updated portable technology to deliver a slippery anti-traction material that effectively denies mobility and access to selected areas, making it impossible for people or vehicles to traverse.

D026201_4333

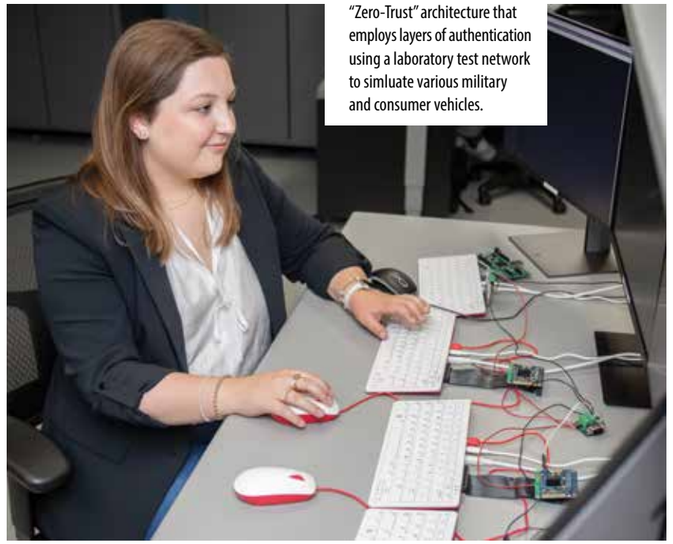
D026352_8326

SwRI developed a maritime communications electronic support system for the Royal Australian Navy, which includes an antenna, signal processing equipment and operator display technology.

D026352_8304

In 1978, the Air Force began using the A-10 for close air support of ground forces, search and rescue, and forward air controller missions. SwRI has supported A-10 advancements for over 30 years, most recently redesigning the A-10C Thunderbolt II Central Interface Control Unit (CICU), the aircraft's main mission processor. The CICU handles the digital stores management system, providing smart weapons and situational awareness data to the pilot. The upgrade increases CICU reliability and fortifies the unit hardware to withstand extreme environmental temperatures and vibrations from the aircraft's seven-barrel Gatling-style autocannon. In 2023, SwRI completed the design and integration of the CICU components, proving that the unit can run government-developed flight software. Integration testing is underway, and flight testing is expected to begin in early 2024.

As a leader in neuromorphic processing, SwRI is exploring how advanced artificial intelligence and neuromorphic engineering can help protect military troops and assets. Neuromorphic engineering models computers after the human brain with spiking neural networks that mimic human data processing. The computer "learns" more like a human, leading to faster processing and lower power consumption. SwRI is developing a cognitive EW architecture for airborne and shipboard applications integrating these next-generation technologies. Equipped with advanced AI power, cognitive EW quickly adapts to adversarial attempts to locate an aircraft or battleship, disrupting



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For automotive cybersecurity, SwRI evaluates a comprehensive "Zero-Trust" architecture that employs layers of authentication using a laboratory test network to simluate various military and consumer vehicles.

D026447

SwRI's Ultra-Wideband Receiver is an adaptable, "continuously staring," next-generation electronic warfare system, using cutting-edge algorithms to detect advanced enemy radar signals. The open-system-based receiver can be integrated into existing defense systems.

electromagnetic signals on the spot to confuse the enemy and conceal friendly forces. Cognitive EW controls the electromagnetic spectrum to strengthen protection and defense.

SwRI engineers used internal research funding to develop the Audio Localization for Team Communication (ALT-C) platform. The prototype drop-in system is designed to give the impression of a sound source as emanating from a direction within a 3D environment, a critical capability for military, first responder and security radio communications. Integrating binaural audio could help users identify the locations of other users intuitively, through the perceived 3D directional representation of the incoming audio. During this program, the technical team successfully implemented a real-time spatial audio processing algorithm onboard a microprocessor. The system receives incoming audio from a standard two-way radio, using onboard GPS and inertial measurement units to assign direction and elevation information to the audio. The audio can then be played into the receiver's headset in real time with imperceptible delay.

SwRI is also advancing cutting-edge hypersonics technology, exploring materials science, aerodynamics, propulsion, manufacturing and system performance. The Institute is home to a range of ballistic launch facilities and flight ranges providing extreme hypersonic flight environments that cannot be achieved in wind tunnels. In the last year, engineers used SwRI's ballistic facilities to evaluate the aerodynamics of novel system designs, demonstrate unique laser-based diagnostic techniques, and probe high-temperature chemical reactions around hypersonic test articles in new and innovative ways.

SwRI continues to develop automotive cybersecurity solutions to protect proliferating embedded electronics and networks in vehicles. Staff members identified weaknesses in conventional approaches to protect individual components, exploring a comprehensive "Zero-Trust" (ZT) architecture that employs layers of authentication. ZT requires devices to prove their identity rather than assuming trust. SwRI demonstrated ZT in laboratory test networks to simulate consumer and military vehicles.

ENERGY & ENVIRONMENT

D026333_7909

The United States and many other countries have set goals to reach carbon neutrality by 2050 or sooner. To achieve this target, entire economies will need to decarbonize, including their energy sectors. Transitioning gradually from fossil fuels using carbon-neutral hydrogen gas could offer a natural progression away from carbon-based fuels.

D026446

As energy companies explore blending hydrogen into natural gas streams to curb carbon emissions, SwRI is studying the possible impact on existing infrastructure, evaluating natural gas pipelines and flow meters to assess their performance with blended gases.

D026321_7369

SwRI chemists are collaborating with professors from Tecnológico de Monterrey in Mexico to develop techniques to recycle and reuse industrial rubbers and plastics. Researchers characterize the industrial materials to develop biobased compounds and create environmentally friendly raw materials.

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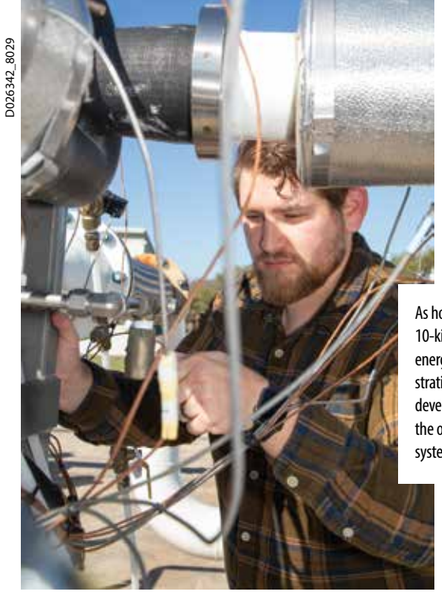


As home to a full-scale, 10-kilowatt pumped heat energy storage demonstration facility, SwRI is developing and validating the operations and control system technology.

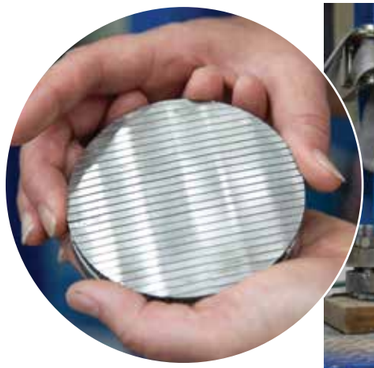
In 2023, SwRI scientists traveled to Turkey as part of the National Science Foundation's Geotechnical Extreme Events Reconnaissance program to observe and document liquefaction-related damage following a series of devastating earthquakes in February.

Blending hydrogen into natural gas streams could curb carbon emissions for conventional natural gas power generation using existing national pipeline infrastructure and conventional power generation machinery. However, steel pipelines are susceptible to a phenomenon known as hydrogen embrittlement. SwRI is evaluating how hydrogen affects the mechanical performance of pipeline materials by performing mechanical tests in high-pressure hydrogen gas environments for fracture-mechanics-based integrity and fitness-for-service assessments to support these efforts.

In 2023, SwRI also investigated using existing natural gas distribution infrastructure to supply homes and businesses with natural gas blended with carbon-neutral hydrogen, as gas companies propose using these gas blends in the next decade. Because the density of the resulting blends would be significantly different than natural gas alone, flow meters calibrated to measure natural gas will have some error when measuring blended gases. It is critical to accurately quantify the energy transferred from the gas distribution companies to individual customers once hydrogen is added. In 2023, SwRI assessed the performance of four common flow meters using blended gas, measuring the density and energy content of the blends at common temperatures and pressures.

Supercritical carbon dioxide (sCO_2) is carbon dioxide held above its critical temperature and pressure, where it has high density and fluid properties that change rapidly with temperature. These characteristics enable highly efficient and compact power generation systems but make turbomachinery and component design challenging. SwRI is a leader in sCO_2 power cycles, collaborating with the Department of Energy on more than 20 projects demonstrating the feasibility of the power cycle and developing machinery and components to support it. The STEP Demo project featured in the front of the report is a culmination of this research, which is expected to lead cleaner and more efficient energy production.

As the renewable electricity market grows, so does the need to develop cost-effective long-duration energy storage technologies to stabilize electrical grids integrating variable, intermittent green energy sources, such as wind turbines and solar photovoltaic farms. SwRI is developing new technologies, including the successful commissioning and operation of a pumped thermal energy storage demonstration system. Engineers are also designing cryogenic turbomachinery for liquid air



D026324_7239/ D026324_7260

SwRI has created and validated innovative methods to evaluate the performance and durability of sand screens used in oil and gas production wells, characterizing erosion as particles pass through the screen gaps.

energy storage, creating pump-as-turbine designs for geomechanically pumped storage and advancing aerogel technology to improve hydrogen storage density. The team also developed a software tool through the internally funded "Project Z," evaluating zero-carbon generation and storage technologies to optimize pathways for net-zero electricity production at SwRI's San Antonio campus.

The electric utility industry is striving to modernize the electric grid to more effectively match supply and demand, which can fluctuate drastically over the course of days, weeks and seasons. The industry is experimenting with storing excess energy in batteries. However, the safety and long-term effects of using batteries this way are unclear. As part of a recently completed, 28-month Battery Energy Storage System for Electric Grid joint industry program, SwRI engineers used internal funding and in-kind member support to develop a unified model to chart the performance degradation, capacity and fire hazards associated with using a lithium-ion cell for mixed grid duty. SwRI developed a grid-connected research battery to support the program, and the models developed are available for evaluation and licensing in early 2024.

Since 1987, SwRI has operated the Center for Nuclear Waste Regulatory Analyses (CNWRA®) as a federally funded research and development center to assist the U.S. Nuclear Regulatory Commission (NRC) with responsibilities associated with radioactive waste storage, transportation and disposal. Under contracts renewed in Spring 2023, CNWRA experts provide the NRC technical assistance and research support on advanced reactor fuel, artificial intelligence, defense radioactive wastes, commercial low-level wastes and other technical areas. CNWRA scientists have also supported the NRC's natural hazard assessments, including technical support for the development of seismic engineering guidance for nuclear facilities in the U.S. Beyond its primary mission of providing technical assistance to the NRC, CNWRA staff led a committee evaluating earthquake hazards at a nuclear power plant site in South Africa. SwRI staff are also collaborating on a worldwide next-generation liquefaction project to develop models to better predict the triggering and consequences of earthquake-induced soil liquefaction, when water-saturated but otherwise solid soil temporarily behaves as a viscous liquid in response to seismic shear waves.

D026344_8381

SwRI developed the m-Presa™ modular structural steel buttress dam designed to reduce the time and expense associated with constructing reservoirs for closed-loop pumped storage hydropower systems for long-term energy storage.

D026442

Using internal research and capital equipment funding, SwRI completed the design and fabrication of a 30-inch-diameter deep sea simulation chamber for evaluating the quality and operation of components for oil producers, pipeline and subsea parts manufacturers, and the U.S. Navy.

In 2023, SwRI developed a process for converting wood pulp into a refinery feed from a renewable carbon source. A life-cycle assessment performed by the client found that the SwRI process was carbon-negative as well.

D026320_7615

SwRI evaluated the erosion resistance of sand control screens used in oil and gas production wells to keep formation and fracturing sand in the reservoir while allowing fluids to be produced. Fine formation sands, smaller than the screen gaps, periodically pass through the screens, causing screen erosion that can eventually lead to failure, potentially endangering production equipment. SwRI research evolved to include advanced 2D and 3D microscopic image processing techniques to characterize screen performance, quantifying the material loss and how it changes over time, which allows operators to schedule maintenance or decommissioning before a failure occurs.

SwRI provides exploration and production support to oil and gas companies, using structural geology and geomechanics to optimize hydrocarbon production. SwRI recently initiated the third phase of our Permian Basin Consortium, integrating outcrop- and core-based observations of mechanical stratigraphy and natural deformation to support the energy industry.

For decades, SwRI has created custom systems to create high-pressure subsea and downhole conditions, commissioning pressure vessels in six different countries to specific client needs, jurisdictional requirements and ASME standards. The Institute is now home to a 30-inch-diameter test chamber with a unique geometry and fast-acting closure. Developed with internal research and capital improvement funding, this chamber will support evaluating the quality and operation of components developed by oil producers, pipeline and subsea parts manufacturers, and the U.S. Navy.

SwRI engineers and scientists develop and validate novel processes to upgrade and refine fuels and other high-value products from unconventional sources, using custom catalysts, pilot plants and laboratory facilities. In 2023, SwRI supported the development of a process for converting wood pulp into a refinery feed. These chemicals are developed from a renewable carbon source instead of fossil fuels. A life-cycle assessment performed by the client found that the planned commercial process was carbon-negative as well.

Water quality and availability remain important global and local concerns, particularly in association with climate change. SwRI continues to focus on water resource management issues across Texas and in the Mexican border region using field- and lab-based hydrochemistry, applying remote sensing techniques to better characterize ecosystem health and hydrologic vulnerability.

In a good stewardship program for the Department of Energy, SwRI is collecting potentially hazardous radiation sources from university labs and hospitals. The Institute uses a high-capacity crane and other facilities to repackage and prepare the materials for transport.

D026431

EARTH & SPACE

D026025_0449

IMAGE COURTESY SwRI/UNH

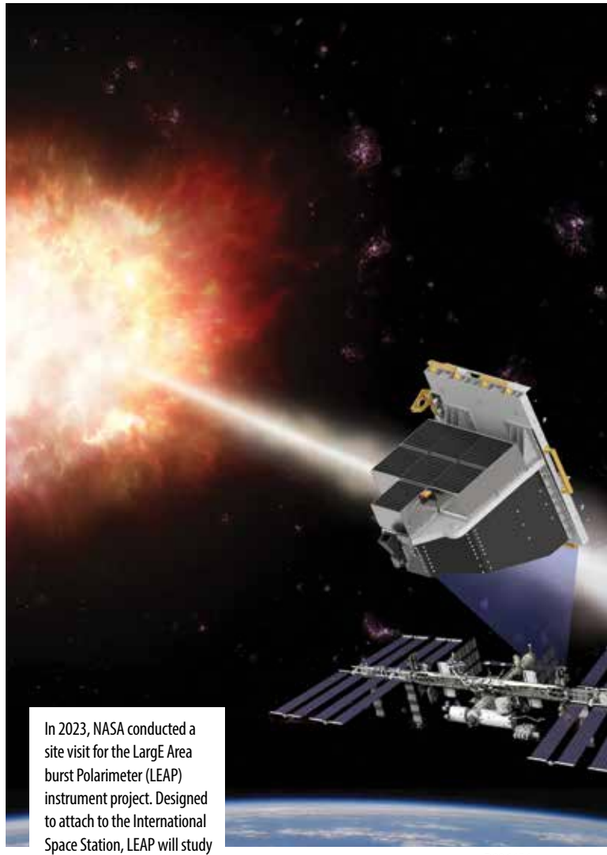
From aboard the Lunar Vertex lander, the Magnetic Anomaly Plasma Spectrometer (MAPS) will study the interaction of the solar wind with surface materials on the Moon, particularly lunar swirls that correspond with anomalous regions of magnetic rocks.

Southwest Research Institute is home to one of the nation's leading space science and engineering programs, conducting fundamental and applied research and developing innovative technology for commercial companies and government agencies worldwide. In 2023, SwRI reorganized its space science program and added a new building to support tremendous growth in the small satellite and commercial spaceflight arenas. The Institute's strong Earth science expertise complements our space research.

In addition to investigating space phenomena and developing payload instruments, electronics and spacecraft, SwRI scientists are leading five space missions. The Juno mission continues to explore Jupiter and its moons, while New Horizons proceeds through the Kuiper Belt, exploring the edge of our solar system. The four Magnetospheric Multiscale (MMS) spacecraft continue studying magnetic reconnection in the Earth's magnetosphere. And the Polarimeter to UNify the Corona and Heliosphere (PUNCH) mission, which will explore connections between the solar corona and solar wind, made major progress in 2023, integrating and testing four spacecraft and five instruments in preparation for a 2025 launch.

The Lucy mission to Jupiter's Trojan asteroids added a new flyby target in early 2023, a small main-belt asteroid now named Dinkinesh, to test drive the spacecraft's novel terminal tracking system. Designed to keep tabs on a target as the spacecraft flies past at 10,000 miles per hour, the system performed flawlessly, and the Lucy team discovered that Dinkinesh was not just two objects, the main asteroid and a moonlet, as first imaged, but that the moonlet itself is a contact binary — two smaller objects touching each other. Over Lucy's 12-year mission, the spacecraft will observe eight target asteroids with three known satellites, including the newly discovered moonlet now named Selam.

In 2023, NASA selected SwRI to lead the Center for Lunar Origin and Evolution (CLOE), which will conduct basic research to support science enabled by human exploration of the Moon as well as the Endurance-A mission concept, a far-side lunar rover mission. SwRI will also lead a NASA/NOAA lunar lander/rover instrument suite, Dating an Irregular Mare Patch with a Lunar Explorer, or DIMPLE, designed to expand our understanding of the Moon's volcanic history. DIMPLE will use cameras and radioisotope-based dating to determine the age and composition of an anomalously young-looking patch of basalt named Ina. It will use the first-ever, purpose-built radioisotope-rock-dating instrument for use in space, called CODEX (Chemistry Organic and Dating Experiment), which was initially developed using SwRI internal funding.



In 2023, NASA conducted a site visit for the LargE Area burst Polarimeter (LEAP) instrument project. Designed to attach to the International Space Station, LEAP will study distant energetic events, such as the birth of black holes and death of massive stars.

D026454

SwRI evaluates space systems, such as SmallSats, in a new aerospace acoustic test chamber outfitted with six speakers that can collectively produce up to 150 decibels, simulating the harsh, complex acoustic environments associated with rocket launches.

D026225_5288

SwRI delivered the innovative MASPEX instrument for integration and functional testing on the Europa Clipper spacecraft. MASPEX has a mass resolution hundreds of times finer than anything that has flown to space before.

D026456

In 2023, SwRI delivered three instruments for spacecraft integration, including the Mass Spectrometer for Planetary Exploration (MASPEX) instrument for NASA's Europa Clipper spacecraft. Along with SwRI's Ultraviolet Spectrograph (UVS) delivered in 2022, MASPEX will investigate gases around the Jupiter moon and its potential habitability. The Lunar Magnetotelluric Sounder (LMS) is being integrated into a lunar lander scheduled to arrive at the Moon in 2024 to measure the electrical conductivity of its subsurface. SwRI also delivered the Magnetic Anomaly Plasma Spectrometer (MAPS) for NASA's Lunar Vertex mission to study how the solar wind interacts with the Moon's surface materials in anomalous regions of magnetic rocks.

SwRI continues its work on NASA's Interstellar Mapping and Acceleration Probe (IMAP) mission, which completed its critical design review in 2023, managing its payload office, providing the scientific instrument Compact Dual Ion Composition Experiment (CoDICE), and participating on other instrument teams for the mission. IMAP will study the interaction between the solar wind and the interstellar medium as well as the fundamental processes of particle acceleration in space.

SwRI's Solar Wind Plasma Sensor (SWiPS) for a NASA/NOAA space weather satellite mission is built and undergoing evaluation. SWiPS will measure the properties of solar wind ions, including the very fast ions associated with coronal mass ejections that interact with the Earth's magnetic environment. The Institute is also developing a cost-effective, high-resolution space-based infrared imaging system, Pleaides, that can be optimized to map wildfires or detect methane pipeline leaks in real time. Designed

In 2023, SwRI integrated and tested three Wide Field Imagers for the PUNCH mission, which will study the inception of the solar wind.

D025805_3405

IMAGE COURTESY NASA/JPL-CALTECH/SwRI/MSSS/BJÖRN JÓNSSON © CC NC SA

During Juno's extended mission, the NASA spacecraft flew past Jupiter's volcanic moon Io, capturing JunoCam images from a distance of only 7,260 miles. JunoCam images are processed by citizen scientists around the world.

D026419

SwRI developed a micrometeoroid and orbital debris (MMOD) detector to find potentially dangerous small objects in low Earth orbit (LEO), addressing challenges associated with increasing numbers of LEO satellites.

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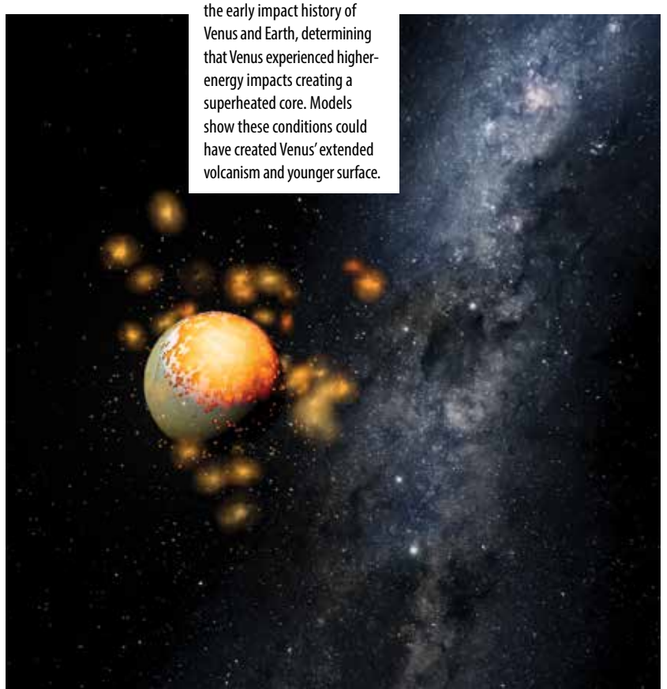

An SwRI-led team compared the early impact history of Venus and Earth, determining that Venus experienced higher-energy impacts creating a superheated core. Models show these conditions could have created Venus' extended volcanism and younger surface.

D026417

for SmallSat constellation deployment, Pleaides uses machine-learning-based algorithms to rapidly and autonomously process, detect and map data.

NASA and NOAA selected SwRI to develop Quicksounder, the first project in NOAA's Near Earth Orbit Network. For this pathfinder mission, SwRI will develop the spacecraft, integrate NOAA's Advanced Technology Microwave Sounder Engineering unit, qualify the observatory, deliver for launch and operate the mission for three years. QuickSounder will support NOAA's next-generation satellite architecture development for its future low-Earth orbit program, providing weather forecasting, climate monitoring and environmental observation for years to come.

While the number of satellites in low Earth orbit (LEO) is increasing exponentially, potentially destructive LEO objects less than 4 mm in size cannot be detected using current technology. SwRI has developed a unique micrometeoroid and orbital debris (MMOD) detector to identify the location and size of small objects as well as their impact velocity, angle and nature by analyzing impact-generated strain waves between a pair of additively manufactured aluminum plates. This detector can be mounted on a spacecraft to understand the MMOD environment at various orbits.

SwRI heliophysicists took on several new, exciting projects in 2023. Institute scientists will create unique data of the April 8, 2024, solar eclipse through two groundbreaking, simultaneous projects. Scientists will image the solar corona in infrared light from NASA's high-flying WB-57 scientific aircraft and in polarized white light from a series of 35 separate observing stations spaced along the path of totality through the Citizen Continental-America Telescopic Eclipse 2024 project. The Southwest Solar Coronagraph (SwSCOR) effort, initially developed with internal funding, also won a Phase A contract, a definition-phase study to develop the next generation of operational instruments to forecast space weather with live images of the Sun's corona and solar events.

SwRI is leading two "Precursor Science Investigations for Europa" teams to understand critical topics in advance of NASA's Europa Clipper mission to the Jupiter moon. Both projects are investigating the connection between Europa's icy surface and its subsurface, which is thought to

contain a potentially habitable ocean. One project will specifically track 3D ice shell evolution and material exchange between the surface and subsurface to predict the features likely to provide the best information and context for interpreting Clipper data. The second project will identify compositional signatures of subsurface environments, track how they evolve due to transport processes and then use machine learning to process related laboratory data from the MASPEX engineering model.

SwRI is collaborating with the University of Western Sydney and the International Centre for Neuromorphic Systems to investigate new sensor technology for space applications. These sensors would emulate the functionality of the human brain, greatly reducing the processing required and data generated for space applications ranging from docking to Earth observation and astrophysics research.

SwRI scientists are researching additively manufactured microchannel plates to detect signals from electrons, ions, x-rays and gamma rays. Using additive manufacturing to create microchannel plates can improve collection efficiency, amplification control and thermal resistance, which could lead to a new generation of space science and Earth observation instruments.

Using internal research funding, staff conducted field work in the high arctic region of Canada to develop techniques to understand the microbiology of subterranean icy environments to ultimately drive developments for future missions in search of life, including in the Martian subsurface.

SwRI is developing new software and testing tools to support the emerging field of space robotics. The Maturing Adaptable Space Technologies project is developing software that models robotic motion in the challenging environment of space. To simulate microgravity, the new Space Robotics Center will conduct nearly frictionless planar motion testing using a robotic arm and a granite slab. Surrounding trusses use motion capture cameras and lighting to support video analysis of the motion data.

In another effort, we adapted source code from the SwRI-developed Cyclone Global Navigation Satellite System (CYGNSS) spacecraft to reduce the time and associated costs needed to develop, test and demonstrate flight software.

SwRI is providing the CoDICE instrument for the IMAP mission. CoDICE combines the capabilities of multiple instruments into one patented sensor to measure the distribution and composition of interstellar particles entering our solar system.

D026420

To simulate microgravity, a new space robotics facility will conduct nearly frictionless planar motion testing using a collaborative robot and a large granite slab.

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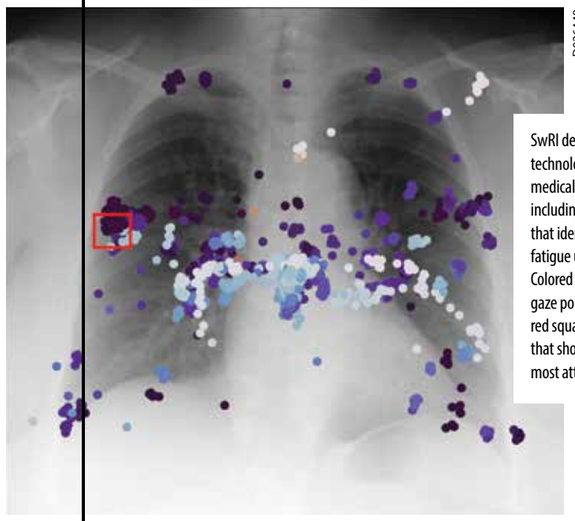
HEALTH & BIOMEDICAL



D026448

SwRI develops technology to support medical professionals, including an algorithm that identifies radiologist fatigue using gaze data. Colored spots represent gaze points, while the red square is the area that should receive the most attention.

Southwest Research Institute supports the biomedical and health care industry, developing biomaterials and pharmaceuticals while supporting human performance, product evaluation and food safety studies.

An internally funded research project launched the development of a perfusion-based bioreactor platform to manufacture biopharmaceuticals such as CAR-T cells, stem cells, exosomes and viral vector vaccines. SwRI licensed the technology to a third party in the CAR-T cell field. We are also working with other biomanufacturing companies to license the technology for other fields of use. SwRI continues to develop the technology as well as the enabling methodology to use it, including the ability to produce induced pluripotent stem cells, which are reprogrammed animal and human differentiated cells that can be transformed into multiple cell types.

SwRI has developed several promising compounds as broad-spectrum antivirals targeting hemorrhagic fevers, including the Ebola, Marburg and Sudan strains. Chemists used SwRI's proprietary Rhodium™ 3D modeling software to produce a pharmacophore model, the ensemble of features and structures needed to interact with a specific viral target and inhibit its ability to infect a host. Powered by artificial intelligence, Rhodium virtually screened millions of possible compounds, identifying 88 that were synthesized for testing. Three compounds exhibited sufficient potency to warrant scale-up and testing for safety and efficacy, helping SwRI close in on an effective treatment for these deadly diseases.

A new Human Performance Laboratory features a markerless motion capture system that allows SwRI to develop advanced biomechanical analysis tools with machine vision algorithms and data analytics.

D026376_9202

MANUFACTURING & RELIABILITY

D026237_5592

Engineers evaluate drones inside this one-acre tented area that does not require FAA flight approval.

Southwest Research Institute supports the manufacturing industry with advanced automation technology, creating adaptable tools and providing workforce training. We also help ensure that aging infrastructure and new products meet or exceed standards for safety, durability and performance. For more than 35 years, SwRI has been developing innovative automation and robotics solutions. World-class experts and experienced engineers work in automation engineering facilities, including state-of-the-art laboratories and large prototyping areas for development.

MANUFACTURING

SwRI celebrated the 10-year anniversary of ROS Industrial® (ROS-I), an open-source project that advances industrial applications of the Robot Operating System (ROS). SwRI helped found ROS-I and continues to support the organization by hosting training, organizing events and curating software repositories. SwRI's ROS-I innovations include robotic finishing techniques for cast metal components, enabling a human-in-the-loop to use simple tools such as paint pens to guide the robotic processing. In another robotics project, SwRI's open-source robotics tools allowed generalists to build advanced robotic applications using a unique computer-aided-design environment and end-user feedback.

For 28 years, SwRI has operated the Texas Manufacturing Assistance Center, supporting small and medium manufacturers in South Central Texas with automation and process improvement solutions. Regional demand for manufacturing assistance is growing with reshoring trends and growth in the automotive and semiconductor industries.

SwRI designed, fabricated and tested novel carbon-fiber-reinforced polymer composite components for high-risk applications. Engineers investigated using carbon nanotubes as hybrid reinforcements and evaluated adhesive bonding responses to surface preparations for these unique materials. The team is evaluating the structural integrity of the components using nondestructive acoustic analyses and standardized mechanical testing.

RELIABILITY

For more than 45 years, SwRI has supported the U.S. Air Force's Aircraft Structural Integrity Program, comprehensively evaluating airframes to extend the life of aging military fleets. In 2023, SwRI began developing digital twins of A-10 and T-38 aircraft. These digital representations of the aircraft contextualized in a digital simulation of their environment will help researchers understand real scenarios the airframes must withstand. SwRI also deploys robotics to sustain aircraft and to inspect infrastructure, including using autonomous drones.

Engineers recently converted a one-acre tented facility to evaluate unmanned aerial systems in a GPS environment. Operating a drone inside the contained space does not require FAA approval, allowing initial testing of unproven systems and flight algorithms. SwRI also maintains provisions to allow open-air testing of more mature systems on campus, providing a range of check-out capabilities.

To support condition-based maintenance, SwRI installed 500 sensors to monitor 64 installations at NASA's Johnson Space Center in Houston, so maintenance is performed as needed while avoiding unexpected failures and downtime.

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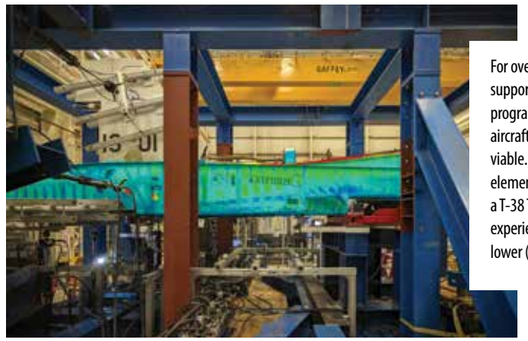
D026434



For over 45 years, SwRI has supported the USAF ASIP program to ensure aging aircraft remain structurally viable. This image shows finite element analyses overlaid on a T-38 Talon to indicate areas experiencing higher (red) and lower (blue) stress.

D026261_5679

SwRI adapted commercial equipment to develop a fully autonomous forklift capable of conducting warehouse operations on its own, keeping personnel away from hazardous materials while complying with industry standards.

D026238_5913/ D026238_6406

D026238_5811

SwRI designs, fabricates and evaluates novel carbon-fiber-reinforced polymer composite components for high-risk applications.

COMMUNITY CONTRIBUTIONS

D026396_0984

SwRI staff members collected a room full of gifts and bikes to donate to the U.S. Marine Corps Reserve Toys for Tots Program.

In 2023, Southwest Research Institute continued its long-standing support of the San Antonio community, including contributing more than $1.5 billion to the local economy.

In 2023, SwRI sponsored its 30th annual Young Engineers and Scientists program, a 13-day event followed by staff mentoring.

D026129_0533

For the first time, SwRI organized a team to participate in San Antonio's 2023 MLK March.

D025761_2169

D026426

SwRI staff volunteered for another first-time service event, helping prepare and serve 25,000 meals at the Raul Jimenez Thanksgiving Dinner.

SwRI employees and their families, the Board of Directors, advisory trustees, retirees, contractors and Signature Science staff members raised a record-breaking $1.3 million for the United Way, which included an SwRI contribution, exceeding the million-dollar mark for the fourth year in a row. During the campaign, staff members dedicated nearly 700 volunteer hours to local United Way organizations. SwRI President and CEO Adam Hamilton served as the 2023 United Way of San Antonio and Bexar County Community Campaign Chair.

Many of SwRI's community outreach efforts emphasize supporting science, technology, engineering and math (STEM) education, particularly for underrepresented populations. This year marked the 30th year that SwRI supported the SA BEST robotics competition and sponsored the 13-day Young Engineers and Scientists (YES) Program. For the second year, SwRI collaborated with Community of Churches for Social Action to provide renewable scholarships and internships to students who live in underserved communities. Other STEM support includes participating in career days, science fairs, STEM curriculum and mentoring students.

In addition, staff members volunteered with local agencies, logging more than 700 hours for the San Antonio Food Bank and delivering over 7,000 meals to homebound seniors through Meals on Wheels. SwRI's Research Recreation Association hosts monthly blood drives, which allowed employees to donate nearly 900 pints of blood in 2023. Other charitable initiatives included collecting 36 large boxes of school supplies for San Antonio students and donating a room full of toys and bikes for the U.S. Marine Corps Reserve Toys for Tots Program.

FINANCIAL HIGHLIGHTS 2023

STATEMENTS OF FINANCIAL POSITION | in millions of dollars

	For the year ended September 29, 2023	For the year ended September 30, 2022
Current Assets	$474	$443
Property & Equipment, Net	436	401
Other Assets	110	94
Total Assets	**$1,020**	**$938**
Current Liabilities	$164	$162
Noncurrent Liabilities	91	68
Net Assets	765	708
Total Liabilities and Net Assets	**$1,020**	**$938**

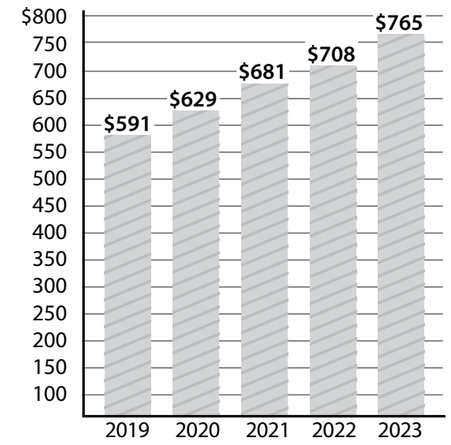
Consolidated revenues hit a record high of **$844** million

Consolidated net income from operations was **$33** million

Capital expenditures exceeded **$47** million

Internal research spending exceeded **$9.4** million

NET ASSETS | in millions of dollars



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