FALL 2026

SOUTHWEST RESEARCH INSTITUTE®

TECHNOLOGY TODAY®



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10 ENGINEERING ENERGY RESILIENCY

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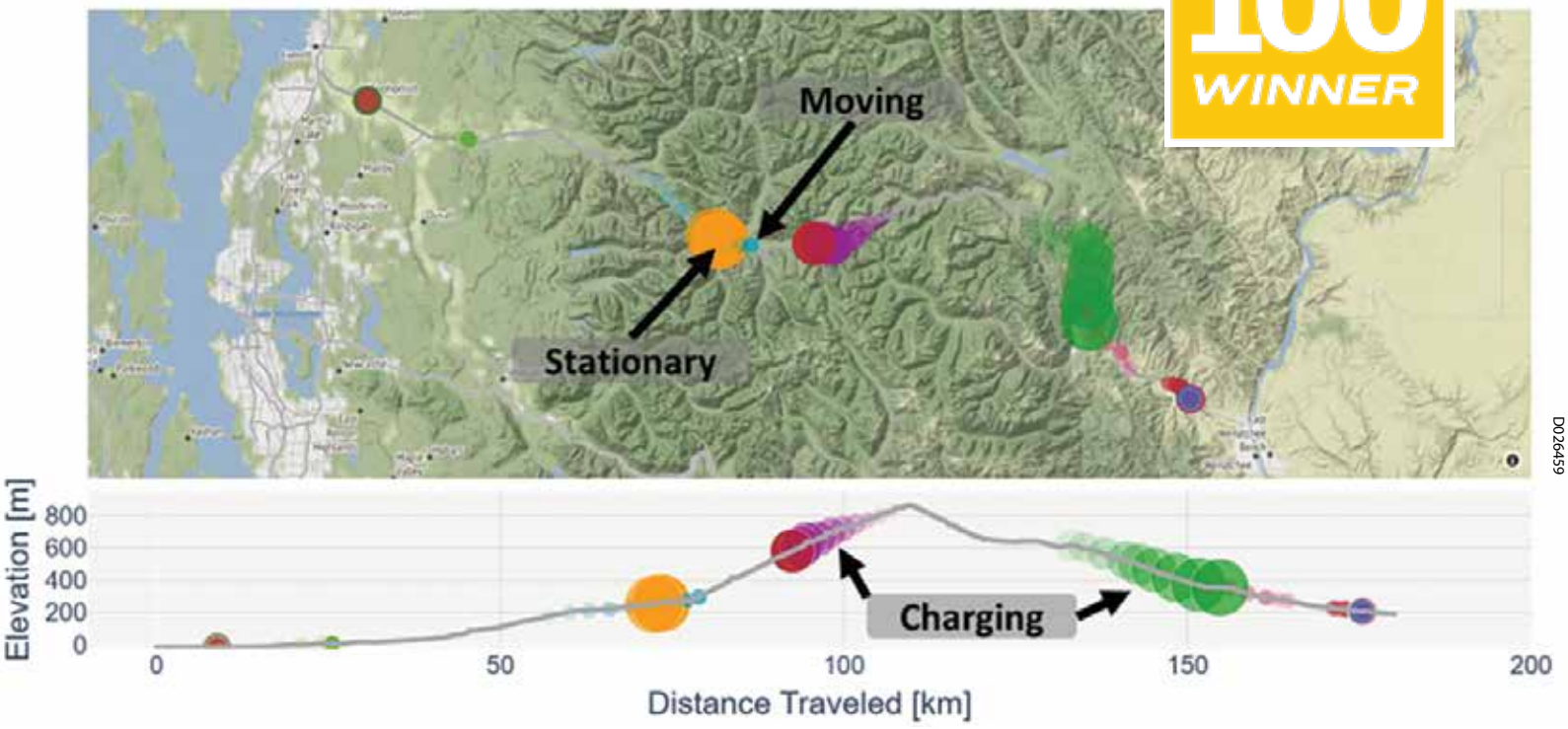
Two Southwest Research Institute-developed technologies have been selected as winners of prestigious R&D 100 Awards. R&D World magazine recognized SwRI's patented Parallelogram Synchronized Truss Assembly (PaSTA) technology and the Advanced Locomotive Technology and Rail Infrastructure Optimization System (ALTRIOS) as two of the most important innovations of 2026.

PaSTA uses a patented framework of interconnected elements in a truss structure to increase solar array stability and rigidity. That rigid structure is crucial for the precise docking maneuvers performed by an emerging class of solar-powered servicing spacecraft. For instance, SwRI is using PaSTA in the Provisioner refueling spacecraft it is building, integrating and testing for Astroscale U.S. and the U.S. Space Force.

Developed in collaboration with the U.S. Department of Energy's National Laboratory of the Rockies, ALTRIOS is the first fully integrated open-source tool that simulates the real-world impacts and costs of adopting new locomotive propulsion technologies. ALTRIOS simulates a route for a battery electric locomotive, with dot size indicating state of charge. The model accounts for train stops (orange), battery drain as trains climb mountains (red) and regenerative charging as trains descend (green).

R&D 100 WINNER

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FALL 2026 • VOLUME 47, NO. 3

TECHNOLOGY TODAY


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ON THE COVER

SwRI is building on decades of experience in off-road perception and automation to advance smart agriculture. These systems can help equipment "see" windrows and bales and automatically guide tractors and balers along the optimal path.

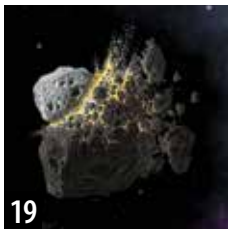
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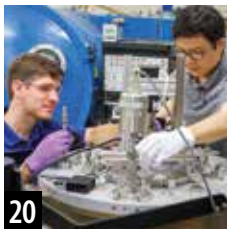
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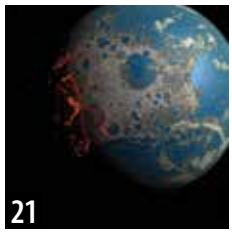
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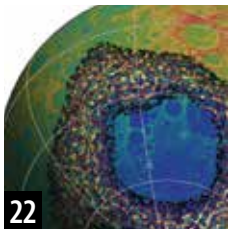
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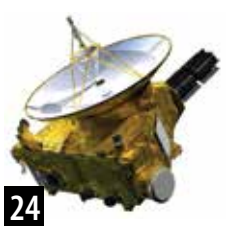

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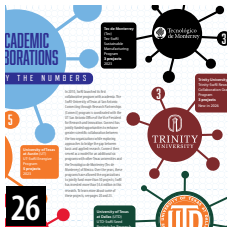


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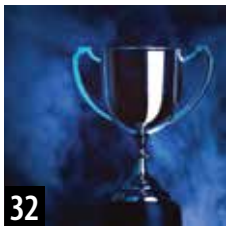


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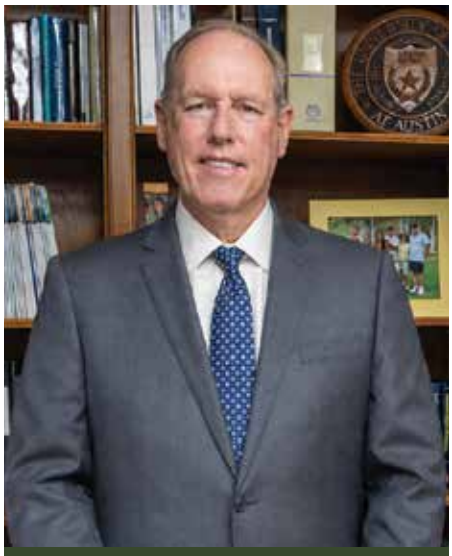
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IN THIS ISSUE

As a nonprofit contract research and development organization, Southwest Research Institute offers its clients a range of key advantages. Among our strongest assets is our ability to bring together scientists, engineers and analysts from different disciplines to offer fresh perspectives on challenging problems. These collaborations also extend beyond the Institute.

The cover story discusses adapting off-road autonomous operations developed for military applications to help meet growing global demands for food. Intelligent agriculture can help solve many of the challenges the farming industry faces today. SwRI is also collaborating with the University of Texas San Antonio to prepare the next generation of specialists in smart agriculture.

As we faced rising global energy prices in 2026, SwRI's multidisciplinary teams were already hard at work engineering energy resiliency for the future. We feature five diverse projects looking at a range of energy solutions and supporting technologies. These projects target enabling processes to make research and development less risky for our clients.

We also include an infographic highlighting seven collaborative programs SwRI has forged with universities in Texas and Mexico, with a focus on bridging the gap between basic and applied research.

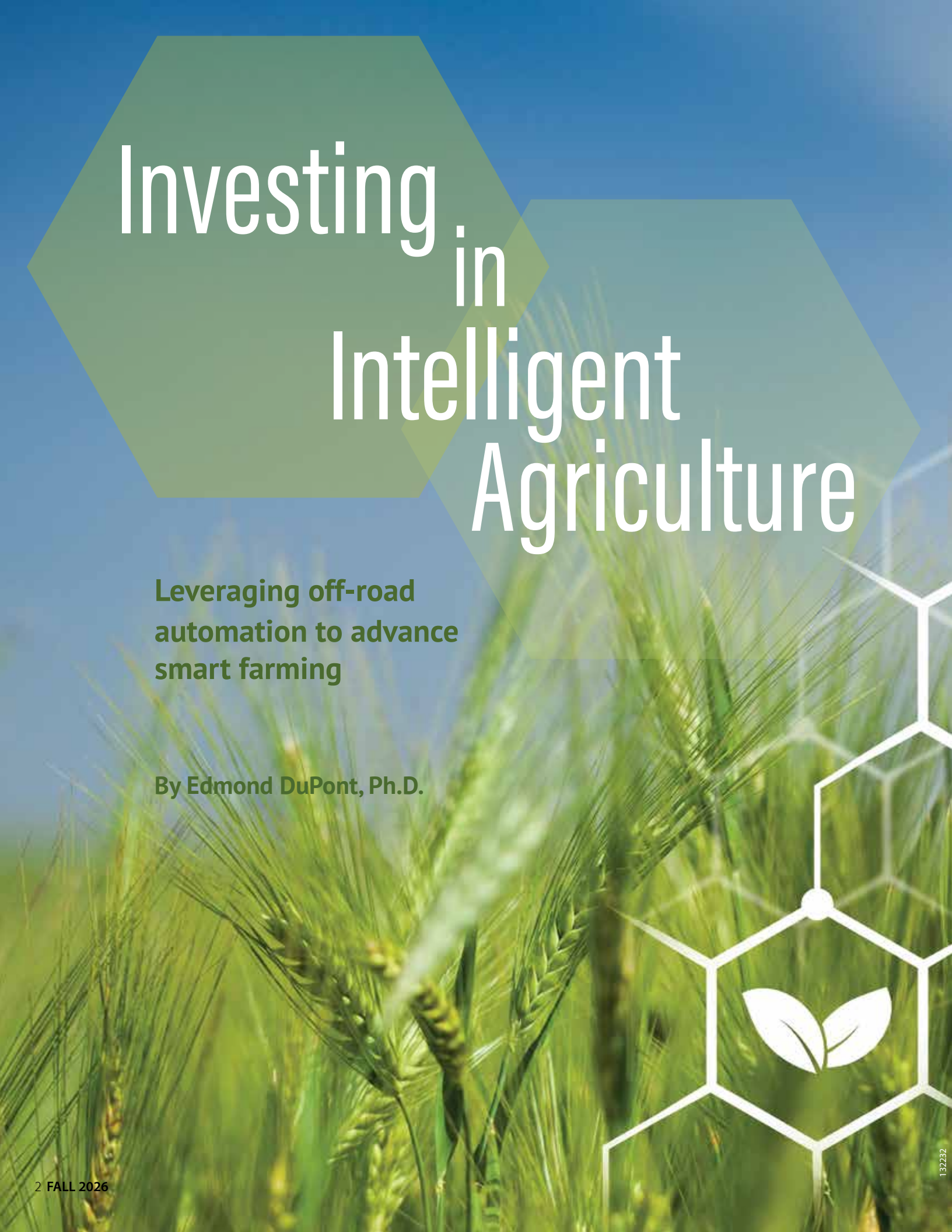
Read more about how SwRI brings together collaborative teams to create tomorrow's technical solutions in this issue of Technology Today.

Dr. Ben H. Thacker, P.E.
Chief Operating Officer

Investing in Intelligent Agriculture

Leveraging off-road automation to advance smart farming

By Edmond DuPont, Ph.D.



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Global food production must increase by 50-70% to feed world populations expected to increase from 8 billion to 10 billion by 2050. At the same time, the agriculture industry is facing seismic shifts as farmers and ranchers contend with multiple challenges from a shrinking labor pool to climate change, which affects water resources, growing seasons and migration patterns. Fortunately, advances in automation and robotics technology are enabling more precision in the field—from automated planting to real-time data on yields and soil conditions.

Southwest Research Institute has a long history of supporting the agriculture sector through research and development of technologies such as microencapsulation to control the release of agrochemicals and conducting chemical analyses of soil. More recently, SwRI's Intelligent Systems Division has invested in advancing autonomous systems that are increasingly being adapted for farming, vineyard management and other agricultural applications across the country.

Building on decades of experience in off-road perception and automation, SwRI is now advancing smart agriculture by adapting technologies originally developed for rugged military operations. Robust sensor fusion, computer vision and machine learning techniques enable autonomous systems to identify crops and obstacles while navigating uneven terrain and operating safely around workers.

These systems support tasks such as weed mitigation, automated harvesting and continuous monitoring of crop health and soil conditions, all aimed at reducing labor demands and improving resource efficiency. By tailoring its perception and autonomy solutions to the unique challenges of farms and ranches, SwRI is helping accelerate the transition to data-driven, resilient agricultural operations.

MACHINE VISION & PERCEPTION

Agricultural producers and farm managers have traditionally relied on manual operations in the fields. However, soil inspection, harvesting and pest or crop management are becoming increasingly difficult due to supply shortages, labor restrictions and changing environmental conditions. Smart agriculture technologies that use machine vision and perception are pivotal to overcoming these challenges. The new technology supports advanced operations in row crops, foraging and other production areas. SwRI offers deep expertise using a full array of visual technology deployed using aerial drones, ground vehicles and remote sensing.

In the forage industry, timing and precision can make the difference between producing premium-grade feed or experiencing reduced yields. Before hay can be rolled into round bales, it must be cut in long, uniform windrows and air-dried in the sun. After cutting and raking, tractor operators pull baling equipment, maintaining precise alignment along windrows for quality harvesting. Once bales are formed, they must be quickly located, collected and cleared from the field before the weather changes, a challenge for large acreage or hilly terrain. Smart

DETAIL

A windrow is a long, narrow row of hay or grain left in a field to dry, or a similar pile of material like snow, leaves or compost formed by wind, machinery or plows. Farmers usually rake hay in the same direction it was mowed or in a counter-clockwise loop around the field to help heavy stems dry and facilitate baling.



Outfitting agricultural tractors with machine vision allows detailed mapping of the environment, capturing row geometry, obstacles and crop locations to support advanced autonomous planning.





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SwRI developed intelligent systems to visualize rows of drying hay and automate baling operations.

DETAIL

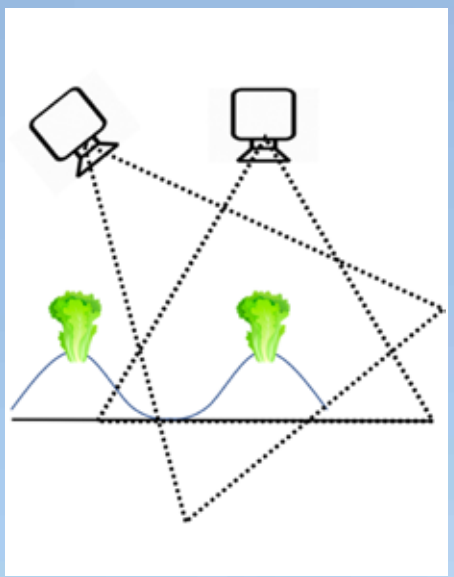
Farm implements are equipment typically attached to a tractor, such as plows, mowers, and harrows.

perception systems and machine vision can help equipment "see" windrows and bales and automatically guide tractors and balers along the optimal path. Identifying bales and mapping their locations for efficient collection reduces waste, operator fatigue and time spent in the field.

In May 2025, SwRI earned Patent No. 12,306,318 for its Synchronized Windrow Intelligent Path Estimator (SWIPE) used for hay baling equipment. This system combines advanced sensing with embedded intelligence to actively predict and lock onto the optimal path along a windrow. As it moves, the navigation-assisted technology not only tracks vehicle position and speed, but also continuously builds a rich profile of the windrow, capturing its size, density and direction and enabling more consistent bale formation with less operator effort.

Autonomously clearing a field of round bales introduced a new set of perception challenges, requiring detection of each bale's position and orientation with less than 5% error. Uneven and rutted terrain, variations in bale size and shape and fluctuating lighting over the course of a day made robust detection challenging. SwRI worked with a client to address these issues and integrated a tailored perception solution into their custom autonomous system to reliably locate, approach and collect bales across the field. Integrating advanced perception with intelligent machine learning allows the system to map each bale for collection while accurately assessing its orientation. This solution allowed consistent bale pickup, efficient routing and faster field clearing under real-world operating conditions. The technology helped a client win the award for Best Field Robot in the 2021 International Forum for Agricultural Robotics Future Farming category.

Row farming grows plants in straight, evenly spaced lines wide enough to let machinery or tools pass between them for tilling, weeding and harvesting. Weeds emerging alongside high-value crops and competing for the same limited resources present a



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SwRI's dual-camera visualization system observes plants in three dimensions, providing a richer dataset identifying weeds while assessing the health of the crop.





SwRI's advanced dual-view machine vision technology can "see" the crop row in detail, distinguish crops from weeds in real time and guide implements to act precisely where intervention is needed.

DETAIL

Spatial analysis examines the locations, attributes and relationships of features in geographic data to uncover patterns and make informed decisions.

challenge in these fields. Uniformity and quality are crucial for commercial crops, so even modest weed intrusion can reduce yields, increase costs and complicate harvest operations. Producers rely on a mix of mechanical tools, herbicides and lasers or scorching methods to manage weeds, often under tight timing windows, because interventions are most effective early in the growth cycle. At the same time, labor shortages, chemical regulations and requirements for consistent, documented practices are driving the industry toward more automated, data-driven solutions. Within this context, intelligent vision-based systems that can detect, classify and localize plant material in real time offer a path to more precise, efficient and scalable weed management in modern crop row production. These challenges create a clear need for intelligent perception technology that can "see" the crop row in detail, distinguish crops from weeds in real time and guide implements to act precisely where intervention is needed.

SwRI developed an intelligent perception system for crop row automation that uses a dual-camera configuration and advanced machine vision to support weed management in specialty crops. The system employs two synchronized cameras, a top-down view and an angled-side view, mounted on a client's weeding implement for each row. Together, these views feed neural networks and perception algorithms to simultaneously identify crop and weed plants and extract rich geometric features from the canopy. Unlike single-view approaches, this dual-view system provides a more complete understanding of plant structure and context within the row, enabling both precise weed targeting and deeper insights into crop condition.

SwRI's solution observes crops in three dimensions, analyzing features such as plant height, spacing and apparent vigor, while still reliably detecting weeds. By combining these perspectives, the perception system can inform not only about where to remove weeds, but also about crop uniformity, potential stress and overall quality indicators. This richer data opens the door to more sophisticated strategies, such as adjusting weeding intensity based on crop vigor or flagging areas of the field that may require additional attention. The perception system is designed to integrate directly with client implements that apply multiple weed mitigation strategies.

By combining advanced machine vision, dual-view sensing, and adaptable integration with multiple weed mitigation strategies, the SwRI-developed perception system helps growers automate critical tasks in transplant crops. Ultimately, this technology supports more efficient, sustainable crop production by turning visual information into actionable guidance for modern, automated weeding implements.

NAVIGATION, GEOLOCATION & MAPPING

For specialty farms such as orchards and vineyards, automation must operate in tight, unforgiving spaces where mistakes are costly. Equipment moves through narrow rows bordered by delicate vines, trellises or tree trunks, while the terrain may disguise hazards like gopher holes, ruts and uneven areas. Robust

navigation is crucial for operating in the row, avoiding contact that can damage plants or infrastructure, and maintaining safe, repeatable paths. Detailed mapping of the environment — capturing row geometry, obstacles and crop locations — supports advanced autonomous planning, allowing systems to optimize routes and adjust to changing field conditions. Together, reliable navigation and high-fidelity geolocation and mapping form the foundation for practical, scalable automation to produce high-value specialty crops.

Spatial analysis is vital for enabling intelligent tractors and field equipment to autonomously navigate specialty crops. SwRI developed the Intelligent Perception System for Agricultural Automation (IPSAA) to produce rich maps and gather data, providing information on daily and weekly growth. The system also supports integrated safety to detect pedestrians in the field while maintaining system guidance.

IPSAA fuses advanced sensor data from stereo cameras, lidar and GPS systems with data processing and environment modeling to provide off-road agricultural vehicles with a precise understanding of their surroundings and location. The system processes sensor data into depth, terrain and object information, then leverages GPS and visual odometry to fuse these input data into a robust localization solution to build feature-rich maps.

IPSAA supports navigation, obstacle awareness and data collection tasks crucial for automating operations for specialty crops, where tight rows, delicate plants and complex layouts demand accurate perception and

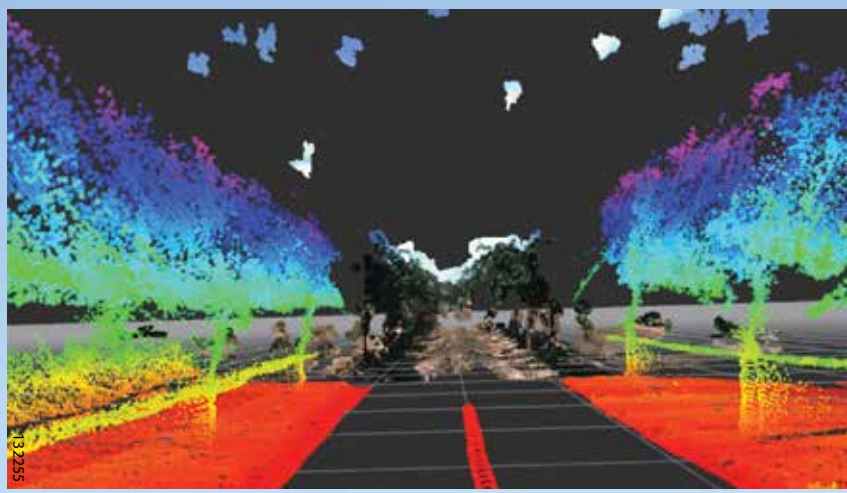


High-value specialty crops such as grapes require systems to operate in tight spaces where mistakes are costly. Advanced autonomous planning allows systems to optimize routes and adjust to changing field conditions.

DETAIL

Lidar, which stands for light detection and ranging, is a remote sensing method that uses pulsed laser light to create precise, 3D maps of objects and the environment.





SwRI developed the Intelligent Perception System for Agricultural Automation for vineyard operations, but the system can be applied to any farming application requiring navigation, obstacle awareness and data collection.

positioning. By globally registering data over multiple passes, IPSAA can capture detailed canopy structures, trellis locations and row geometry, enabling repeatable mapping across the growing season. Comparing these time-sequenced maps can support canopy management, yield estimation and evaluation of crop health trends. In addition, the high-fidelity environment representation improves precision navigation and obstacle avoidance within the rows, providing a foundation for targeted interventions and more efficient, data-driven specialty crop operations.

DETAIL

Edge computing brings computation and storage closer to the data source instead of relying on distant data centers.

INTERNET OF THINGS

Connecting farm equipment to networks, machine learning algorithms and distributed sensors is rarely straightforward, especially in fields with limited connectivity and harsh environments. Agricultural equipment operates in dusty, wet and vibration-heavy conditions, often far from reliable cellular or Wi-Fi coverage. SwRI is positioned to address these challenges by applying AI-powered Internet of Things (IoT) architectures that link edge computing, onboard sensors and cloud services into a cohesive system tailored for agricultural operations.

Conceptually, a tractor system could process sensor data using embedded machine learning models and then publish summarized maps and health indicators to a farm network when connectivity is available. These data streams can include multilayered environmental models — for example, canopy structure, trellis locations, and soil and terrain features — stored and indexed over time to support crop management. In parallel, pedestrian and obstacle detection classifiers run locally to enhance safety, while low-cost row guidance algorithms provide steering cues and positioning without requiring continuous high-bandwidth connections.

Sensor nodes on implements can also report status, usage patterns and anomalies back to centralized dashboards, enabling predictive maintenance and fine-tuning weed management strategies. By carefully partitioning intelligence between the edge and the cloud and using IoT messaging to synchronize perception, control and analytics, SwRI's solutions give growers actionable insights and automation capabilities even in connectivity-constrained, real-world specialty crop environments.



SwRI is collaborating with UT San Antonio to cultivate the next generation of specialists in smart agriculture and related research. Here, Combustion Group Lead Dr. Chris Thomas discusses energy projects, including a MW-scale direct-fired oxy-fuel combustion system incorporating supercritical carbon dioxide as the working fluid.



To remove farmers from hazardous situations, SwRI added a motion sensor to this tractor to help automate pesticide applications.

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THE FUTURE OF FARMING

Smart agriculture is rapidly evolving toward fleets of interconnected, autonomous systems that can sense, study, plan and act covering operations from soil preparation and planting to harvest and post-processing. Emerging technologies will combine advanced perception, robotics, edge AI and cloud analytics to deliver detailed insights on crop health, soil moisture and input efficiency, while enabling precise interventions such as targeted weeding, variable-rate spraying and automated harvesting.

With extensive expertise in offroad autonomy, sensor fusion and artificial intelligence, SwRI is positioned to drive this next wave of innovation across all aspects of agriculture. Building on current work in intelligent perception for row crops, specialty crops and the forage industry, SwRI can expand into projects for autonomy, intelligent implements and aerial drone applications, including automated fruit and vegetable harvesting, precision thinning and pruning, and canopy management using 4D mapping. SwRI's experience in industrial IoT and edge/cloud architectures will underpin scalable data platforms that integrate perception data with agronomic models, farm management software and other external services.

A key part of advancing smart agriculture will be cultivating the next generation of experts and accelerating technology transfer from research to field deployment. SwRI is collaborating with The University of Texas at San Antonio (UT San Antonio) through a joint program designed to train students in robotics, AI, sensing and agricultural engineering for real-world applications. Under this collaboration, SwRI engineers and scientists mentor UT San Antonio students working on applied projects on smart agricultural solutions, creating a talent pipeline skilled in both cutting-edge automation and practical agricultural constraints so that innovations remain grounded in growers' needs.

Questions about this article? Contact Dr. Edmond DuPont at (210) 522-3512 or edmond.dupont@swri.org.



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ABOUT THE AUTHOR:
Dr. Edmond DuPont, a principal engineer in SwRI's Intelligent Systems Division, has extensive experience in automated vehicles, particularly for off-road applications. He is applying that expertise to the growing field of intelligent agriculture.

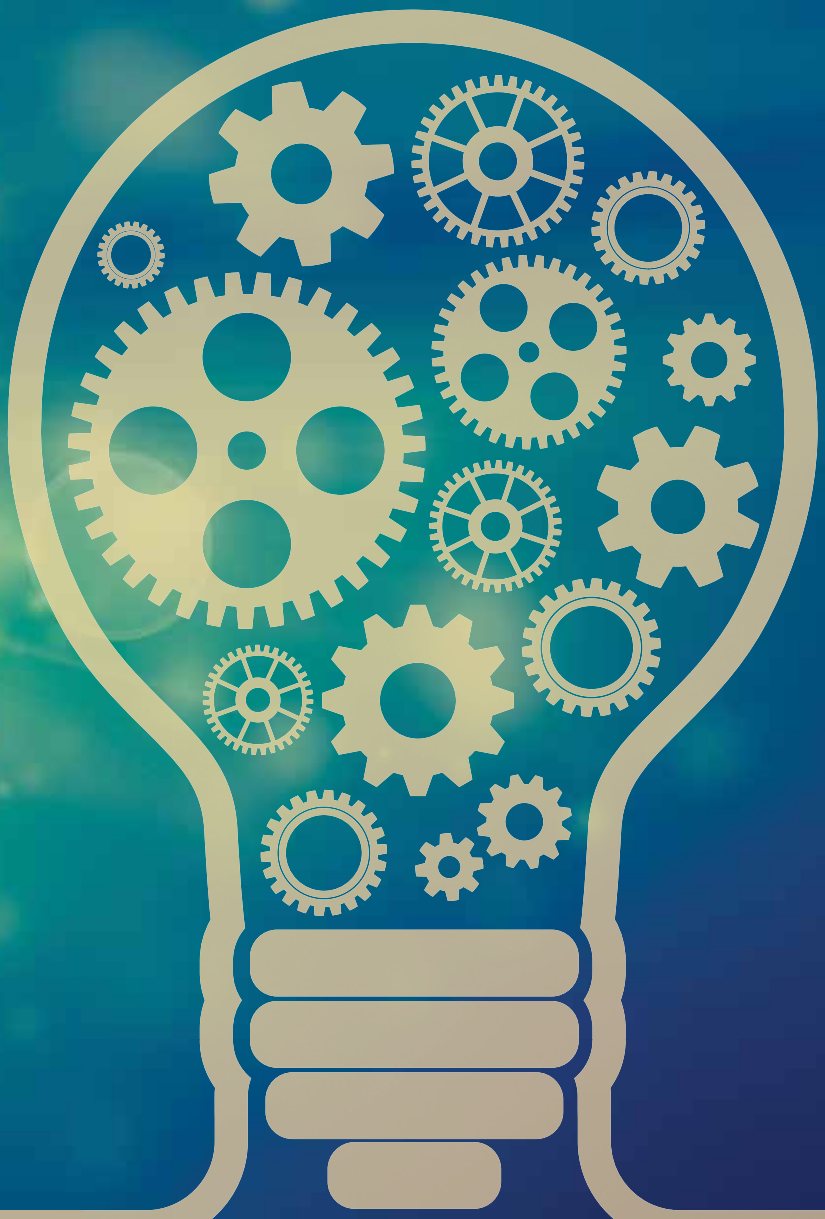
ENGINEERING ENERGY RESILIENCY

5 emerging energy solutions

Global energy disruptions, climate change and the rise of artificial intelligence computing are driving individuals, governments and industries to embrace energy resiliency efforts. On the world stage, this translates into heavier reliance on renewable energy sources as well as fast-tracked development of new industrial processes and nuclear technologies. As global energy prices rose in 2026, the share of electricity generated from renewables, such as wind, solar and nuclear, also grew.

The pursuit of energy resilience will help ensure humanity can continue to meet its basic needs, through innovation and exploration to

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meet rising global demands. With the burgeoning development of AI and the data centers that power them, humanity may experience technological innovations that compare in scale to the introduction of agriculture or the Industrial Revolution. Although thousands of years stretched between the invention of the wheel and steam-powered machines, humans throughout history have always adapted and implemented new technologies to satisfy their need for water, food and shelter as well as with their grandest desires for travel and exploration.

At Southwest Research Institute, multidisciplinary teams of scientists and chemical engineers support research and development of the full complement of energy sources and the supporting technologies. Engineers are developing the machinery, components and infrastructure needed to harness advanced electrical production and storage as well as solar, wind, geothermal, hydroelectric and nuclear power. Beyond engineering, process development and scale-up, SwRI also conducts research to tackle technical barriers for a variety of energy technologies, ranging from biofuels, biomass, synthetic aviation fuel (SAF), renewable diesel, green hydrogen, ammonia and other chemicals.

As an independent third-party R&D organization, when SwRI demonstrates that a process can consistently meet yield, uptime and product quality targets under realistic conditions, the technology gains credibility and becomes more attractive for commercial development and deployment. SwRI generates high-quality engineering data to underpin realistic commercial designs to bridge the space between promising concept and commercial reality, a gap often referred to as the "valley of death" in the innovation arena.

SwRI's independence also amplifies our impact. Stakeholders such as fuel producers, airlines, refiners, regulators and investors rely on objective assessments of emerging technologies. Our engineers evaluate competing processes, verify performance claims and conduct technoeconomic and lifecycle analyses. This neutral perspective not tied to a single vendor or proprietary product helps identify the most promising pathways, avoids costly missteps and guides public and private R&D resources toward technologies with real potential to deliver resilient energy solutions.

SwRI specializes in thoughtful, targeted research to create enabling technologies that make development processes less risky. This methodology actively shapes a more robust energy system capable of withstanding and adapting to economic, environmental and geopolitical pressures in the U.S. and worldwide.

This mindful coordination of multiple energy streams, fuel types and energy systems will allow critical facilities to continue operating reliably as the grid diversifies to meet increased and fluctuating demands. SwRI is engineering energy resiliency for the next age of human history and ingenuity.



Advancing Gen IV Nuclear Reactors

BY MICHAEL HARTMANN

After decades of slow or incremental growth, the development of fourth-generation (Gen IV) nuclear reactors and small modular reactor concepts is now rapidly accelerating. These competitive technologies will enhance safety, reduce waste and improve fuel utilization.

SwRI's extensive knowledge of pilot-plant design, fabrication and operations, along with its diverse scientific knowledge across the energy spectrum — from traditional to renewable and nuclear power generation — informs a holistic and multidisciplinary approach. SwRI supports existing and emerging nuclear technology, as well as the critical infrastructure development and robust supply chains required for its adoption.

Compared to traditional nuclear reactors, most modern designs require a higher enrichment of uranium to increase power density, reduce refueling frequency and support innovative cooling and core designs. These materials can be post-processed into different form factors such as encapsulated spheres, metal alloys, ceramic oxides, molten salts and carbides.

SwRI advances process design and manufacturing to meet demands for fuels such as TRISO (tri-structural isotropic), a multilayer kernel of uranium, carbon and oxygen to supply Gen IV reactors. TRISO fuel is engineered with layers of protection and is meltdown-proof due to its physics and material makeup.

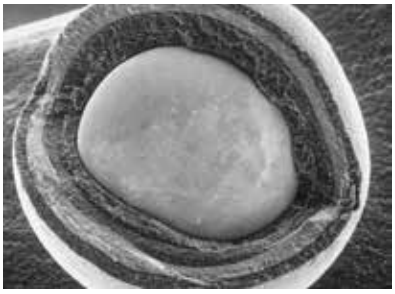
Each TRISO particle is 750-900 micrometers in diameter, resembling a grain of sand, and is essentially its own containment system to reduce overall reactor size and cost over conventional nuclear facilities that require concrete containment structures. To produce TRISO, SwRI is targeting a Sol-Gel process that dissolves enriched uranium in a strong acid to create the correct uranium molar concentration. A nozzle disperses tiny droplets suspended in oil to create gel microspheres, which are washed, dried and heated to form solid microspheres.

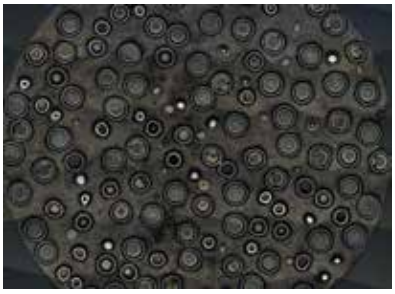
A fluidized-bed chemical-vapor deposition process heated to temperatures in excess of 1,600° Celsius can deposit layers on the TRISO molecule. After subsequent post-processing steps, the particles can be formed into various configurations.

Safety is paramount to any reactor design; having an intrinsically safe fuel helps reduce risks. Pyrolytic carbon and silicon carbide layers allow TRISO to withstand extreme temperatures upward of 1,600° C. In the event of cracking or melting, the fuel will cool itself without human intervention.

As the global nuclear sector pivots toward advanced Gen IV reactors, small modular reactors and hybrid energy systems will support decarbonization and energy security. Success will hinge on innovative reactor physics and reliable access to advanced fuels, qualified materials, manufacturing capabilities and robust supply chains that support large-scale deployment. By leveraging decades of experience in pilot plant design, extreme-environment process development and multidisciplinary engineering, SwRI is helping to turn these promising nuclear concepts into practical deployable systems capable of delivering safe, flexible, low-carbon energy for the long term.

IMAGES COURTESY DOE


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TRISO particles (top) can be compacted (middle) into various form factors to meet different reactor specifications, including pebble designs, such as these billiard-ball-shaped spheres (above).


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Michael Hartmann manages SwRI's Carbon Capture and Utilization Process Development Section, with a specialty in developing pilot-scale technologies for industrial decarbonization with an emphasis on operations, scale-up and novel process engineering.

From Fuel Concept to Commercial Reality

BY HSIANG YEE HOEKSTRA AND JATE COX

Turning unconventional sources into fuels for conventional use can be challenging. With its focus on applied research and integration, SwRI turns alternative fuel techniques and technologies into operable processes. In thermochemical conversion, especially gasification and pyrolysis, the Institute designs and operates pilot-scale systems that can run on real-world feedstocks instead of clean ideal laboratory samples. Biomass, municipal solid waste and industrial residues as alternative renewable feedstocks to make fuels are inherently variable and often contaminated. SwRI engineers develop feedstock conditioning strategies, adjust reactor designs and tune operating conditions to handle variability and still produce specification fuels and chemicals. The performance data generated at pilot scales reflect the realities of commercial operation and form a sound basis for scale-up and techno-economic analysis.

SwRI's expertise in catalytic upgrading and refining technologies to support alternative fuels includes Fischer-Tropsch synthesis, hydrotreating and hydrocracking. The Fischer-Tropsch process converts synthesis gas or syngas — a mix of carbon monoxide and hydrogen — into liquid hydrocarbons and waxes. Hydrocracking is an exothermic process that breaks down long, heavy hydrocarbon chains and waxes into shorter, lighter liquid fractions. Hydrotreating cleans and stabilizes hydrocarbon streams using a hydrogen-addition process to generate the many liquid fuels we use today.

The Institute builds and operates high-pressure, high-temperature pilot units to refine biocrudes, bio-oils, pyrolysis oils and syngas into renewable diesel, SAF and synthetic gasoline components. Running these units with realistic purity levels and continuous operations allows SwRI to evaluate catalyst performance under conditions that closely resemble commercial plants. When catalysts indicate deactivation, fouling or unwanted side reactions, chemists and materials scientists evaluate interactions and develop



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SwRI helps clients develop laboratory- and pilot-scale plants to refine processes and advance renewable energy, power generation and chemical processing technologies.



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SwRI's chemical engineering staff design, construct and operate high-pressure, high-temperature pilot units to refine biocrudes, bio-oils, pyrolysis oils and syngas into renewable diesel, synthetic aviation fuel and synthetic gasoline components.



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Jate Cox is a senior research engineer specializing in refinery and catalyst pilot plant services in the Chemistry and Chemical Engineering Division. Hsiang Yee Hoekstra leads the Refinery and Catalyst Pilot Plant Services Section, offering experience developing and scaling up chemical processes to generate renewable fuels and chemicals.

mitigation strategies. SwRI also works with catalyst suppliers and clients to modify formulations and operating parameters. The iterative, data-driven refinement extends catalyst life, improves yields and lowers operational risk — all key elements for economic viability and reliable fuel output.

Many alternative fuel technologies work well in isolation: gasifiers produce syngas, fermenters produce alcohols and reactors upgrade intermediates. Challenges arise when these steps are combined into a continuous process that must be controlled safely and efficiently. SwRI engineers design integrated flowsheets, specify equipment and develop control strategies to address heat management, mass transfer limitations and dynamic behavior across the entire system. When pilot plants reveal bottlenecks such as insufficient heat recovery, difficult separations or unstable reactor behavior, SwRI diagnoses the causes and implements design changes. This systems-level approach converts promising reaction chemistry into viable end-to-end production processes.

SwRI also closes the gap between new fuels and the stringent performance and safety requirements of users. For example, the aviation sector demands extensive data before approving new SAFs. SwRI provides detailed fuel property measurements, emissions characterization and engine and turbine performance testing to support certification. The Institute evaluates combustion behavior, material compatibility, deposit formation and long-term performance, helping developers demonstrate that alternative fuels meet or exceed existing standards. Similar work is carried out for diesel and gasoline applications, giving refiners, fleet operators and regulators a clear understanding of how new fuels behave in conventional engines and distribution systems.

Long-duration Storage for Reliability

BY JOSHUA SCHMITT

Long-duration energy storage (LDES) plays a key role in ensuring energy resilience. As the name suggests, this technology stores energy during times of high abundance or low cost and returns it for use with some expected losses. These losses are typically calculated as the round-trip efficiency (RTE) that represents the total energy delivered relative to energy input.

Another key metric is duration, the amount of time it takes to discharge the stored energy at full power output, which is typically measured in hours. The LDES storage-release cycle is typically 10 or more hours of duration, the value needed for daily cycling. Energy storage adds to energy resiliency by alleviating spikes in supply or demand, keeping grid operation stable and preventing blackouts.

The United States military has recently increased its resiliency requirements with requests for proposals to install new LDES technologies with at least 14 days (336 hours) of storage duration to achieve 99.9% annual system uptime. This necessitates fewer than 9 hours of outages per year. Lithium-ion batteries are a common storage technology with high RTE in excess of 80%, but they typically max out at 4 hours of duration. Scaling the size of lithium-ion batteries for longer durations is possible at increased costs and shorter service lives, perhaps only lasting 15 years, depending on how they're used.

The safety and durability of these systems are crucial. SwRI conducts abuse-testing on battery packs to ensure safe operations and minimize fire risks. Engineers develop methods to detect defects and isolate issues in the batteries to extend the life of a system.

Thermal, mechanical and chemical energy LDES systems may provide a solution for the long-duration energy storage quagmire. Thermal LDES stores energy as heat and returns it to support industrial processes or for conversion to electricity. Thermal LDES can store heat in rocks, molten salts and water, among other suitable substances. SwRI developed a heat pump thermal system at the kilowatt scale for the DOE and is working with a commercial collaborator pioneering electrified thermal storage in bricks for industry. This system can provide hot air at temperatures over 1,500° C, greater than any other electrified systems and rivaling the capability of fuels.

Mechanical LDES often refers to compressing gas for storage in underground caverns, which then drives a turbine to produce power. Alternative versions use the dramatic density swings of supercritical carbon dioxide to store and release energy. Chemical LDES includes producing hydrogen, ammonia or other fuels from electricity for use in fuel cells or engines. These technologies can achieve long durations for seasonal grid resiliency, but their RTE is typically 60% or less. SwRI is working with industry, conducting technoeconomic and system optimization studies to position these technologies competitively for grid reliability.



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The "buy low, sell high" finance maxim is an apt metaphor to explain thermal long-duration energy storage. The system works by capturing excess electricity during times of abundance and lower cost. The stored energy is converted into heat, which can be converted back into electricity during periods of waning supply associated with higher prices.



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Assistant Program Manager Josh Schmitt focuses on energy storage and industrial decarbonization research, exploring heat thermal storage, oxy-combustion plants, cryogenic carbon capture and electrified heat production in SwRI's Mechanical Engineering Division.

Out with the Old, In with the New

BY RYAN WILLIAMS

Internal combustion (IC) engines are often portrayed as "old" technology, while electric and fuel cell vehicles represent the "new." Yet for heavy-duty, high-power or extended-duty-cycle applications such as long-haul trucking it's becoming clear that IC engines will remain the primary workhorse for decades. Deeply embedded in global infrastructure and supply chains, IC engines already meet demanding requirements for durability, refueling speed and cost.

The question is not whether engines disappear from the transportation energy landscape but how best to adapt and utilize them. The recent SwRI-led H2-ICE consortium demonstrated how to adapt a conventional engine platform to run on a new fuel with relatively modest vehicle changes. By reoptimizing combustion, air handling and control strategies, hydrogen engines can achieve reduced carbon emission objectives while preserving much of the existing hardware. In parallel, other research teams at SwRI are advancing battery, fuel cell and hybrid systems to coexist and complement the "new" engine offerings.

Building out entirely new manufacturing facilities and infrastructure for new fuels or powertrain concepts is neither economical nor feasible, at least in the interim. By reusing as much existing infrastructure as possible, the automotive and mobility sectors can ensure a resilient transition. One recent SwRI internal research and development program demonstrated a high-efficiency spark-ignited combustion concept that uses a "diesel-like" flat cylinder head. This architecture allows a gasoline-type ignition system to be packaged into an engine layout more commonly associated with diesel, making it possible to produce both engines on the same manufacturing line. The result is a pathway to higher efficiency and new fuels without discarding decades of technological investment.

Finally, energy resiliency for mobility will require greater fuel flexibility. Even when two fuels use the same basic combustion process, differences in energy content and chemical makeup can change power output and emissions. Ideally, you would develop a tailored calibration for each fuel and only operate the engine on that fuel — something that is impossible at scale.

Closing this gap requires engines that can sense and adapt. SwRI's FuelSpot™ concept uses sensors to detect when fuel properties change within an engine and adjusts control parameters in real time to optimize performance and emissions for the new fuel. This kind of "smart" fuel adaptation is a key enabling technology for a resilient, fuel-diverse future — one where a company's fleet or its industrial equipment can remain in operation despite changing fuel specifications and supply-chain disruptions caused by global events.



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Using sensors to detect fuel properties, SwRI's FuelSpot technology adjusts engine control parameters in real time to optimize performance and emissions for different fuel types.



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Internal combustion (IC) engines provide the power required for heavy-duty, high-power or extended-duty-cycle applications including long-haul trucking. SwRI supports IC engine research to adapt and optimize for tomorrow's fuels while taking advantage of existing global infrastructure and supply chains.



132276

Ryan Williams manages SwRI's Engine Systems Research & Innovation Section and served as the program manager for the H2-ICE consortium, a joint SwRI-industry project that modified a Class 8 heavy-duty truck to run on hydrogen fuel.

Hybrid Energy Storage

BY RICHARD FU, Ph.D.

Battery energy storage systems (BESS) are an essential component of modern microgrids, providing almost instantaneous power to address fluctuations in renewable energy to meet electricity demands. But batteries are most effective for short-duration energy storage. Hydrogen energy storage complements batteries by extending energy storage from hours to days or even seasons.

During periods of surplus production, an electrolyzer splits water into hydrogen and oxygen using excess electrical power, particularly from renewable energy from peak solar or wind resources. The resulting hydrogen is contained in physical or chemical forms depending on scale and application and fed back into a fuel cell or combustion turbine to generate electricity and heat during times of peak demand.

Together, batteries and hydrogen combine fast response with long-duration energy capacity, enabling resilient behind-the-meter microgrids that can support critical facilities such as AI data centers, hospitals, military installations and industrial campuses. This addresses demand during prolonged grid outages or periods of low renewable generation while strengthening the use of diverse domestic energy resources.

Researchers at SwRI, in collaboration with Southern Methodist University (SMU), are developing an AI-driven hybrid microgrid controller that intelligently coordinates battery and hydrogen energy storage to improve grid resiliency and enable long-duration energy storage. The project is funded through the Seed Projects Aligning Research, Knowledge and Skills (SPARKS) program, a joint initiative between SwRI and SMU that supports collaborative research with strong potential for future federal and industry funding.

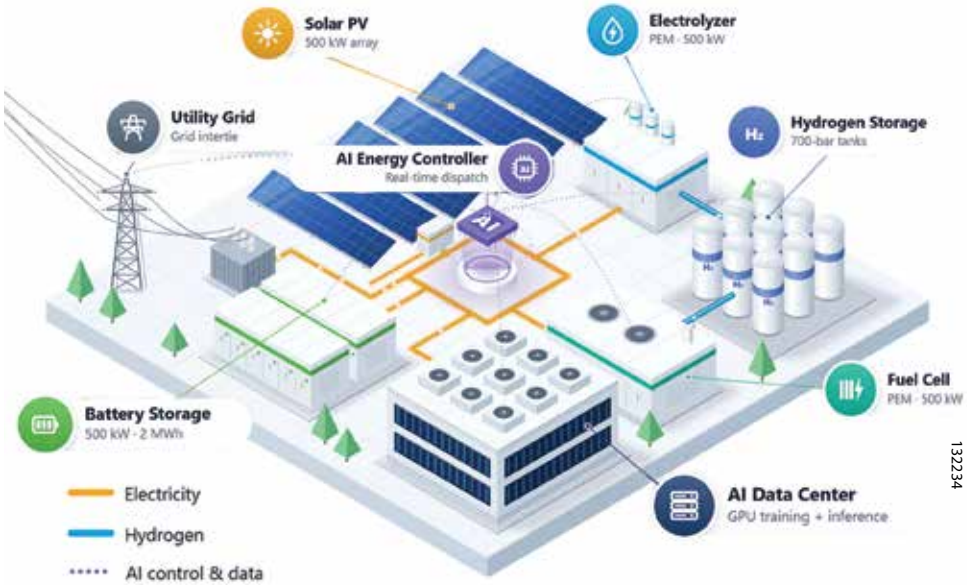
The project focuses on developing a physics-informed AI controller capable of coordinating energy flows among photovoltaic generation, battery storage, hydrogen production, hydrogen storage and fuel cell power generation. Unlike conventional rule-based energy management systems, which use pre-defined conditions, the controller uses reinforcement learning. This system continuously optimizes operations while accounting for equipment operating limits, battery degradation, hydrogen system dynamics and changing electrical loads. By learning from both historical and simulated operating data, the controller will intelligently determine how to balance fast-response battery storage with long-duration hydrogen storage under a wide range of operating conditions.

To accelerate development, the team is creating a hybrid digital twin environment that combines real hardware with high-fidelity digital twin simulations. SwRI will validate the controller using its existing grid-connected photovoltaic and BESS assets, while hydrogen technologies — including electrolyzers, fuel cells and solid-state metal hydride hydrogen storage — will be represented initially through simulation models. This approach allows researchers to evaluate controller performance under realistic operating conditions before advancing to future hardware demonstrations, reducing technical risk while accelerating technology development. The research establishes a foundation for large-scale demonstrations of intelligent microgrids that can improve renewable energy utilization, reduce stress on the electric grid and enhance the resilience of critical infrastructure.



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Dr. Richard Fu is a research engineer in SwRI's Powertrain Engineering Division. He has extensive experience in hydrogen and fuel cell technologies, supporting the development and deployment of clean, high-efficiency energy systems.



132234

SwRI is developing a hybrid microgrid controller to coordinate solar photovoltaic, battery energy storage, hydrogen production through electrolyzers, hydrogen storage, fuel cell power generation and grid interaction to balance short- and long-duration energy needs and support resilient operation of AI data centers and other critical infrastructure.

LINKING ASTEROID COLLISION TO IMPACT SHOWER

An SwRI-led study has proposed a connection between a specific collision in the main asteroid belt and an inner-solar-system-wide bombardment episode that may have had measurable biological and geological consequences on Earth. The research suggests that the catastrophic breakup of the Eulalia parent body could be linked to an impact shower that struck the terrestrial planets about 800 million years ago.

"The role impacts have played in shaping the origin and evolution of life in our solar system is poorly understood," said Dr. William Bottke, an executive director in SwRI's Solar System Science and Exploration Division in Boulder, Colorado, and lead author of a paper describing this research. "The heavily cratered surface of the Moon serves as a reminder of the large impacts in Earth's past, but so far, only the Chicxulub impact event 66 million years ago has been strongly linked to a specific effect on life, namely the mass extinction of the dinosaurs."

Finding geological evidence of impacts older than 650 million years ago on Earth is challenging due to the constant renewal of the surface of our home planet. The Earth's landscape constantly changes as constructive forces such as volcanoes and plate tectonics build it up, while destructive forces such as weathering wear it down. One way researchers have searched for clues about Earth's past is to study asteroid shower events.

"These rare events, triggered by large, well-positioned collisions in the main asteroid belt, bombard all inner solar system worlds," Bottke said. "So, evidence preserved on the Moon's static surface can be used to infer what happened on Earth and Mars in ancient times."

Scientists have proposed that a substantial surge in large lunar impacts occurred approximately 800 million years ago, based on the ages of large lunar craters and the age distributions of impact glass materials found by the Apollo missions.

"Our cosmic forensics team used collisional and dynamical models to link these to the formation of the Eulalia asteroid family, when a primitive carbonaceous chondrite-like object collided with another object," Bottke said. "The location of the parent asteroid was key — it broke up on the brink of the gravitational 3:1 mean motion resonance with Jupiter."

The J3:1 resonance serves as a gravitational escape hatch for the asteroid belt, delivering objects into planet-crossing regions, and the Eulalia breakup would have delivered up to 75% of its fragments to J3:1 within 150 million years. The Eulalia breakup can plausibly account for the observed lunar craters formed around 800 million years ago and may have had widespread repercussions across the inner solar system.

"Given that the peak of this barrage coincides with a period of widespread cooling and major shifts in our biosphere, it is tempting to suggest that the former produced the latter," Bottke said. "On Mars, these impacts would have triggered substantial episodes of seismic shaking and can be linked in time with a surge in volcanic activity. Together, this showcases how certain catastrophic collisions in the main belt could have had far-reaching consequences for the history of the terrestrial planets."

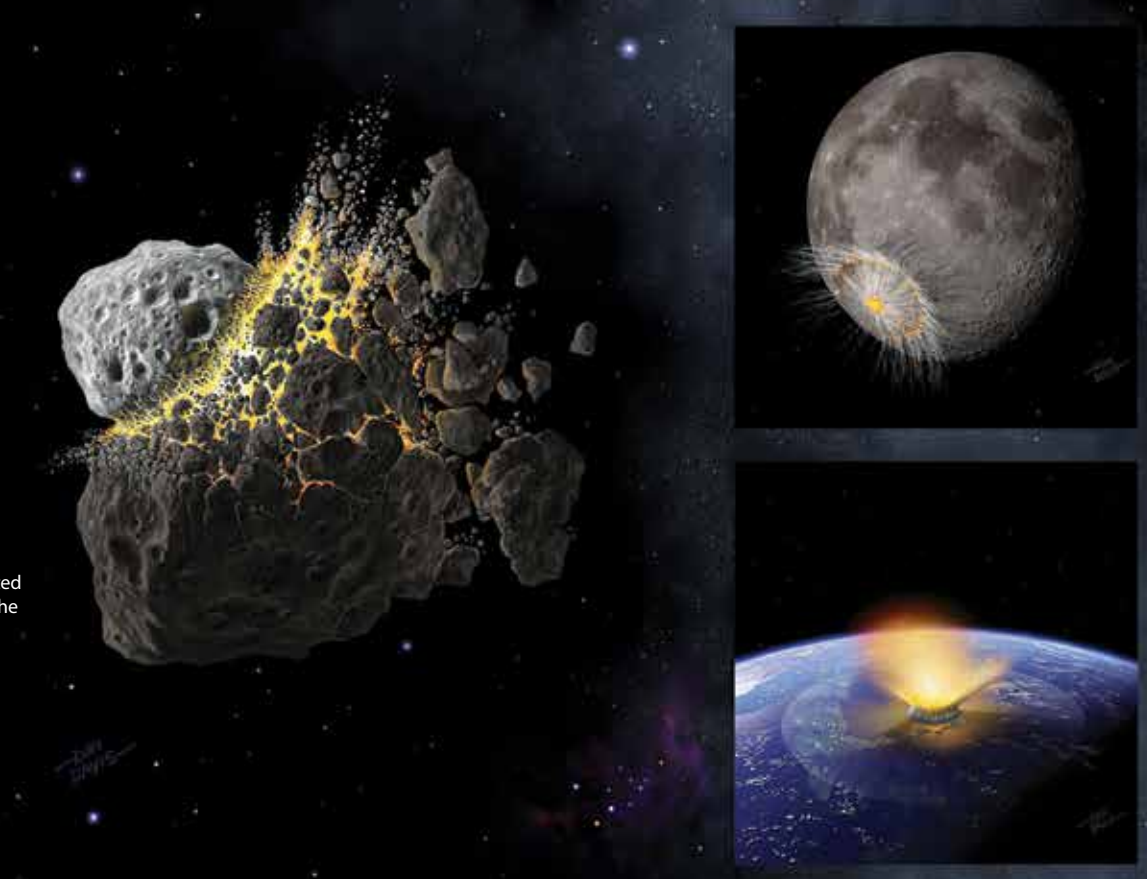


IMAGE COURTESY SwRI/DON DAVIS 132235

An SwRI-led study has connected a specific asteroid collision in the main belt to an inner-solar-system-wide bombardment episode that may have had measurable biological and geological consequences on Earth and Mars.

SwRI, SMU Collaborate on Energy Projects

SwRI and Southern Methodist University (SMU) are collaborating on projects using grant funding from the Seed Projects Aligning Research, Knowledge and Skills (SPARKS) joint program, which aims to strengthen and cultivate long-term research alliances between SwRI and SMU.

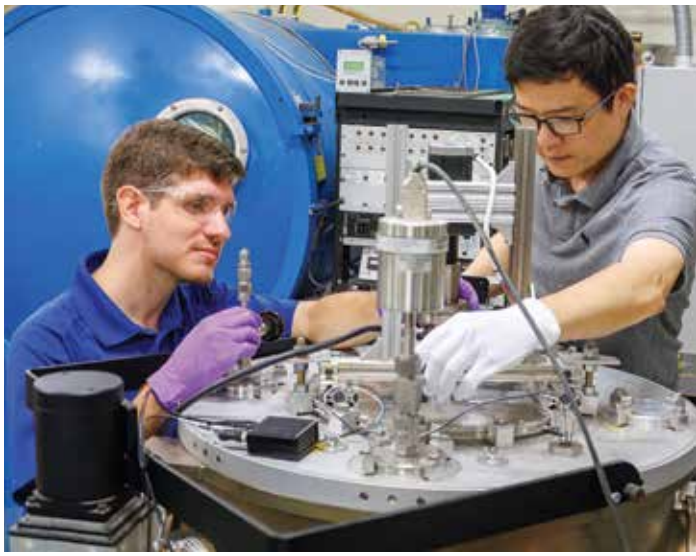
ADVANCING SOLID-STATE BATTERY TECHNOLOGY

Researchers at SwRI and SMU are engineering ultra-thin films for solid-state batteries to reduce degradation and resistance at the anode-electrolyte interface, with the goal of improving their reliability and stability.

Solid-state batteries are safer, longer-lasting and more efficient alternatives to traditional lithium-ion batteries, offering faster charging and greater energy storage potential. They are especially promising for powering electric vehicles, but current designs fall short due to degradation of electrodes and interfaces over time.

"Solid-state batteries are next generation technologies with huge potential for energy storage, particularly for electric vehicles, but they haven't been widely commercialized because of manufacturing and materials challenges," said Dr. John Hemmerling, a senior research engineer in SwRI's Materials Engineering Department. "One of the biggest technical hurdles is the unstable interface between the lithium metal anode and the solid electrolyte."

The project will leverage SwRI's expertise in thin-film deposition and SMU's strengths in solid-state battery development to establish quantitative structure-property-performance relationships linking interfacial chemistry, lithium nucleation behavior and long-term electrochemical performance.



132277

SwRI and SMU are collaborating to advance solid-state battery technology to improve stability and reliability. SwRI Senior Research Engineer Dr. John Hemmerling and Staff Scientist Dr. Jianliang Lin are engineering ultra-thin films to reduce degradation and resistance at the anode-electrolyte interface of a solid-state battery.

AI CONTROLLER FOR COMPLEX ELECTRIC MICROGRIDS

SwRI and SMU are developing an AI-driven controller for hybrid microgrid systems that integrate multiple energy sources and storage systems. Battery systems are effective for short-term energy storage, while hydrogen storage systems can potentially extend energy storage from hours to days. This can potentially enable greater system resilience and efficiency during periods of prolonged outages or renewable energy shortfalls, particularly as energy demands escalate with the proliferation of AI computing and data centers.

The SwRI and SMU project will develop an AI controller for a microgrid configuration that integrates a battery energy storage system (BESS) with a long-duration hydrogen energy storage system (HESS). The application will integrate fuel cells, advanced solid-state storage technologies, renewable energy generation and the local energy grid. The grid will power electrolyzers to split water into hydrogen and oxygen through electrolysis to store hydrogen as energy.

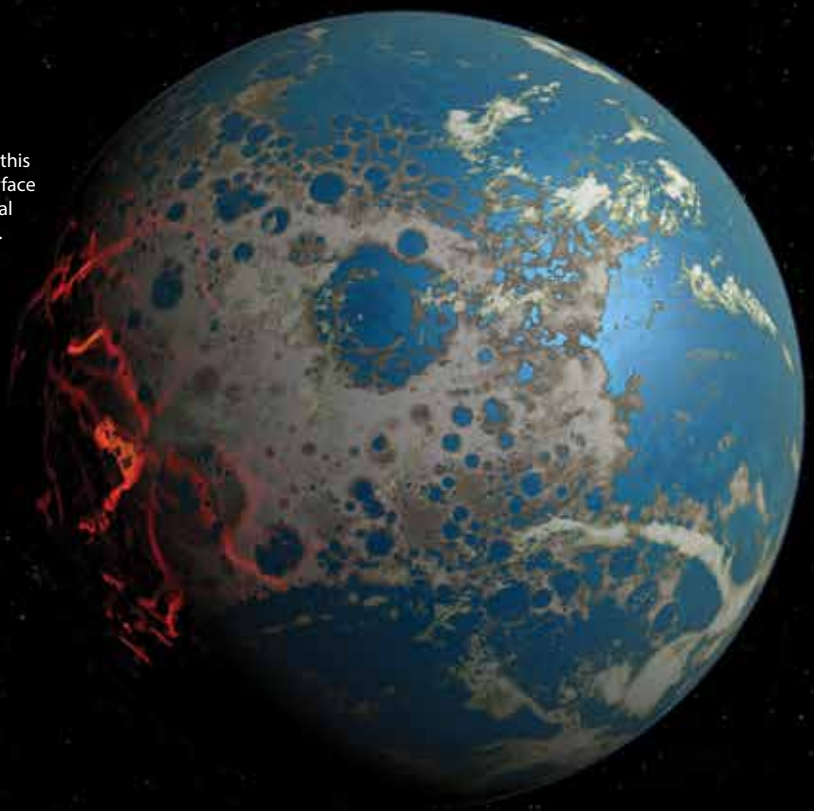
"The rapid expansion of AI computing is creating unprecedented electricity demand, challenging both utilities and data center operators to find reliable and scalable power solutions," said Dr. Richard Fu, a research engineer in SwRI's Powertrain Engineering Division and one of the project's principal investigators. "We are working to create a control system that integrates short- and long-duration energy storage with renewable power resources — without sacrificing reliability."

Dr. Jianhui Wang, the Mary and Richard Templeton Centennial Chair of Electrical Engineering and a professor in SMU's Department of Electrical and Computer Engineering, will develop the AI controller to regulate the microgrid's performance efficiently.



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The SwRI-SMU SPARKS program is developing an AI-driven hybrid microgrid controller that coordinates battery and hydrogen energy sources and storage systems to improve the reliability, efficiency and resilience of critical facilities such as data centers. The project leverages real-world testing using SwRI's on-campus infrastructure, including the grid-connected battery energy storage system shown.



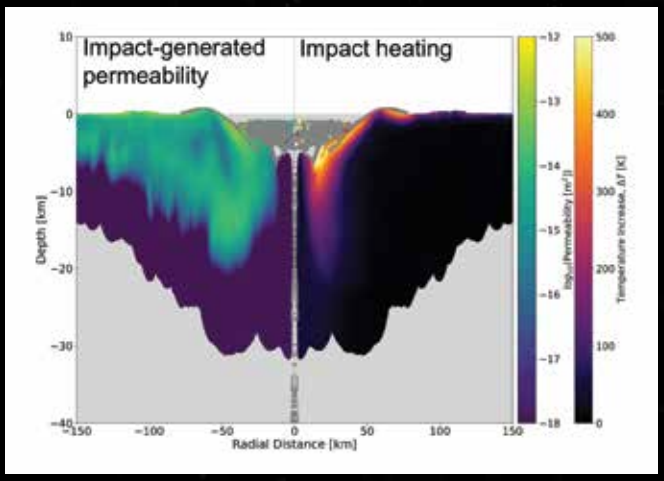
SwRI Institute Scientist Dr. Simone Marchi created this artistic rendering of early Earth, which shows a surface pummeled by large impacts, creating hydrothermal conditions that could support the evolution of life.

COULD IMPACTS HAVE CREATED CONDITIONS FOR LIFE?

SwRI scientists modeled the early impact history of Earth, seeking insight into potential origins of life. These models show that asteroid impacts on the early Earth plowed up surfaces and generated hydrothermal systems, environments where life could have evolved.

The team used a shock physics code that integrates how impacts fracture hard materials and generate porous environments, allowing the first comprehensive study to quantify impact-generated permeability. These conditions allowed water to flow through in the upper crust of the early Earth.

"This modeling is both novel and crucial for understanding the earliest environments life may have emerged from," said SwRI's Amanda Alexander, lead author of an AGU Advances article about this research. "While often considered catastrophic in the context of dinosaur extinction, impact bombardment was also likely critical for creating environments for prebiotic chemistry."



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Modeling the early impact history of Earth, scientists found that a 6-mile (10-kilometer) asteroid striking the early Earth at 9 miles per second (15 km/second) could excavate a crater with impact-generated permeability (left) and heat profiles (right) and possibly create hydrothermal conditions conducive to life.

The Earth formed around 4.5 billion years ago, followed by a calamitous time of intense bombardment. Hypervelocity impacts fragmented large volumes of underlying rock while also vaporizing and launching molten rock across the landscape. Intense heating from the impact, coupled with the background geothermal gradient of the Earth's interior, could allow hot fluids to circulate through the fractured crust. The resulting hydrothermal systems — comparable to the network of geysers around Yellowstone National Park — may have provided the environment for the origin and evolution of early life on Earth.

The modeling allowed the scientists to simulate asteroid impacts of different sizes and velocities hitting the Earth, while also varying the temperature conditions and crustal compositions. The team then calculated the volume of crust impacts made permeable by fractures to understand fluid flow for each case.

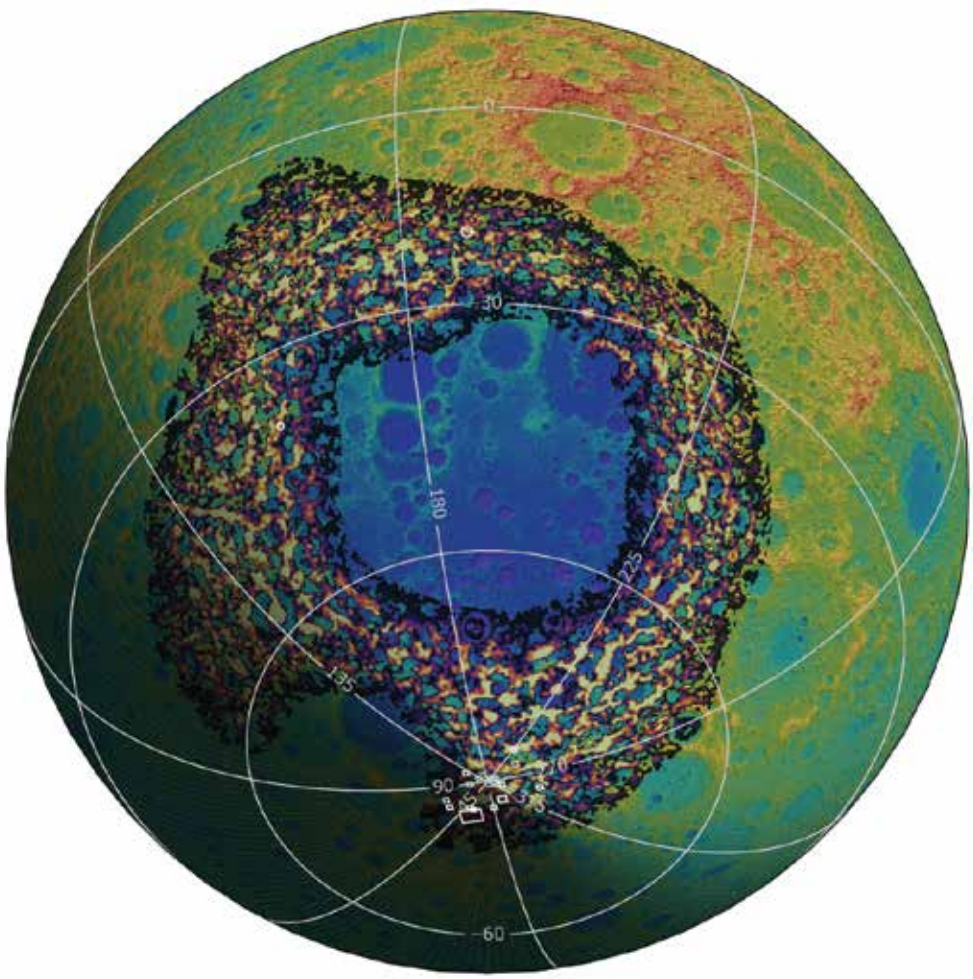
Each individual impact during this phase of bombardment may have generated up to 100 times the hydrothermal activity present in modern-day Yellowstone geography.

"Because life could have originated or evolved in hydrothermal environments, it is important to understand and quantify the generation of these systems by impacts on the early Earth," Alexander said, emphasizing that researchers will need to refine the data for a clearer understanding of the hydrothermal systems.

The simulations suggest that the volume of impact-induced permeable regions depends strongly on impact energy, determined by impactor size and velocity. The range of generated permeability within those regions, however, depends on the geothermal gradient and crustal composition. The models also considered the frequency of impacts.

"These results show that impacts were instrumental in driving hydrothermal changes to the early Earth's crust, with important consequences for the geochemical evolution of near-surface environments," Alexander said.

132260



Scientists studied materials excavated when a large impactor created the ancient South Pole-Aitken (SPA) basin (blue), a massive structure on the Moon's far side. Scientists determined the area around SPA contains mantle-derived rocks (orange and black), offering information about the interior of the Moon and its earliest history. This site is within range of proposed landing sites (white squares) for upcoming Artemis missions, potentially allowing astronauts access to these materials.

IMAGE COURTESY NASA/JPL-CALTECH/GODDARD/GABE GOWMAN-U.ARIZONA. DATA FROM NASA'S GRAIL MISSION AND LUNAR RECONNAISSANCE ORBITER LASER ALTIMETER 132278

UNCOVERING CLUES FOR FUTURE LUNAR ASTRONAUTS

Scientists from the Center for Lunar Origin and Evolution (CLOE), SwRI's team in NASA's Solar System Exploration Research Virtual Institute, have helped uncover new details about the formation of the Moon's oldest and largest impact crater, providing fresh insight into what future Artemis astronauts could encounter near the lunar south pole. The findings are outlined in two new companion studies.

Researchers studied the South Pole-Aitken (SPA) basin, a massive impact structure on the Moon's far side, considered one of the Moon's oldest surviving features. Regions near SPA are also potential landing sites for NASA's Artemis missions.

"The basin offers scientists a rare opportunity to study the Moon's earliest history," said Dr. William Bottke, director of CLOE and executive director of SwRI's Science Directorate in Boulder, Colorado. He is a co-author of the studies. "The collision struck the lunar surface with such force that it may have excavated material from deep inside the Moon, including portions of the lunar mantle."

Using advanced models and simulations, the research team recreated the SPA-forming impact and identified new evidence about the direction and composition of the object that struck the Moon.

"Our simulation produces the right shape and nature of the impact basin. It also tells us about the projectile that created it and the direction of the impact," said Dr. Shigeru Wakita of Purdue University, lead author of the SPA impact study.

The modeling suggests the impactor was not a simple, uniform body but a differentiated object with an iron core surrounded by rock, such as a small protoplanet or differentiated asteroid. As this impactor struck the Moon at a low angle, it excavated a deep, asymmetric cavity and melted the rock in the central basin. The collision lofted large amounts of material from both the lunar crust and mantle, which later settled back onto the basin floor.

In the companion gravity study, researchers analyzed how this ejecta is distributed in and around the basin. The team compared high-resolution gravity data with models that include both crustal and mantle material, determining that SPA likely contains substantial amounts of mantle-derived rocks within its interior and mixed into the ejecta blanket surrounding the basin. A few subsequent impacts within the SPA basin appear to have excavated these underlying mantle deposits, bringing some of this material to the surface, where it could be readily sampled by robotic rovers or astronauts during future missions.

"The precise distribution of mantle material has been a big unknown," said Dr. Gabriel Gowman of the University of Arizona, lead author of the gravity-based study. "Some of that material at a trace level may exist in regions being considered for the Artemis landings."

SwRI, ST. MARY'S UNIVERSITY COLLABORATIONS

SwRI and St. Mary's University (StMU) have launched a new grant program to support collaborative research. The StMU-SwRI Technology & Applied Research (S^2TAR) program aims to strengthen the technical ties between the organizations and cultivate long-term collaboration. Seed funding from StMU and SwRI is designed to advance research and position teams to jointly pursue and secure external research funding from government and industry.

PREDICTING HYDROGEN STORAGE DURABILITY

SwRI and StMU are collaborating to develop a physics-based forecasting tool that can predict the degradation and durability of TiFe-based metal hydride vessels through a chemical and thermo-mechanical framework.

Metal hydrides are chemical compounds, often powders, formed when hydrogen reacts with metals or alloys. Metal hydrides can lock and store hydrogen in the compound's lattice through a process known as chemisorption, offering one of the safest and most compact solid-state storage options for hydrogen available.

"Metal hydrides absorb hydrogen like a sponge at moderate pressures without the explosion risk of high-pressure tanks or the energy costs associated with liquefied hydrogen," said Dr. Richard S. Fu, co-principal investigator of the project and a research engineer in SwRI's Powertrain Engineering Division. "One of the unresolved barriers preventing their wider adoption as a storage vessel is their low durability. After repeated charge and discharge cycles, the alloy powder fractures, the powder-bed densifies and the vessel's performance quietly degrades."

Currently, the only methods of predicting degradation in these vessels require expensive, lengthy physical tests. Fu and Dr. Mohamed Shaat, co-principal investigator of the project and an StMU assistant professor of mechanical engineering, aim to replace traditional, time-intensive physical test cycles with a high-fidelity modeling framework.

IMPROVING METABOLIC COST PREDICTION

Another SwRI-StMU project seeks to expand and validate a system to estimate metabolic costs of movement to improve performance or rehabilitation. The team will combine the Engine for Automatic Bio-mechanical Evaluation (ENABLE®), SwRI's markerless motion capture technology, with musculoskeletal modeling and machine learning to improve metabolic cost prediction for healthcare.

"Metabolic cost is the amount of energy a person's body uses to do an activity, like walking or running," said Dr. Nicholas Vandenberg, a research engineer in SwRI's Mechanical Engineering Division who is working with Dr. Ricardo Ramirez, an assistant professor of electrical engineering at StMU, on the project. The team is building on Ramirez's work that uses 2D video footage and machine learning algorithms to predict metabolic costs. The team is extending the approach using 3D video captured by SwRI's ENABLE tool.

The team will use ENABLE to capture movement data for people with below-the-knee amputations and people without limb loss. The researchers will use a metabolic cart to directly measure how much energy their bodies are using to move. Then the team will run the 3D motion data through musculoskeletal models. Comparing model outputs and experimental metabolic measurements to machine learning predictions, the researchers can validate and refine the algorithms.

The team hopes to improve outcomes for patients facing mobility challenges by allowing clinicians to understand movements that make patients work harder than necessary.



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A joint SwRI–St. Mary's University project seeks to replace traditional, time-intensive physical hydrogen storage vessel durability testing with a high-fidelity modeling framework to advance metal hydride vessel technology as a reliable solid-state storage solution.



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The SwRI and St. Mary's University research will advance StMU's machine learning algorithms to predict metabolic costs using ENABLE's 3D markerless motion capture and musculoskeletal modeling capabilities.

New Horizons & the Boundary of our Heliosphere

NASA's New Horizons mission made history with its 2015 encounter with the Pluto-Charon system, followed by its flyby of the Kuiper Belt Object Arrokoth in 2019. More recently, the SwRI-led mission has segued to include heliospheric and solar wind studies as it approaches the edge of the solar system. New research has highlighted recent findings as New Horizons hurtles toward this mysterious region of space in anticipation of becoming just the third spacecraft to reach interstellar space, following Voyager 1 and 2.

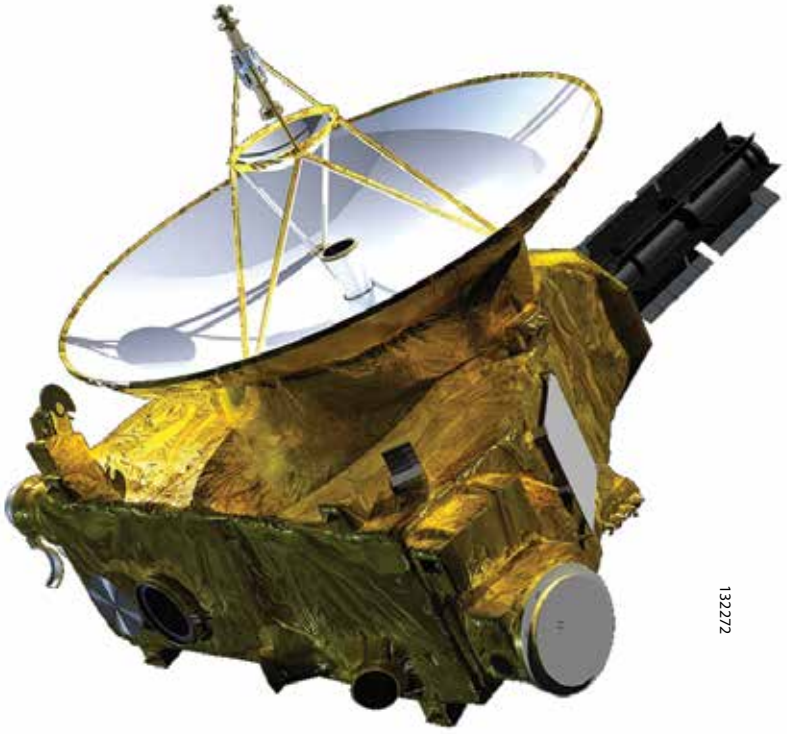
THE SLOWING SOLAR WIND

The first study used data from NASA's New Horizons spacecraft to uncover fascinating insights into why the solar wind gradually slows as it approaches the boundary of our heliosphere.

New Horizons is currently roughly 66 AU from the Sun. One AU, the distance from the Earth to the Sun, is roughly 93 million miles. The researchers, led by SwRI's Dr. Heather Elliott, studied how the solar wind's speed, measured by the Solar Wind Around Pluto (SWAP) instrument aboard New Horizons, changed between 21 and 58 AU compared to measurements taken nearer the Sun.

"As the solar wind travels away from the Sun at supersonic speeds, roughly 1 million miles per hour, eventually it encounters incoming interstellar neutral gas particles entering the heliosphere," Elliott said. "These neutral interstellar atoms become ionized via charge exchange with solar wind ions." The solar wind assimilates these interstellar materials, adding mass that causes it to slow down.

Previously, New Horizons and Voyager 2 measurements between 30 and 43 AU indicated the solar wind was 5-10% slower than at 1 AU near Earth. Now, New Horizons researchers found that at 58 AU the solar wind is 13-15% slower than the wind at 1 AU. This gradual slowdown aligns with previous models of how interstellar material enters the heliosphere and affects the solar wind. It also demonstrates how the Sun's influence decreases over long distances.



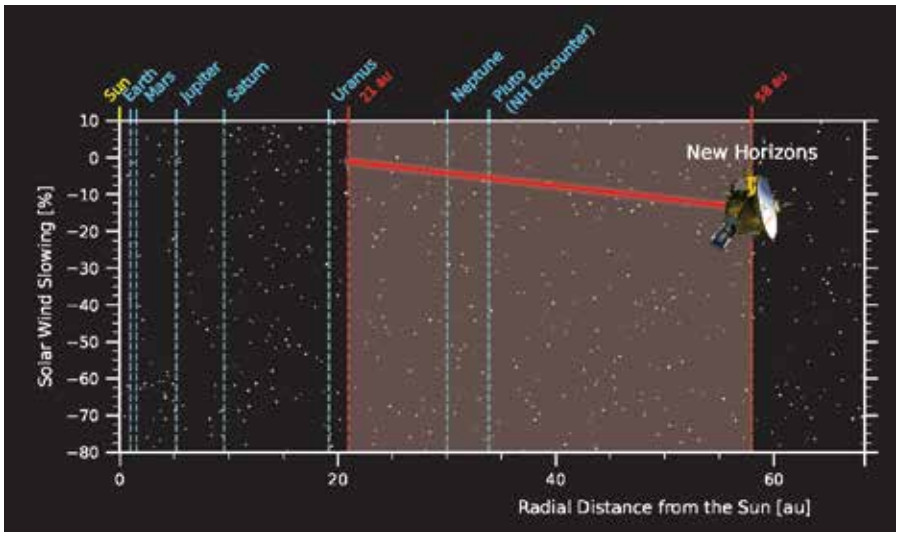
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DEFINING HELIOSPHERIC BOUNDARIES

SwRI scientists are using a solar wind forecasting method combined with analytic and numerical heliosphere models to define the boundaries of the outer heliosphere and predict when New Horizons will reach the edge of our solar system.

SwRI researchers are studying the heliosphere's dynamic outer boundaries, including the termination shock and the heliopause, where the solar wind slows and then abruptly stops when interacting with interstellar material. These boundaries constantly expand and contract in response to changing solar conditions. During solar maximum, the "turbocharged" solar wind expands the heliosphere. During solar minimum, the waning solar wind allows the heliosphere to contract.

"When the spacecraft reaches the boundary of the heliosphere, we will be prepared to take measurements and download data about this region," said SwRI's Dr. Jonathan Gasser, lead author of two papers. "We predict that New Horizons will encounter the termination shock between 2029 and 2040. And it is possible that it could cross the boundary more than once as the heliosphere continues to expand and contract."



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NASA's New Horizons spacecraft measured the solar wind as it traveled from just beyond Uranus' orbit into the outer Kuiper Belt (shaded region), detailing the gradual slowdown caused by interactions with interstellar materials (red line).

SwRI JOINS HYDROPOWER TESTING NETWORK

The U.S. Department of Energy has selected SwRI to join its Hydropower Testing Network (HyTN), which helps industry develop and demonstrate new technologies.

Hydropower is a renewable energy resource that uses the natural flow or fall of moving water to generate electricity and power machinery. The HyTN links hydropower developers with testing facilities and experts across the country. These organizations now can benefit from SwRI's wide range of technical services to help develop and improve hydropower technologies.

"Hydropower is where clean energy, grid reliability and long-lasting infrastructure come together," said Jacqueline Manders, a program manager in SwRI's Fluids Engineering Department. "Our teams blend advanced modeling, full-scale testing and real-world field services to tackle some of the toughest challenges in the industry. Now, as a HyTN provider, we're ready to use that expertise and our facilities to help move the future of hydropower forward."

As a HyTN testing capability provider, SwRI's hydropower capabilities include:

- Customized, high-fidelity testing of hydropower components
- Mechanical spin testing on hydropower turbines
- Comprehensive materials testing and characterization
- Advanced computational fluid dynamics (CFD) modeling and simulation
- CFD analyses tailored to simulate complex flow in hydropower turbines
- Turbine mechanical design studies
- Roadmapping, energy analysis and technoeconomic evaluations
- Root-cause failure analysis
- Hydropower digital twin creation and analysis

The testing, modeling and analysis capabilities selected by the DOE HyTN program leverage the core competencies and extensive test infrastructure across SwRI's Fluids Engineering, Machinery and Materials Engineering departments.

SwRI supports hydropower machinery testing at up to 3 MWe and variable speeds exceeding 20,000 rpm, using instrumentation to assess shaft, bearing and rotordynamic performance.



132221



IMAGE COURTESY NASA

132217

SwRI is developing electronics and flight software for the next-generation NASA/USGS Landsat 10 satellite, which will improve Earth observation data generated by the current Landsat satellites shown.

LANDSAT 10 SPACECRAFT SUPPORT

SwRI is developing electronics and flight software for the NASA/U.S. Geological Survey (USGS) Landsat 10 satellite scheduled to launch in 2031 to collect new and improved Earth observation data. The mission is a continuation of NASA's and USGS' partnership on the ongoing Landsat program, which has launched nine satellites since 1972 and provided over 10 million images of the Earth's surface.

"Landsat 10's technological innovation differs from previous missions in terms of the amount of image data collected," said Patrick Phelan, who oversees SwRI's role in the project. "Landsat 10 will process ~1.8 gigabits of data each second."

Landsat 10 data will be unmatched in precision and quality, supporting a vast array of science applications and providing important insights about water quality, quantity and use, as well as agricultural production, soil conservation and forest management.

SwRI serves as a subcontractor to Raytheon, an RTX business, which is developing the Landsat Instrument Suite (LandIS), including the multispectral imager for Landsat 10. SwRI will provide electronics and software that allow LandIS to capture image data and compress it before transmission back to Earth.

SwRI is also developing control technology to regulate the instrument's temperature and to position the camera's mirrors, which direct and focus light to help LandIS capture wide, detailed images of Earth. The Institute is developing operational and interface simulators that mimic the behavior of the spaceborne payload to rehearse scientific campaigns on the ground.

"This new technology will continue Landsat's legacy of Earth observations," Phelan said. "We are leveraging our work on previous NASA and private space industry projects to accomplish our goals."

ACADEMIC COLLABORATIONS

BY THE NUMBERS

Tec de Monterrey (Tec)
Tec-SwRI Sustainable Manufacturing Program
3 projects
2023

In 2010, SwRI launched its first collaborative program with academia. The SwRI-University of Texas at San Antonio Connecting through Research Partnerships (Connect) program is coordinated with the UT San Antonio Office of the Vice President for Research and Innovation. Connect has jointly funded opportunities to enhance greater scientific collaboration between the two organizations while exploring approaches to bridge the gap between basic and applied research. Connect then served as a model for an additional six programs with other Texas universities and the Tecnológico de Monterrey (Tec de Monterrey) of Mexico. Over the years, these programs have allowed the organizations to jointly fund more than 50 projects; SwRI has invested more than $4.6 million in this research. To learn more about some of these projects, see pages 20 and 23.

5

TEXAS

University of Texas at Austin (UT)
UT-SwRI Energize Program
5 projects
2023

4

SMU

Southern Methodist University (SMU)
SMU-SwRI Seed Projects Aligning Research, Knowledge and Skills (SPARKS) Program
4 projects
2020, 2026

University of Texas at Dallas (UTD)
UTD-SwRI Seed Projects for Research, INnovation, and Technology (SPRINT) Program
2 projects
2024

Tecnológico de Monterrey

3

St. Mary's University
(StMU)
StMU-SwRI Technology and Applied Research (S2TAR) Program
2 projects
New in 2026

ST. MARY'S UNIVERSITY

2

Trinity University
Trinity-SwRI Research Collaboration Grant Program
3 projects
New in 2026

3

TRINITY UNIVERSITY

"The Connect program offered the perfect opportunity for SwRI's Engineering Dynamics Department to collaborate with UT San Antonio's Hypersonics Lab and resulted in SwRI collaborating with UTSA on multiple follow-on proposals. One contract was awarded to UT San Antonio by the Joint Hypersonics Transition Office for $1.5 million. SwRI served as a subcontractor."
— Dr. Nicholas Mueschke



2

THE UNIVERSITY OF TEXAS AT DALLAS
EST. 1969

University of Texas at San Antonio
UT San Antonio-SwRI Connect Program
32 projects

THE UNIVERSITY OF TEXAS AT SAN ANTONIO

32

132262

DISCREPANCIES IN AI CRATER CATALOGS

An SwRI-led study compared eight AI-generated lunar crater catalogs, discovering that many of their published performance metrics drop sharply when the databases are evaluated using the same scientific standards humans are held to. Crater catalogs provide a comprehensive record of impact craters on planetary surfaces. They log the precise location, dimensions and physical characteristics of impact structures to help scientists understand the geological history of the solar system and its components.

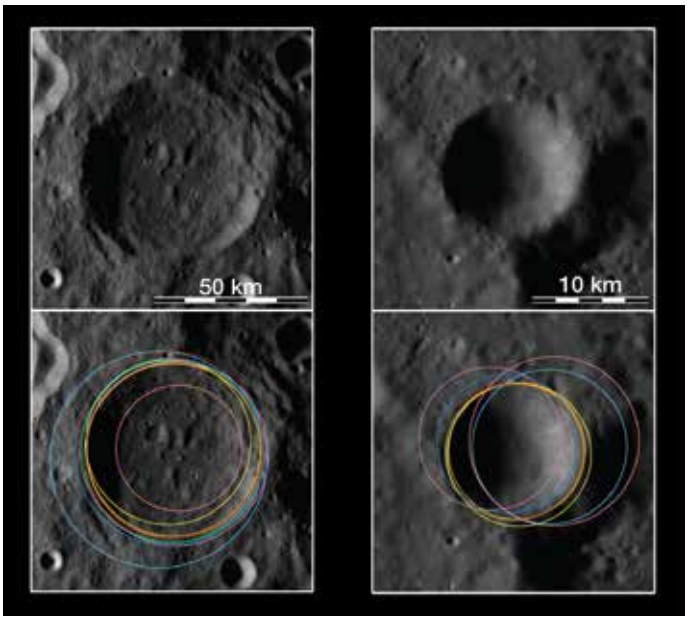
Impact craters are the dominant geologic feature on the Moon and many other solid worlds. Scientists count craters to estimate the ages of planetary surfaces. Because small asteroids strike at a roughly steady rate, surfaces with more craters are older than those with fewer.

Automated crater detection — using artificial intelligence and machine learning — could save researchers years of painstaking manual work and help tackle problems otherwise impossible to address in a lifetime.

"AI has enormous potential to help with repetitive, time-consuming scientific tasks, especially gathering some of our data," said Dr. Stuart J. Robbins of SwRI's Solar System Science and Exploration Division in Boulder, Colorado, and lead author of the study. "But our analysis shows that researchers should not assume an AI-generated crater catalog is ready for scientific use solely based on its published metrics."

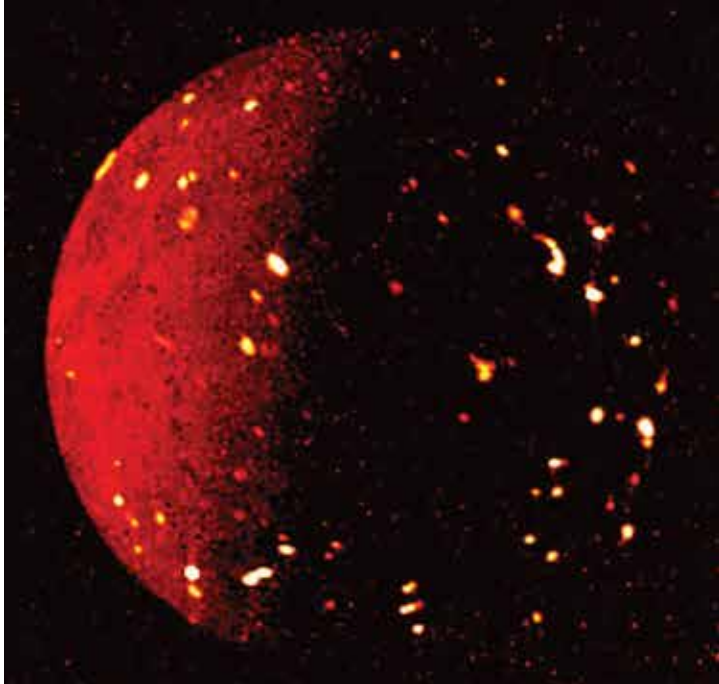
Robbins and co-author Dr. Rachael H. Hoover, also of SwRI, evaluated each database against a large, manually compiled lunar crater catalog that took Robbins years to construct. The team found that performance depends strongly on how a crater "match" is defined.

"A crater catalog is not just a random list of circles," Robbins said. "If a crater is shifted, duplicated or improperly sized, that can affect the science that depends on those metrics."



132220

A new SwRI-led study compared AI-generated lunar crater catalogs, finding their performance metrics drop sharply when compared to human-built resources. These examples map the results from the different catalogs, including the human-derived data in green, showing inaccuracies in size and location associated with automated systems — flaws that could skew scientific studies.



NASA'S JUNO TAKES THE SUBSURFACE TEMPERATURE OF JUPITER'S FIERY MOON

NASA's Juno mission has made the first direct measurements of the temperature below the surface of Jupiter's moon Io, which reveal significant heating in the upper few feet of the most volcanically active world in the solar system.

These findings, derived from data collected by Juno's Microwave Radiometer (MWR) during two close flybys, were published July 22 in the Journal of Geophysical Research: Planets. SwRI's Dr. Scott Bolton, co-author of the paper and Juno's principal investigator, invented and designed the MWR to investigate Jupiter's atmosphere below the cloud tops. The novel instrument has also proven invaluable for studying Jupiter's ice-covered and volcanic moons as well.

New data from MWR also show that the majority of Io's surface is remarkably smooth at large scales and more similar in density to volcanic ash or pumice than to solid rock. These results break new observational ground for both fiery and icy worlds beyond our planet.

"The Juno microwave radiometer directly observed Io's heat output by looking below the surface," Bolton said. "The discovery that we could see below the surface of a rocky moon was a surprise with potentially important implications for the study of Earth's volcanoes."

The mission's extended phase provided the opportunity to observe three of the gas giant's Galilean moons, Ganymede, Europa and Io. The Juno radiometer uses six microwave antennas acting as a single instrument capable of simultaneously detecting microwaves at a wide range of wavelengths.

"The novel aspect of the instrument is that each wavelength explores a different depth to characterize the deep atmospheres of giant planets or the subsurface crusts of icy and rocky bodies," Bolton said. "At Ganymede and Europa, we probed tens of miles into their ice shells. At Io, the MWR measured thermal emissions at depths ranging from a few inches down to tens of feet."

IMAGE COURTESY NASA/JPL-CALTECH/SwRI/ASI/INAF/JIRAM

132282

SwRI PATENTS ENERGY-EFFICIENT EZ FLOW

SwRI recently received a patent for its EZ Flow™ technology, which reduces the viscosity of heavy crude oil by 60% or more. Developed through internal research funding, EZ Flow could help address a significant barrier for utilizing heavy crude oil in North America.

In the simplest terms, viscosity measures a fluid's resistance to flow. It indicates how thick or thin a fluid is and how easily it moves under an applied force. Viscosity is affected by temperature, pressure, composition and impurities.

"When first developing EZ Flow, our goal was to make transport of heavy crude oil possible through existing pipelines," said Principal Scientist James Wood. "Traditionally, moving heavy crude oil required cost-prohibitive chemical treatments, the addition of large volumes of diluent and/or heating. EZ Flow addresses those challenges."

EZ Flow is a two-part process that starts with a proprietary low-concentration chemical additive followed by controlled hydrodynamic cavitation, a mixing process that uses a rotor to produce microscopic bubbles. Shockwaves produced when the bubbles collapse heat and mix the additive into the heavy crude oil, reducing its viscosity for extended periods of time. This process does not change the chemical composition of the heavy crude oil, and the chemical components added do not affect downstream processing.

SwRI scientists have found the process offers at least six months of reduced viscosity. However, Wood says more testing is needed to understand the effectiveness of EZ Flow at lower ambient temperatures.

"EZ Flow is designed to bring down the costs associated with transporting heavy crude oil, which could ease supply chain shocks caused by global shifts in energy markets," Wood said. "We are excited to bring this technology to our clients through licensing or technology transfer."



132222

SwRI, COLLABORATORS RESEARCH A LUNAR INITIATIVE

SwRI, Astroport Space Technologies Inc. and the WEX Foundation have signed a memorandum of understanding (MOU) to explore the possibility of an independent National Lunar Research Center (NLRC) on SwRI grounds. The NLRC would focus on accelerating the research and development efforts needed to advance lunar surface infrastructure technologies, demonstrate assisted and autonomous lunar construction capabilities and prepare a specialized workforce to fulfill NASA's Ignition and Moon-to-Mars objectives.

The proposed initiative would leverage approximately 180 acres of SwRI-owned property adjacent to its main campus in San Antonio. The site would be used to simulate the geography of the Moon's de Gerlache Ridge as well as the footprint of NASA's Artemis Moon Base. The NLRC would complement other small- and mid-scale facilities to provide a comprehensive ecosystem for research, development, testing and evaluation of equipment and processes designed to support a sustained presence on the lunar surface.

"SwRI is committed to solving the most difficult technical challenges in space exploration," said Adam L. Hamilton, P.E., president and CEO of SwRI. "The NLRC would provide a full-scale analog site that could be used to prepare for construction and operation of a Moon base."

The initiative leverages the unique local resources available to launch the next generation of space occupation and exploration programs.

"Our lunar civil engineering work for NASA has established a clear engineering baseline for construction on the Moon," said Sam Ximenes, founder and CEO of Astroport Space Technologies. "The NLRC would provide the infrastructure needed to rehearse these complex operations at scale, validating site preparation and infrastructure tools on Earth for safety and endurance before they are committed to a lunar manifest."



IMAGE COURTESY ASTROPORT/TANGRAM3DS 133249

To support NASA's Moon-to-Mars objectives, SwRI is working with local organizations to explore the possibility of hosting a site for simulating the geography of the Moon and the footprint of a moon base on its San Antonio campus.

LUCY MISSION STUDIES WOBBLING PEANUT ASTEROID

SwRI scientists studying the inner main belt asteroid Donaldjohanson have found that its rotation wobbles. Rather than rolling through space in a steady pattern, Donaldjohanson turns on two axes, rotating end-over-end once every 10.5 Earth days and wobbling around its horizontal axis once every 26.5 days.

"This is just one of many surprising things learned since NASA's Lucy spacecraft flew by Donaldjohanson on April 20, 2025," said SwRI's Dr. Simone Marchi, deputy principal investigator of the Lucy mission and the study's lead author. "Lucy images confirmed its elongated shape, initially suggested by Earth-based telescope observations. The flyby revealed that the small asteroid, half a mile in diameter, resembles a peanut, with a two-lobed structure connected by a narrower neck."

The spacecraft also detected iron-rich clay minerals, formed long ago in the presence of liquid water. These findings indicate that the asteroid likely formed from fragments of a larger, carbon- and water-rich asteroid that broke apart 155 million years ago, following a collision in the main asteroid belt, a region between Mars and Jupiter.

Lucy's encounter with Donaldjohanson is considered a test run for its primary mission to explore the Trojan asteroids, two swarms of ancient objects that lead and trail Jupiter as it orbits the Sun.

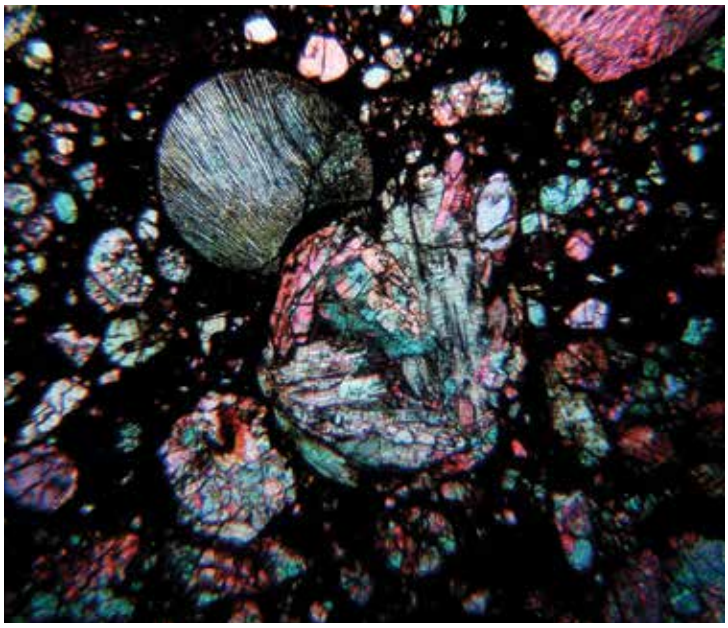
"This encounter gave us an opportunity to test our instruments and our procedures to make sure we are ready when we get to Jupiter's Trojans," Marchi said. "Once we start learning more about the Trojans — a completely different population of objects — our understanding of solar system formation is likely to be challenged."

To watch a visualization of Donaldjohanson's wobbly orbit, visit: https://www.youtube.com/watch?v=Qi4f8xwRiKI.



132247 IMAGE COURTESY LUCY/NASA/GODDARD/SWRI/JOHNS HOPKINS APL/NOIRLAB

During its April 20, 2025, encounter with the main belt asteroid Donaldjohanson, NASA's Lucy spacecraft discovered iron-rich clays on the surface of the asteroid, evidence of the presence of water on its parent asteroid in the distant past.



132219 IMAGE COURTESY MAX ROUGER CC BY-SA 4.0

An SwRI-led study connected the evolution of millimeter-sized, spherical mineral grains known as chondrules, shown here in a polarized light micrograph, to the meteorites found on Earth.

MINI-MOONS MAY EXPLAIN METEORITE COMPOSITION

A new SwRI-led study proposes a solution to a long-standing puzzle in planetary science — what caused the concentration, assembly and preservation of millimeter-sized, spherical mineral grains within the parent bodies of the most common meteorites?

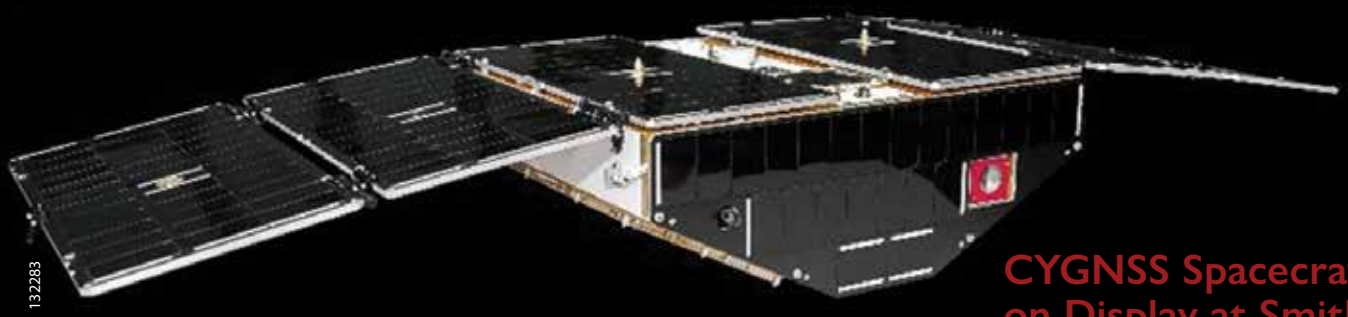
Chondritic asteroids are ancient bodies that orbit the Sun, while a chondrite meteorite is a rocky fragment that falls to Earth. Both contain primitive materials. Chondrite meteorites are largely made of chondrules — tiny, once-molten droplets of rock — embedded in a fine-grained matrix.

"While several mechanisms may have created the chondrules themselves, I have always been surprised by how homogeneous the chondritic asteroids seem to be," said SwRI's Hal Levison, first author of a new paper outlining this research. "We were looking for a process that corrals these small droplets into asteroid-sized bodies."

The new research indicates that the answer may lie in the chaotic final stages of terrestrial planet formation, when planetary embryos — Moon- to Mars-sized bodies — frequently collide. Using numerical simulations, the team investigated giant impact scenarios between planetary embryos that generate sheets of molten and solid ejecta. Some of these materials remain gravitationally bound and settle into a dense, rotating debris disk around the impacted embryo.

"This circum-embryo disk orbits a growing protoplanetary embryo, accumulating into larger bodies and forming asteroid-sized satellites," Levison said. "The resulting asteroid-sized satellites are composed almost entirely of material from the original impact."

Crucially, the study finds that some of these satellites can be dynamically liberated from their orbits around the planetary embryo and placed into independent orbits around the Sun. These escaped satellites then become the parent bodies of chondritic asteroids — the source of the chondrite meteorites found on Earth.



132283

CYGNSS Spacecraft Model on Display at Smithsonian

The Smithsonian's National Air and Space Museum in Washington now includes a model of an SwRI-built Cyclone Global Navigation Satellite System (CYGNSS) microsatellite. The model is a part of a permanent exhibit at the museum showing the evolution of spacecraft over several decades. SwRI designed, built and continues to operate the constellation of CYGNSS microsatellites.

"CYGNSS's eight satellites were the first built by SwRI, and seeing the breadth of the mission's impact has been very rewarding," said Susan Pope, executive director of SwRI's Space Science Division, who also served as CYGNSS's deputy project manager from 2013 to 2016.

Launched in 2016, the CYGNSS constellation's mission is to improve tropical storm and hurricane forecasting. Each of the CYGNSS microsatellites is roughly the size of a piece of carry-on luggage and designed to make frequent measurements of ocean surface winds and to monitor the location, intensity, size and development of tropical cyclones.

"CYGNSS is a big part of the small satellite revolution, and I always say we're small but mighty," said Jillian Redfern, CYGNSS project manager in SwRI's Solar System Science and Exploration Division in Boulder, Colorado. "It was remarkable to start seeing CYGNSS data used in so many scientific studies, including tracking locust migrations in Africa, microplastics in oceans, and wildfires. We're very proud of how productive these little satellites have proven to be in the last decade."

SwRI assembled the display model from leftover spare parts from the original CYGNSS mission and engineering model components. The model represents the external structural skeleton of the microsatellite.

"CYGNSS was a milestone for SwRI and for the space industry," said William Wells, CYGNSS project systems engineer. "It paved the way for small satellites to have a larger presence in our industry, and it led to a wide range of interesting science in the past 10 years."



132215

SwRI's Dr. Pablo Bueno and Ben Uresti use the Institute's large two-stage light-gas gun to create hypervelocity impacts representative of missile defense intercepts and meteor impacts to study the spectra of light revealed in the resulting flashes.

IMPACT FLASH REVELATIONS

SwRI is studying flashes generated by high-speed impacts to better understand the materials involved in the collisions. Advances in this area could support missile defense, making it possible to determine the composition of an intercepted missile and its payload. The work could also help scientists identify the origins of meteorites or asteroids, based on their composition.

"When a meteorite strikes the surface of a moon or planet, the energy of the impact creates a flash emitting so much energy that the chemical signatures of its constituent materials are visible at different wavelengths," said Dr. Pablo Bueno, a lead engineer in SwRI's Mechanical Engineering Division.

Bueno and Senior Research Engineer Roberto Enriquez-Vargas recently completed an internally funded project that developed and refined methods for using high-speed spectroscopy to analyze the light emitted during hypervelocity impacts. These impact flashes last a few microseconds, which requires capturing spectral data quickly and precisely.

The team used SwRI's two-stage light-gas gun to create hypervelocity impacts representative of missile strikes or asteroid impacts. Typically used in ballistics studies, the 72-foot-long gun system generates velocities up to 15,660 miles per hour.

Because these impacts and resulting flashes are so fleeting, Bueno and Enriquez-Vargas developed a laser-based triggering system to precisely detect the instant an impact occurs, accurately measuring impact timing within 100 nanoseconds, or one 10-millionth of a second.

SwRI scientists studied the flash for the distinct spectra the materials emitted under the intense heat and pressure created by the impact, allowing the team to identify materials present. This project was funded through SwRI's Internal Research and Development Program.

UPCOMING

WEBINARS, WORKSHOPS and TRAINING COURSES HOSTED by SwRI:

Cycle Analysis & Optimization, November 4, 2026, virtual

Gas Turbine & Compressor Short Course, November 9, 2026, San Antonio

Introduction to Microencapsulation, November 11, 2026, San Antonio

Fatigue Life Modeling for Gas Turbine Applications, November 18, 2026, virtual

Introduction to Propulsion Simulation Using NPSS®, Winter Short Course, December 1, 2026, San Antonio

Compressor Skid Design and Foundation Considerations, December 2, 2026, virtual

Pulsation Analysis – API 618 Requirements, Modifications to Legacy Units, Mixed Compression, January 13, 2027, virtual

TRADESHOWS:

AFCC Global Biobased Economy Conference and Exhibit, November 1, 2026, Washington

Gas Turbine for Energy Networks (GTEN) Symposium Industry Showcase, November 2, 2026, Banff, AB, Canada

International Conference for High Performance Computing, Networking, Storage & Analysis, November 15, 2026, Chicago

F-15 TCP Worldwide Review (WWR), November 16, 2026, Orlando, FL

Aircraft Structural Integrity Program (ASIP) Conference, November 16, 2026, San Antonio

International Workboat Show, Dec. 7, 2026, New Orleans

American Geophysical Union (AGU) Annual Meeting, Dec. 7, 2026, San Francisco

AIAA SciTech Forum, Jan. 11, 2027, Orlando, FL

Clean Fuels Conference, Feb. 1, 2027, Phoenix

Hydrogen Technology Expo & Carbon Capture Technology Expo North America, March 1, 2027, Houston

BY THE NUMBERS

July — October 2026



48 presentations conducted in

9 states



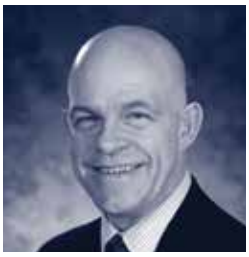
& **8** COUNTRIES



36 papers published in **23** DIFFERENT PUBLICATIONS

4 patents awarded




132263

Staff Engineer **James Dante** of SwRI's Mechanical Engineering Division has been named a Fellow of the Association for Materials Protection and Performance and will serve as an advisor to the association. He was recognized for his outstanding and significant contributions to academic, mentoring, technical and policy efforts in his field.


132280

Dr. Steve Dellenback, vice president of SwRI's Intelligent Systems Division, has received the ITS World Congress Hall of Fame's Lifetime Achievement Award for 2026. The award recognizes luminaries and true thought leaders in the ITS field. Dellenback pioneered SwRI's ITS research program, which began in the 1990s. Today, the Institute provides ITS solutions across the nation through the ActiveITS™ software platform.


D025430_4779

Dr. Kevin Miller, a staff engineer in SwRI's Intelligent Systems Division, had his paper "Turning Regional Data into Multimodal Operations" selected as the Best Technical Paper of the 2026 Gangneung ITS World Congress. The ITS Congress is the world's largest ITS event and was held in Gangneung, South Korea, in October.


132273

Dr. Olivier Mousis, a program director in SwRI's Solar System Science and Exploration Division, has been elected an Academician, or full member, of the International Academy of Astronautics (IAA). Full IAA membership recognizes his distinguished contributions to space science and exploration, particularly the origin and evolution of the solar system.


132223

Institute Scientist **Dr. Kurt Retherford** of SwRI's Space Science Division will serve as vice chair of the American Astronomical Society Division for Planetary Sciences this next year and as chairman the following year. He will then serve three years as chairman pro tem. He specializes in UV studies of planetary surfaces and atmospheres.


132266

Senior Research Scientist **Dr. Justyna Sokol** of SwRI's Space Science Division is serving as the heliophysics community liaison for the Lunar Exploration Analysis Group (LEAG) executive committee. Established in 2004, LEAG supports NASA, analyzing the scientific, technical, commercial and operational issues related to lunar exploration and habitation.

TECHNOLOGY TODAY

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