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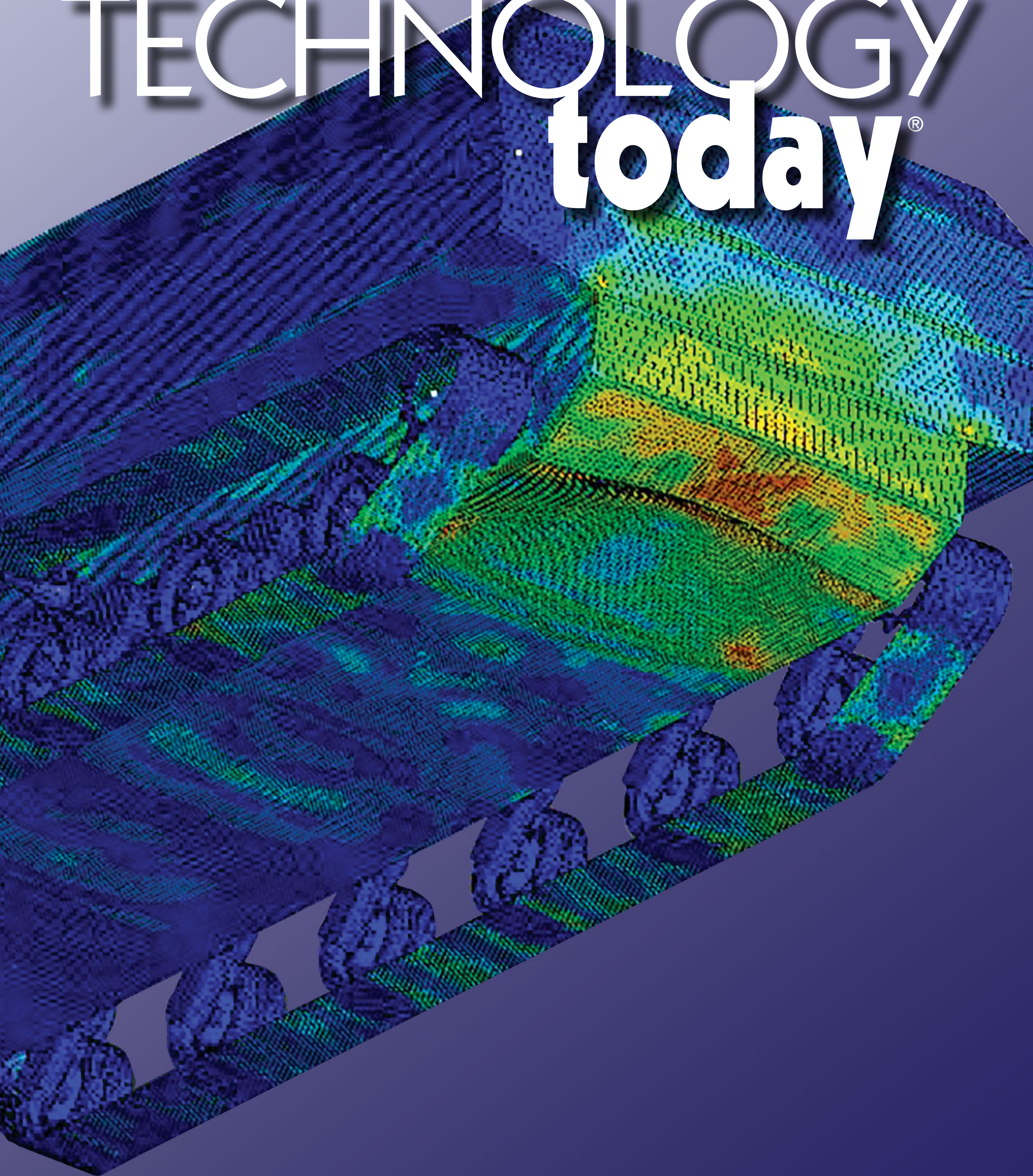

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Since its founding in 1947, Southwest Research Institute (SwRI) has contributed to the advancement of science and technology by working with clients in industry and government. Performing research for the benefit of humankind is a long-held tradition. The Institute comprises 10 divisions engaged in contract research spanning a wide range of technologies.

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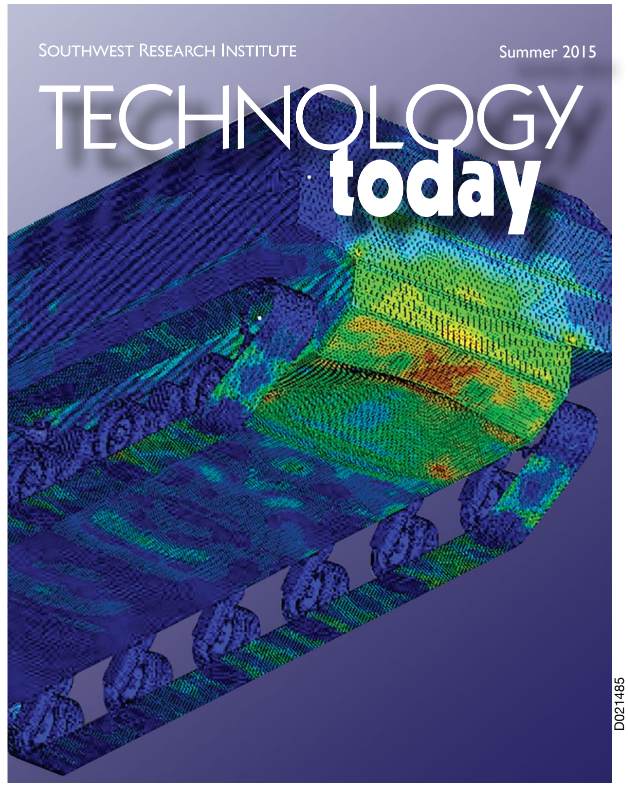
COVER



About the cover
SwRI researchers have developed software analysis tools that will help designers create the next generation of combat vehicles.

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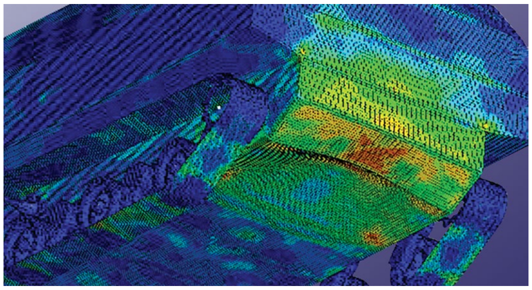
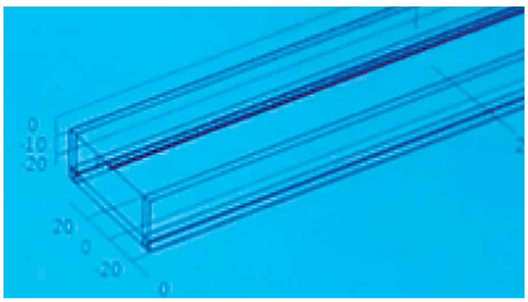
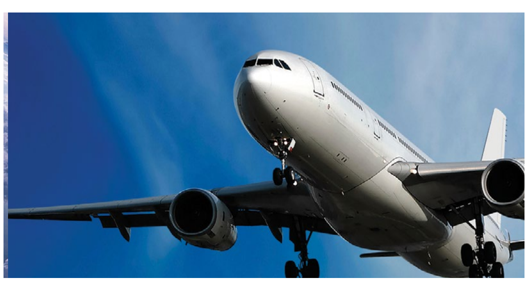






Departments

Faster by Design

An SwRI multidisplinary effort produces software, design tools for next-generation combat vehicles

From left, Dr. James Walker is director of the Engineering Dynamics Department in SwRI's Mechanical Engineering Division. His research efforts focus on the mechanical response of a variety of systems and materials to impact loads. Dr. Sidney Chocron is manager of the Computational Mechanics Section in the Engineering Dynamics Department. Chocron specializes in the response of materials at high strain rates. Dr. Michael Moore, a staff engineer in the Tactical Networks and Communications Section in the Communication and Embedded Systems Department of SwRI's Automation and Data Systems Division, specializes in systems engineering and design. Gregory Willden was formerly a staff member in the Automation and Data Systems Division.

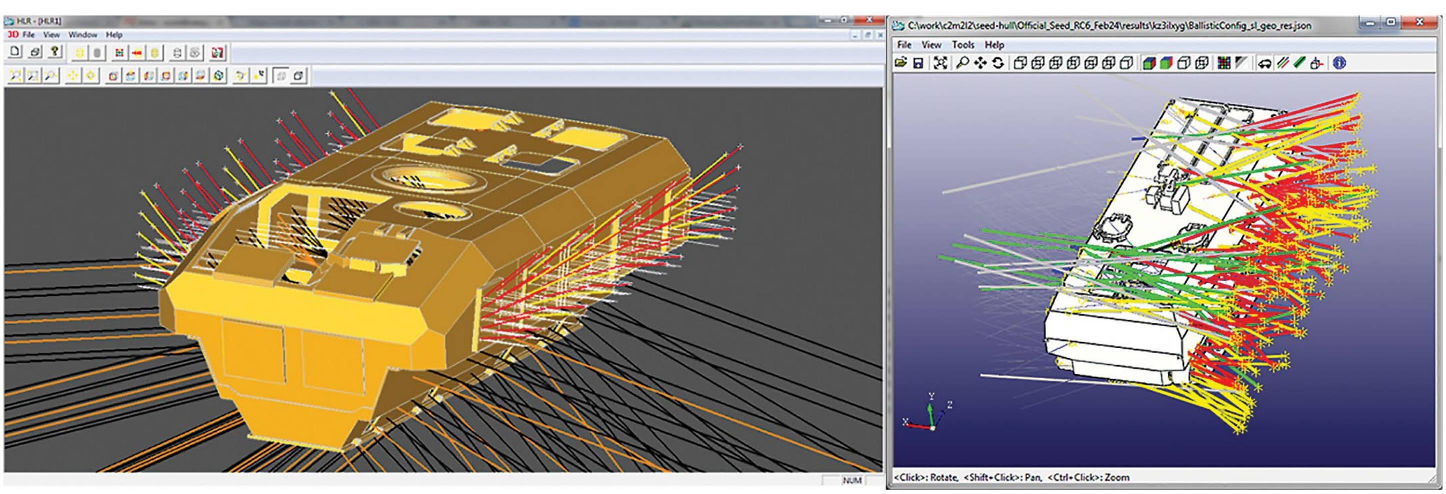
By James D. Walker, Ph.D., Sidney Chocron, Ph.D., Michael Moore, Ph.D., and Gregory C. Willden

Complex military systems are increasingly expensive to develop. Complexity increases cost when it leads to "schedule slip," which leads to changes to the systems, which, in turn, leads to increased complexity. This complexity versus cost spiral oftens results in systems that meet the higher performance objectives, but are no longer affordable. The industry terms this phenomenon "requirements creep."

Over the past six years, three major heavy vehicle development programs for the U.S. Department of Defense have been cancelled. The vehicles for all three programs were complex, electro-mechanical systems intended to replace currently fielded systems with vehicles having new capabilities and enhanced survivability. The need for these advanced vehicles stemmed from threats encountered in the past decade of conflicts. The fact that the new capabilities are just now getting integrated with vehicles, and in some cases have yet to be integrated, is a testament to the difficulties faced by the DoD with the current vehicle procurement model. The Defense Advanced Research Projects Agency (DARPA) launched the Adaptive Vehicle Make (AVM) portfolio of programs with the ambitious goal of reducing the time from concept to rolling vehicle by a factor of five. By changing the design paradigm, the first vehicle rolling off an assembly line would be fully functional, and thus the long years of fixing, redesigning, and requirements creep would not occur. These vehicles would be "correct by construction" rather than "correct by design," meaning that for complex systems, what rolls off the production line would not be exactly the original design, but it would work and meet the requirements.

SwRI and the AVM effort

The AVM effort aimed to foster a new design methodology centered around computer-aided design (CAD) automated



Designers can use the shotline viewer to explore the effects of ballistic impacts.

analysis software tools. These tools would allow designs to be evaluated in the digital space, reducing the number of physical prototypes. The tools were to be tailored and evaluated against designs for ground combat vehicles, specifically an amphibious armored troop carrier.

Southwest Research Institute (SwRI) was awarded the contract to deliver analysis models for the AVM effort in the area of survivability. This was a $5.7 million program, with the majority of the work to be completed in one year. The SwRI team provided models to evaluate the survivability of the vehicle designs against ballistic, blast, and corrosion threats. The team drew from several SwRI technical areas for experts in mechanical engineering, ballistics and explosives, materials engineering, and structural engineering as well as in systems engineering, software architectures, model-driven design, electronics, and training. Four subcontractors also were involved.

Before SwRI was involved in the AVM effort, the tools developed were used in an open design competition, with DARPA awarding a $1 million prize to the winning design team. The powertrain and suspension were integrated into a chassis, and the mobility performance of the as-built chassis was compared to the predictions made by the design software.

In order to further exercise the tools developed, selected vehicle manufacturers used the software developed at SwRI to aid in designing their vehicles. To demonstrate the SwRI-developed survivability software's capability, the government also performed a design exercise, with blast article fabrication and blast testing performed at SwRI under DARPA's Fast Adaptable Next-Generation (FANG) Ground Vehicle program. DARPA transitioned the AVM effort to the newly formed Digital Manufacturing and Design Innovation Institute, where the tools continue to be developed.

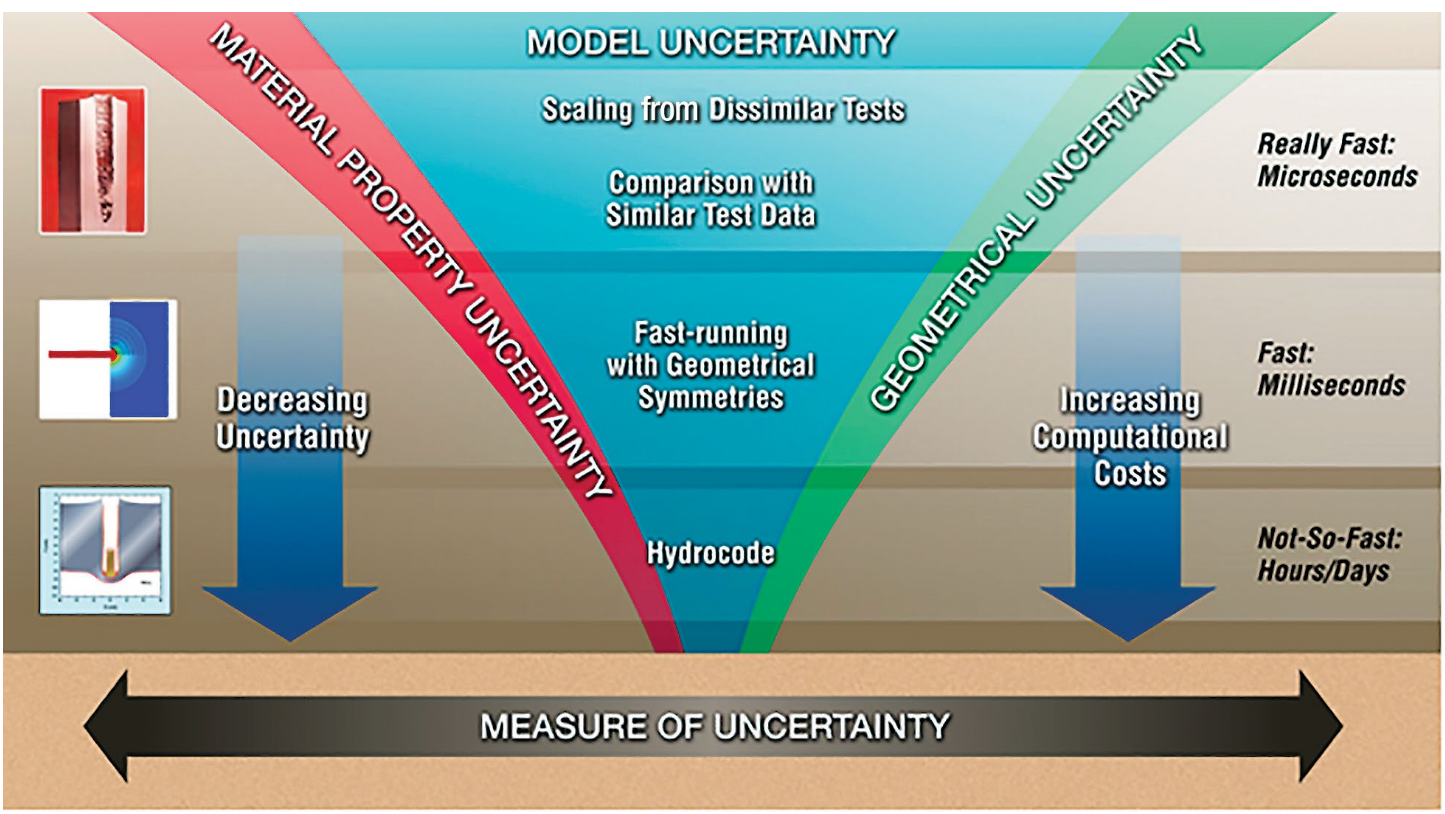
Advanced tools for advanced vehicles

The SwRI team's work resulted in significant advances in analytical software tools such as the survivability tools, which analyze blast and ballistic survivability. The DARPA-funded teams used the survivability tools extensively for design exercises and earned favorable reviews from the commercial engineering design and manufacturing companies that produce defense systems.

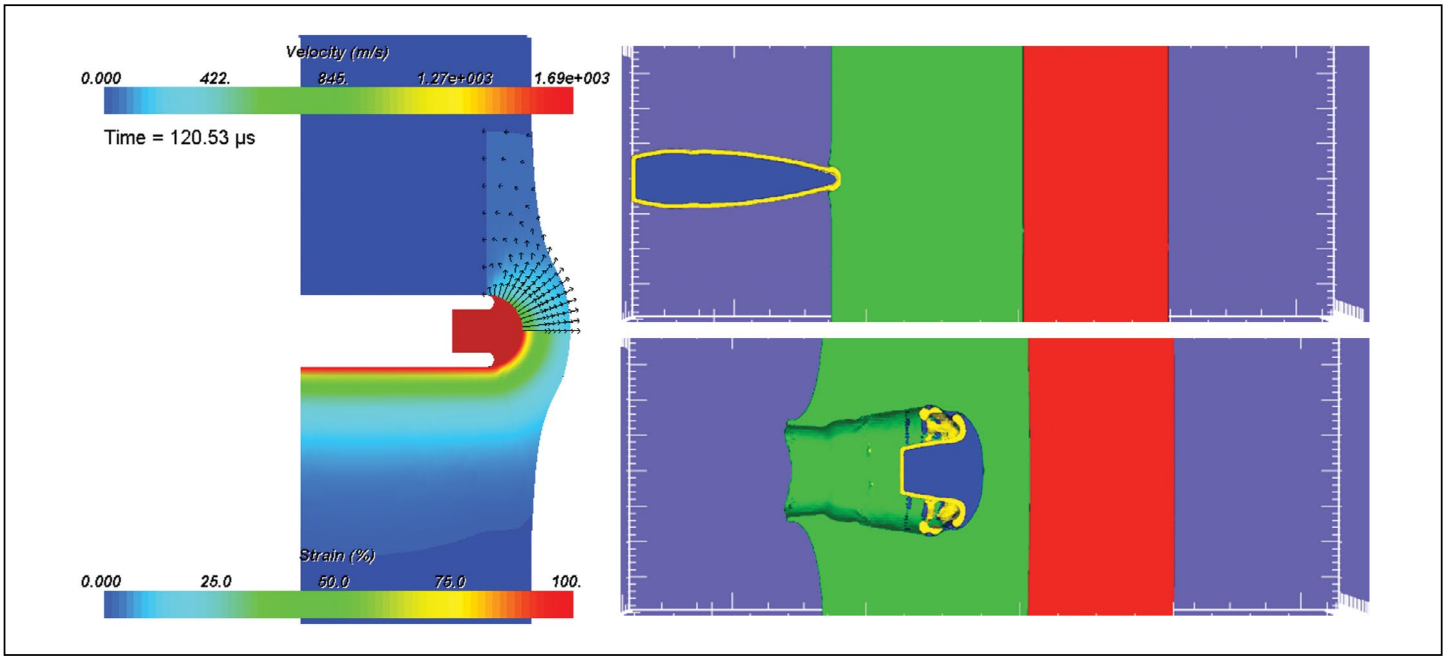
The SwRI team was able to combine its considerable experience and expertise in impact and blast research with SwRI vehicle and software expertise, plus that of our subcontractors, to produce software tools that are best demonstrated by five major innovations developed during the project: multi-fidelity analysis/varying levels of refinement; automated meshing and connecting of parts for complex vehicle structure; uncertainty quantification and development of 95-percent bounding models; and a sophisticated large deformation/material failure material model library and better blast loads analysis tools. The fifth innovation was to connect the whole design "pipeline" together so it executes automatically.

A major goal was to make the survivability analysis tools easy to use. For example, the team developed a shotline viewer that allows a designer to explore the effects of ballistics impacts on a vehicle and shows results of the terminal ballistics models. For blast analysis, the software pipeline produced movies of the explosive event, showing the resulting deformation and damage to the vehicle. These capabilities allow designers with limited background in survivability to quickly understand how these threat environments affect their design.

Another major goal of the tool development was to remain "CAD agnostic" as much as possible. CAD agnostic means that the tools are not tied to one specific CAD system, but rather use a generic



The multi-fidelity modeling approach uses tier levels to allow rapid design assessment.

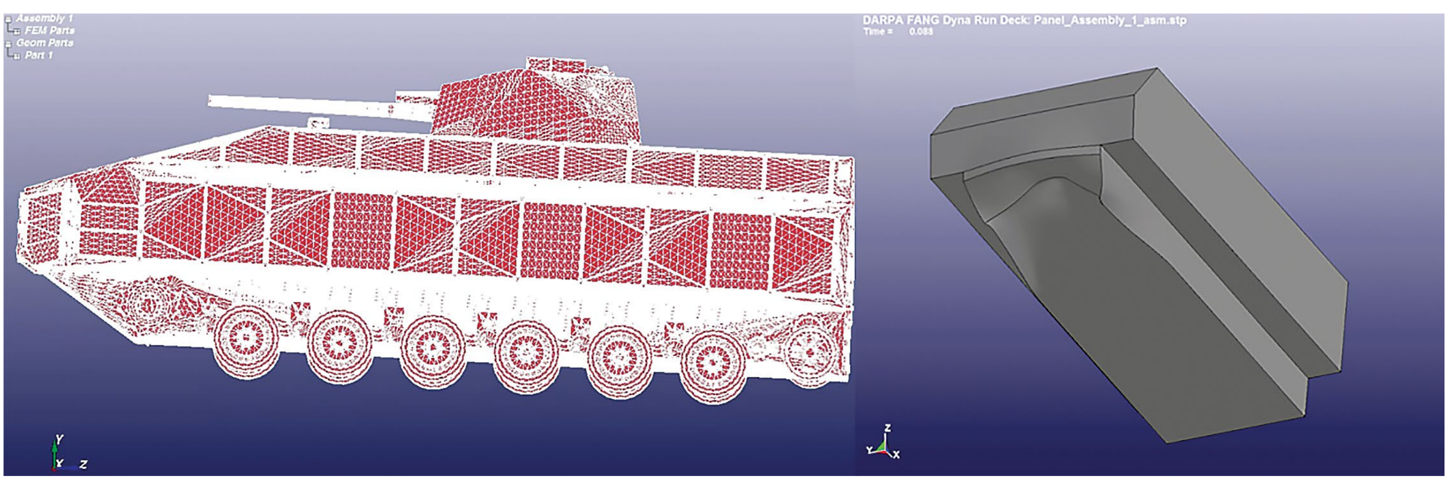


These illustrations show the difference between a fast-running physics-based Tier 2 terminal ballistics model (left) and a highly detailed Tier 3 ballistic computation of a projectile striking an armor plate (right).

CAD format — referred to as STEP (Standard for The Exchange of Product model data) files — so any CAD system would be able to use the SwRI-developed ballistics and blast tools.

Multi-fidelity analysis

A major innovation that SwRI brought to the DARPA program was a multi-fidelity modeling approach employing different tier levels. Each tier had a different level of accuracy and uncertainty, in exchange for different amounts of computational time. For example, lower tier models are simpler, typically based on more assumptions about the physics. Because they include physics assumptions that then require less detailed computations, they have shorter computation run times, and thus are less expensive, but they also are less accurate and have a higher degree of uncertainty. The multi-tier approach allowed rapid exploration of the design space using fast-running lower tier models that sped up the conceptual design phase. In addition, by developing the different tiers of models, simpler, lower-tier models were quickly completed and thus working survivability models were always available in the software development process. This was beneficial for the concurrent development of other pieces of software and the definition of interfaces. Further, the various tiers of survivability solvers could also be used at a conceptual level, where only an outer "concept hull" needs to be defined. This allows a rapid initial design space exploration to determine the amount of armor and structure needed to survive a specified threat. As a design proceeds through more detail, the survivability analysis can be applied many times to allow the designer to make adjustments, such as at manufacturing seams, to ensure designer-level protections. By performing survivability analysis at the conceptual level, it is feasible to automate the design-space exploration.

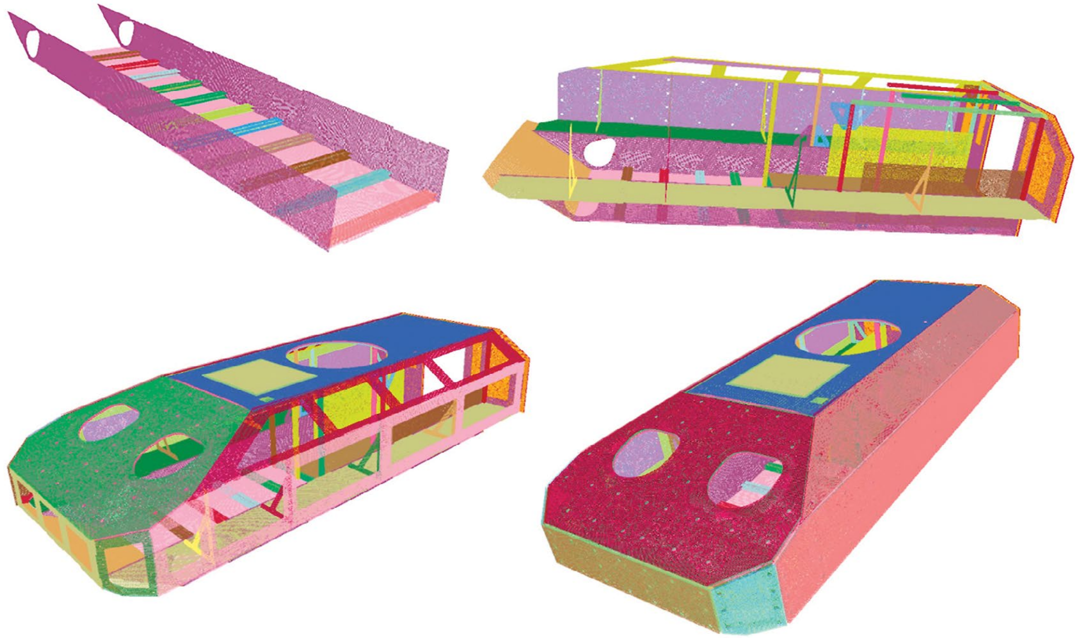


An analysis of motion from a Tier 1 blast (left) takes seconds to compute, while a Tier 3 blast near the front of a conceptual hull (right) requires about an hour of computation time.

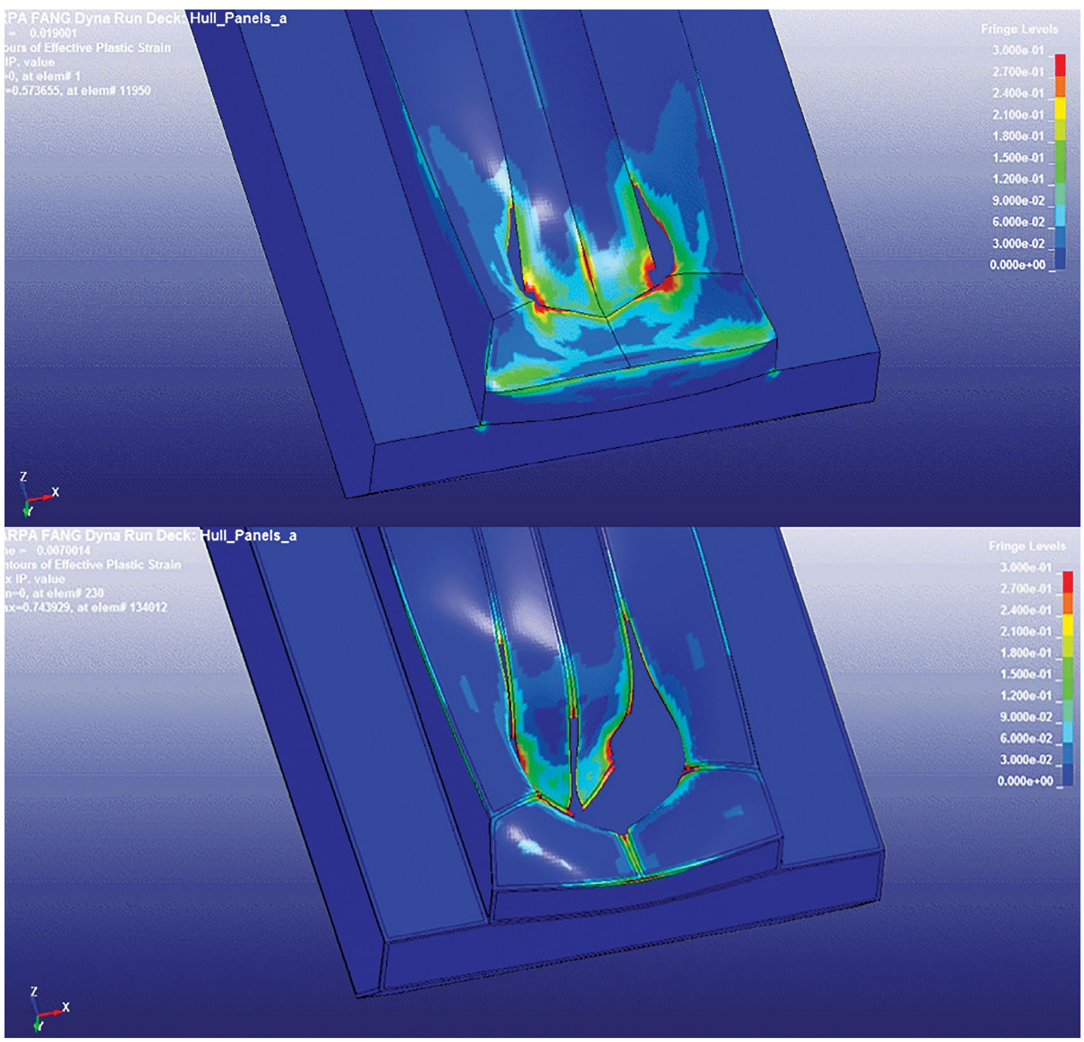
Automated meshing and connecting

One of the more tedious and time-consuming steps in survivability analysis is transforming CAD geometry to a format that is amenable to analysis tools. To make the tools more useful and to head toward the goal of "press one button in CAD to get your analysis," the team developed tools to automatically mesh and then connect parts for the blast analysis. Our tools provided automatic meshing of various structural parts with a focus on producing quad-shell meshes, the types of meshes that have been shown to give the most accurate results in structural blast computations. (Structural parts include plates, panels, skins, and cross-section beams such as I-beams, C sections, and brackets.) The various parts are then automatically positioned in 3-D space, or "assembled" to produce the concept vehicle. Many different types of parts, with various meshing schemes, can be assembled this way. The emphasis is on robustness in automatically producing a good mesh for blast loading.

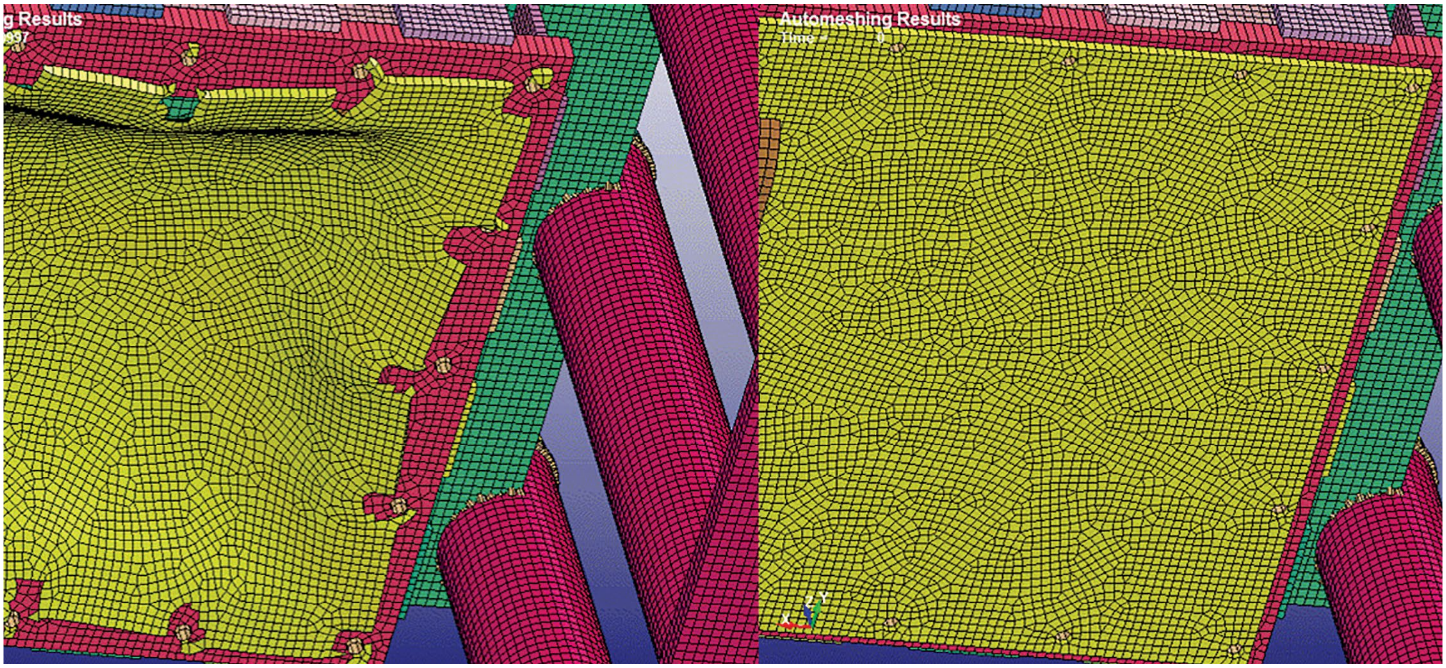
An important part of the assembly of a mesh is its connections. The team developed an electronic "bolter/welder tool," which includes the ability to operate the tool both when connections are specified or in an automatic mode. The combination of the powerful automatic welding feature and the automatic generation of meshes greatly reduces analysis time. Welds are automatically inserted when free edges are seen to be near other objects. Bolts are automatically inserted when holes are found aligned and a bolt for the region has been specified. In particular, the tool can bolt multiple plates together (three or more) if the bolt holes line up.



Using the automated meshing feature, a designer can produce a vehicle, including interior structural members, in about four to five minutes using a conventional computer.



These images show a blast computation on a conceptual hull without (top) and with (below) a heat-affected zone (HAZ). Including the HAZ shows how the materials will be affected by a blast.

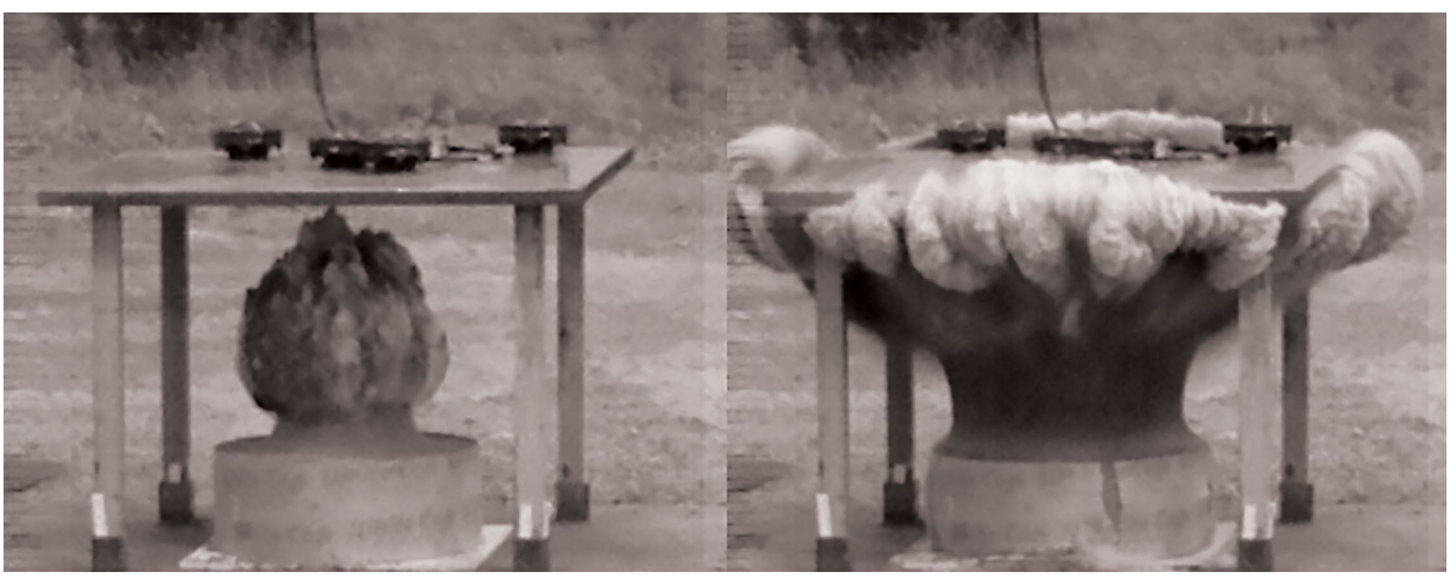


This computation shows that strong bolts can tear a test panel during loading (left), while weak bolts will break (right).

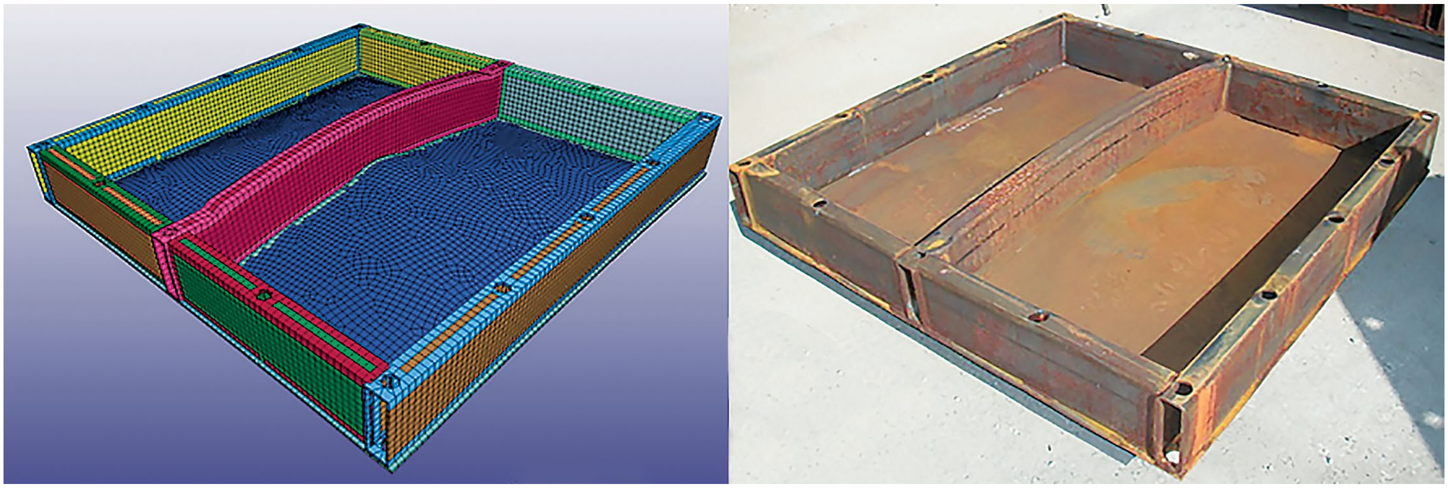
Another important element of the weld-connection and mesh-production capability is the inclusion of a heat-affected zone (HAZ). Not including a HAZ leads to unrealistic strength predictions near joints. The automeshing tool, after connections are complete, passes through the mesh and produces a HAZ near all the welds. The material strength and damage properties are adjusted in the HAZ. It is important to include the HAZ in a mesh when performing blast computations, and the SwRI-developed tools did it automatically. During the connections step, a corrosion analysis also is performed.

Uncertainty quantification

Given the complexity of the computations and the multi-fidelity nature of the tools, the SwRI team quantified uncertainties and developed bounding models. The team developed ballistic and blast models to return 95-percent bounding results in addition to the nominal results. This means that, based on historical knowledge of variations in inputs into the models, one can find the performance bounds of the armors and blast mitigation systems. Using these statistical variations, many executions of the models were run *a priori* for certain situations to allow development of inputs to the physics-based models that would return the 95-percent bounding result. These computations used fast, off-line computations to develop an understanding of the influence of material, geometry, and other variability on the survivability results. With this, one can compute not only the nominal performance of the vehicle under a ballistic or blast threat event, but also the 95-percent bounding or worse-case response. This allows designers to know how close they are to meeting performance objectives, and



SwRI validated the blast survivability tools experimentally, such as this test designed to measure the loads on an armor plate produced by a buried charge.



This side-by-side comparison shows a structural test specimen undergoing blast loads using the computational pipeline (left) and from an experiment conducted at the SwRI test range.

how much resilience is built into their design. This information can be used in an optimization study where robustness is one of the optimization parameters.

A sophisticated material model library

Survivability systems are used once, and the materials are used all the way through failure. Hence, it is necessary to know the large deformation and failure properties of the materials. As part of this program, the SwRI team compiled a database of survivability materials with constitutive properties that described the large-deformation, plastic-deformation, and flow as well as the damage properties. Large deformation means that solid materials reach a limiting strength. Sometimes the deformation is so significant that it causes the material to "flow" similarly to a viscous fluid. A permanent final deformation is referred to as plastic deformation.

Also, because blast loads for buried charges are still a research topic, the SwRI team performed experiments to further characterize the blast loads on simple structures. In addition, experiments were performed using v-shaped hull body designs because in some instances involving buried charges, v-shaped hulls have been shown to reduce loads imparted to the vehicle by underbelly blast.

The team also tested structural members to validate loads and the computational pipeline. Structural members were held in a test frame and blast loaded with buried charges. These same structures were blast-loaded using the computational pipeline. Through this work, as well as extensive use of historical data, the blast survivability tools were validated and showed good results.

Connecting the whole pipeline

Historically, manually performing all the steps in survivability analysis was quite tedious and time-consuming. A concerted effort to automate the whole process paid off by greatly reducing the amount of time required. During one of the DARPA exercises, teams said the survivability software allowed them to perform detailed conceptual design iterations in 30 minutes per iteration, something that previously may have taken two weeks per iteration. Other design teams praised the tools for their ease of use, speed, and the unique ability to convey survivability results to the vehicle designer. Extensive verification and validation exercises were performed on all the models to confirm their implementation and the implementation of the pipelines.

Future applications

The survivability analysis modeling tools are an important and successful part of the DARPA AVM effort. They perform as designed, fully automating complex steps that typically take man-weeks to perform, and also providing estimates and bounds on the soundness of the answers. The SwRI team successfully demonstrated that automating steps ranging from material properties to meshing, connecting, and uncertainty quantification (UQ) analysis is a useful capability for designing blast- and impact-resistant vehicles. In addition to their use by others, SwRI researchers have used these software tools in important follow-on design activities to analyze vehicle survivability.

Questions about this article? Contact Walker at (210) 522-2051 or james.walker@swri.org.

Acknowledgments

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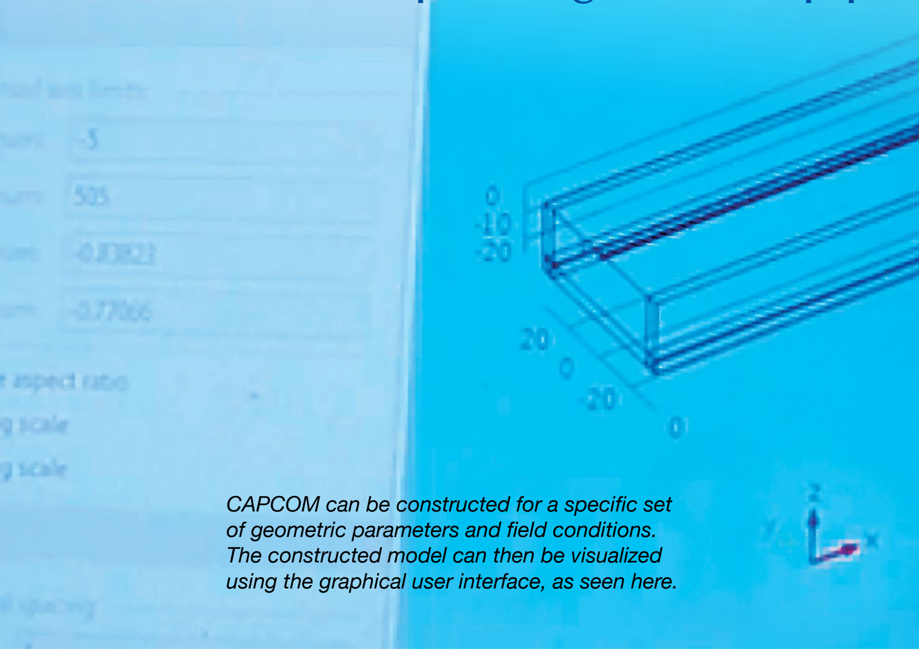
Virtual Inspection for Pipeline Corrosion

An SwRI-designed computer model predicts corrosion risks for hard-to-inspect segments of pipeline



CAPCOM can be constructed for a specific set of geometric parameters and field conditions. The constructed model can then be visualized using the graphical user interface, as seen here.

Dr. Pavan Shukla is a senior research engineer in the Geosciences and Engineering Division. He has expertise in modeling corrosion and chemical processes using finite and boundary element methods. His current work includes assessing degradation on both metallic and nonmetallic pipeline materials, and predicting localized-corrosion-induced damage.

By Pavan K. Shukla, Ph.D.

The oil and gas pipelines criss-crossing the nation pass beneath critical infrastructure, such as highways, railroads, and waterways, as well as population centers. Because more than half of U.S. pipelines date to the 1950s and 1960s, corrosion prevention and related repairs are increasingly important to avoid pipeline failures that can lead to toxic spills or devastating explosions.

Ironically, pipeline segments that lie beneath some of the most sensitive areas are also among the most difficult to inspect. Because these segments need extra protection to avoid damage from nearby excavation, settlement, traffic loads, and erosion, the carrier pipe is often encased within a larger-diameter reinforcing pipe. These segments, called cased pipelines, are subject to not only the normal corrosion caused by time, moisture, and soil chemistry, but also electrolytic corrosion caused by contact between the metals of the carrier pipe and its casing. In addition, the outer casings can adversely affect cathodic protection systems installed to reduce corrosion.

Cased pipelines often are sealed or have a separating medium such as wax placed between the layers of pipe. Over time, the seal can break, allowing the space between pipe layers to become filled with soil or water. Furthermore, the spacers that separate the carrier and casing pipe can break down over time, creating metallic contact between the carrier and casing pipes. It is estimated that there are close to 1 million cased crossings in the U.S., and approximately 40 percent of them may have degraded to the point of metallic contact between pipe layers.

External, visual inspection of cased pipelines is often impractical because of their location. Some are inaccessible, and in other cases obtaining a permit to perform an inspection dig may be difficult or impractical. Inspection of a cased pipe segment requires uncovering the segment, opening the space between pipe layers, and inserting an instrumented probe between layers to inspect the inner pipe's integrity.

Internal inspection by sending a tubular, instrumented device known as a "pig" through the carrier pipeline along with the product requires no excavation, but it is expensive and usually done only once every five years.

Modeling hidden risks

Engineers at Southwest Research Institute (SwRI) have developed the CAsed Pipeline COrrosion Model, or CAPCOM®, to predict the corrosion condition of these double-layer pipeline

Pipeline failures can lead to devastating explosions, such as this one in San Bruno, Calif., in 2010.

segments. CAPCOM uses a unique, specialized application of the finite element method (FEM) to arrive at a mathematical model of the pipeline's condition in relation to corrosion. Mathematicians use FEM to model complex surfaces, structures, or even weather systems, by breaking the problem down into a large number of much smaller, simpler-to-solve components called finite elements. (Imagine approximating the area of a circle by turning it into a great number of extremely thin, pie-slice triangles.) Solutions to those smaller element equations are then re-combined into a solution that approximates the whole. For a cased pipeline, FEM provides a tool for making improved predictions of the integrity, service life, and corrosion risk.

A common source of corrosion in pipelines and many other metallic structures, such as ships or offshore oil platforms, is an electron exchange that happens when two dissimilar metals touch each other or are linked by an electrically conductive fluid, or electrolyte. (Salty sea water is an electrolyte; so are wet soil and rainwater with dissolved minerals.) As with a battery when the switch is turned on, a flow of electrons (electric current) begins, robbing metal molecules from the negative connection, or anode, and depositing them at the positively charged end, or cathode.

To mitigate this metal loss, pipeline operators employ cathodic protection (CP), which makes the metal pipe the cathode of the "battery" and substitutes an easily corroded "sacrificial" metal to act as the anode. The sacrificial metal corrodes instead of the protected metal of the pipeline. For pipelines and some other large structures, a direct-current electrical power source is installed to provide sufficient current. CP systems are used to control corrosion on critical steel structures of all sizes, from pipelines and ships to outboard motors and home water heaters.

In pipeline segments where visual or inline inspection is limited, CAPCOM can provide valuable information on corrosion conditions. By estimating pipe-to-soil electrical potential along the cased pipeline segment, and possible corrosion rates on the carrier pipe, CAPCOM can help determine whether the cased pipeline section is adequately protected, or if it is time for preventive maintenance.

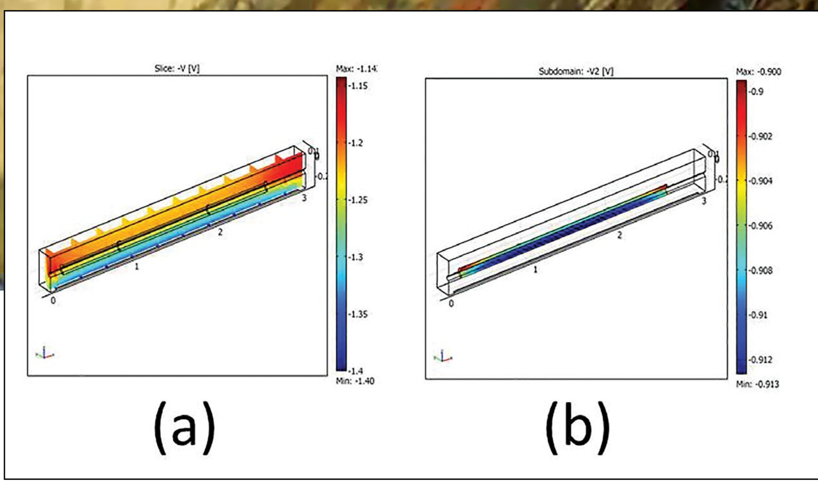
CAPCOM can model complex corrosion scenarios, including electrolytic or electrolytic-plus-metallic contact between the carrier and the casing pipe, defects in the carrier pipe's coating, or combinations of these. It also can identify the level of polarization of the cased-pipeline segment and the rest of the nearby pipeline when there is electrolytic contact between the carrier and casing.

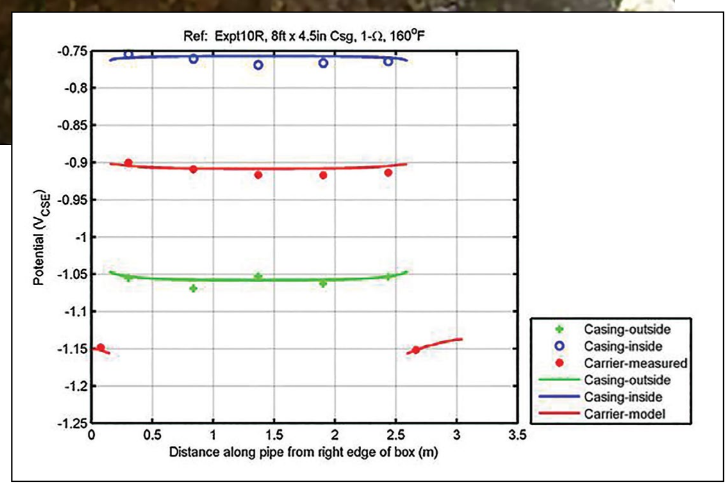
For pipeline segments that use a CP system to prevent electrolytic corrosion, CAPCOM can quantify the system's effectiveness for mitigating corrosion. It also can quantify how much more CP current may be needed to adequately protect the pipeline when electrolytic contact between the casing and carrier pipe has been confirmed.

How it works

CAPCOM employs the same basic mathematical input parameters used in existing models of CP systems for uncased pipelines (such as coating quality, pipeline material, anode output,

A cased pipeline with the carrier pipe inside a larger diameter casing pipe, as shown here, presents special problems with corrosion inspection.





When comparing the CAPCOM model (see above) with an inspection, electric potentials predicted by the model (represented by solid lines in the figure at the right) closely match the potentials measured by actual inspection (represented by symbols).

and the electrical current flowing through the soil and the electrolyte). However, it adds inputs related to the casing pipe itself. For example, CAPCOM inputs for both cased and uncased sections of the pipeline include their dimensions and coating properties, plus soil properties and any electrolytic properties that may exist inside the space between the casing and carrier pipe. CAPCOM analysis also includes the CP design used to protect both cased and carrier pipes in its models.

CAPCOM's FEM method solves the model equations for predicting corrosion conditions of the cased-pipeline section. Using the FEM formulation, CAPCOM also can represent varying conditions that affect the carrier pipe, such as how the soil conducts or resists electrical conduction at different locations near the cased portion of the pipeline.

This capability sets CAPCOM apart from other CP models, which use a different modeling approach known as the boundary element method (BEM). BEM-based software works best when modeling a homogenous medium (such as soil of uniform properties surrounding a pipeline) but it has limited ability to model how the surrounding soil or other fill material with varying chemical composition and moisture content affects pipeline corrosion. This limitation precludes using BEM tools for complex cased crossing conditions.

CAPCOM explicitly accounts for electrolytic-plus-metallic contact between carrier and casing pipe and the soil outside the cased crossing to determine the corrosion condition of the carrier pipe. In CAPCOM, metallic contact and electrolytic contact are accounted for by modeling a resistor and an electrolyte, respectively, between the carrier and casing pipes. CAPCOM also includes specifications for modeling "coating holidays" — places where the protective coating is damaged or missing — both inside and outside the cased pipeline section. After all of the parameters are entered and limits are defined, CAPCOM models the corrosion environment and presents its results in two- and three-dimensional plots. These plots include pipe-to-electrolyte potential for the cased and uncased carrier pipeline sections, as well as the state of the electrical current the CP system supplies to the carrier pipe. The model reveals whether the CP current is diverted to the casing pipe, indicating metallic contact between carrier and casing pipes. With CAPCOM, users can determine the level of CP the carrier pipe will need and evaluate the risk of external corrosion at "holidays" on the carrier pipe inside the casing.

Comparing costs

CAPCOM saves costs compared to both visual and in-line inspections. Visual inspection requires removing the topsoil over the pipeline, exposing the two ends of the casing pipe, and probing the interior with an inspection tool. Visual inspection can cost $50,000 to $100,000, depending on the size and location of the casing. By comparison, analyzing pipelines with CAPCOM software requires only the associated engineering time for the analysis, once the software is purchased. Although the software has an estimated cost of $35,000, it can be used numerous times, allowing this cost to be spread over a number of evaluations.

In-line inspection using an instrumented pig costs $10,000 to $20,000 per mile, but it generally must cover long segments of pipeline to be practical, because the above-ground "launch" and "trap" stations for inserting and recovering the pig are usually about 20 to 50 miles apart. Also, pig inspections are carried out as often as every five years, which could, in many situations, be insufficient to detect and prevent corrosion-induced damage of carrier pipe.

Limitations

CAPCOM does require a large number of input parameters to simulate the corrosion conditions of a cased pipeline. These parameters are determined by field measurements, which may not always be available. However, the SwRI team addressed this potential limitation by formulating CAPCOM such that when a parameter value is unavailable, a nominal value with a variability range can be substituted. Thus, pipeline behavior can be simulated for a range of parameters, yielding a range of expected corrosion conditions and electrode potential of the pipeline casing.

Current and future applications

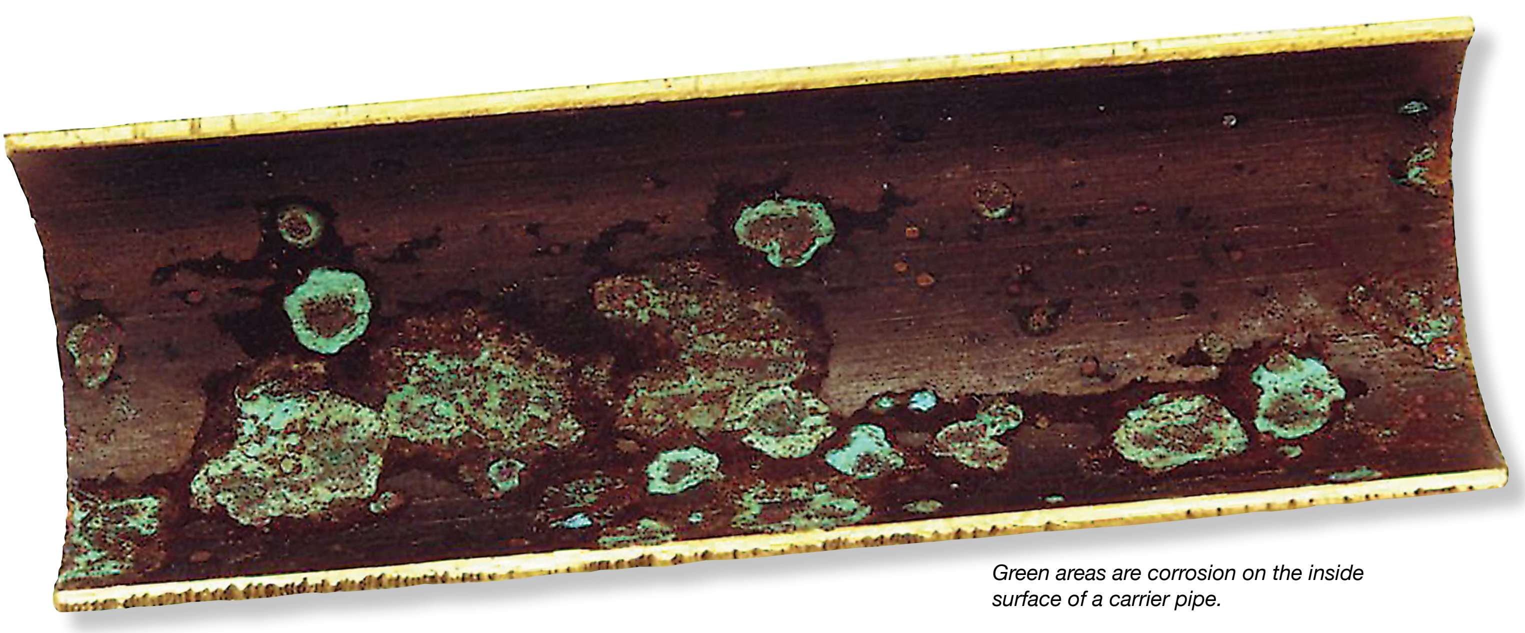
As a modeling tool, CAPCOM has applications not only as an alternative to direct pipeline inspection but also as a tool to assess corrosion-inhibiting products used on pipelines. CAPCOM potentially can save human lives and millions of dollars' worth of private property and public infrastructure. It enables reliable inspection and life prediction of critical pipeline segments that are, by their very nature, difficult to inspect.

Questions about this article? Contact Shukla at (210) 522-6534 or pavan.shukla@swri.org.

For more information, see "Development of Cased-Pipeline Corrosion Model and Its Validation with Experimental Data," by P.K. Shukla, A.Nordquist, and F. Song. Published in the Proceedings of *CORROSION 2014*, paper No. 4353, Corrosion 2014, San Antonio, March 2014.

ABSTRACT

A large-scale FEM-based model was developed for cased pipelines. The model contained features that could be used to evaluate the condition of a pipeline inside casing, without the difficulty and expense of measuring cathodic polarization within the casing. Casings are used to provide load-bearing protection to carrier pipelines at crossing locations, such as highways and railroad lines. The Pipeline Research Council International has published a report containing multiple experiments on cased pipeline. In these experiments, eight parameters were varied; four of them were at 2 levels and four were 3 levels. Overall, the report contained 18 repeats of 36 unique experiments. A computational model of the cased pipeline was developed to simulate experimental conditions in the report using a finite element method-based computer code. This model included significant features of the experimental apparatus. Comparisons were made between the model and the experimental measurements. The model details and its comparison with the experimental data are presented.



Green areas are corrosion on the inside surface of a carrier pipe.

Countdown to

New Horizons sends the first detailed images of Pluto's surface

By William Lewis, Ph.D.

On July 14, 2015, at precisely 6:49 a.m. CDT, the New Horizons spacecraft hurtled past Pluto at an altitude of about 7,750 miles and a spacecraft-record speed of 9 miles per second. It was not until the following morning, however, that the flyby images from the Pluto-Charon system reached Earth: a close-up of Pluto's moon Charon followed by stunningly detailed images of Pluto's weird and puzzling terrain. What these historic images of Pluto revealed was an unexpectedly complex and geologically active world.

In the weeks leading up to the Pluto encounter, New Horizons' Long-Range Reconnaissance Imager (LORRI) had been sending low-resolution images that nevertheless set new records for clarity, showing hints of mysterious surface features on the dwarf planet. This had been the case since mid-May, when onboard imaging first exceeded all previously available views of Pluto.

On the morning of July 15, however, in the first post-flyby images, the tiny planet's mysteries took on definite and detailed forms. Clustered around laptops at the Johns Hopkins University Applied Physics Laboratory (JHU/APL), members of the New Horizons science team were treated to humankind's first glimpse of icy mountains towering as high as two miles above Pluto's surface and of a craterless, strangely patterned plain of frozen carbon monoxide, nitrogen, and methane. The images were electrifying; and, amid expressions of amazement and surprise, the scientists ventured the first tentative interpretations of what they were seeing — an object far stranger than any of them had imagined.

Analysis of these first images and other data is ongoing. Because of the spacecraft's low data rate, however, the New Horizons team has to wait 16 months for all of the data acquired during the encounter to be sent back to Earth.

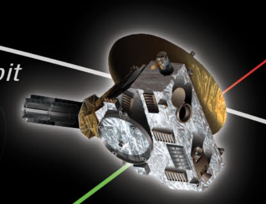
The breathtaking images of Pluto and Charon, as well as the first close-up images of the moons Nix and Hydra, have understandably attracted the most attention. However, New Horizons has also made important discoveries about the structure and composition of Pluto's atmosphere and its interaction with the solar wind, the million-mile-an-hour outflow of electrically charged particles — ions and electrons — from the Sun. These discoveries include a tenuous haze layer extending nearly 100 miles above Pluto's surface and a "plasma tail" of heavy ions escaping from the atmosphere. And images of Styx and Kerberos, Pluto's faintest moons, are still to come.

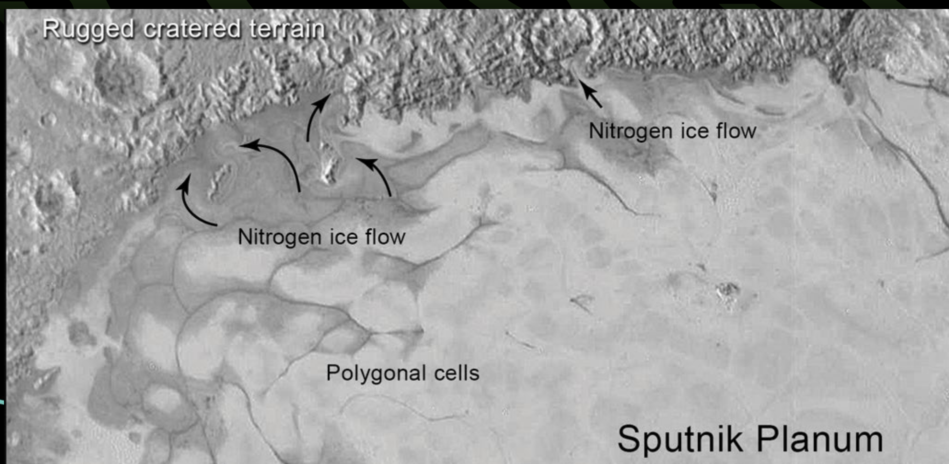
The encounter with Pluto and Charon highlighted a nine-and-a-half year, 3-billion-mile (4.8-billion-kilometer) journey that began with the launch of the spacecraft on an Atlas V rocket from Cape Canaveral, Florida, on January 19, 2006. The spacecraft was designed and built by JHU/APL, which also manages mission operations. The mission is led by Principal Investigator Dr. Alan Stern, an associate vice president of Southwest Research Institute's (SwRI's) Space Science and Engineering Division. SwRI is responsible for science operations and encounter science planning and built two of New Horizons' seven instruments—the Alice ultraviolet imaging spectrograph

(Courtesy Bill Ingalls/NASA)

Principal Investigator Alan Stern, Ph.D. (center, seated), and other New Horizons team members examine the first post-flyby images of Pluto on the morning after the encounter. SwRI team members include John Spencer, Ph.D. (left foreground), Randy Gladstone, Ph.D. (standing, second from left), and Maria Stothoff (standing, second from right). At center behind Stern is author William Lewis, Ph.D., a principal scientist in SwRI's Space Science and Engineering Division. "After a journey of more than nine years through space, it's stunning to see Pluto, literally a dot of light as seen from Earth, becoming a real place right before our eyes," said Stern.

a Close-Up





NASA/JHUAPL/SwRI

This LORRI image shows the northern edge of Pluto's icy plain where it meets more rugged, cratered terrain. The image was acquired at a distance of 48,000 miles from Pluto and shows features as small as half-a-mile across.

and the SWAP (Solar Wind Around Pluto) plasma analyzer. SwRI also collaborated with Ball Aerospace and NASA's Goddard Space Flight Center on the development of the Ralph visible/near-infrared imager.

Also on board New Horizons are LORRI and the PEPSSI (Pluto Energetic Particle Spectrometer Science Investigation) instrument, both developed at JHU/APL; the REX Radio Experiment (Stanford University and JHU/APL); and the Venetia Burney Student Dust Counter (VB-SDC), developed and operated by students from the University of Colorado at Boulder.

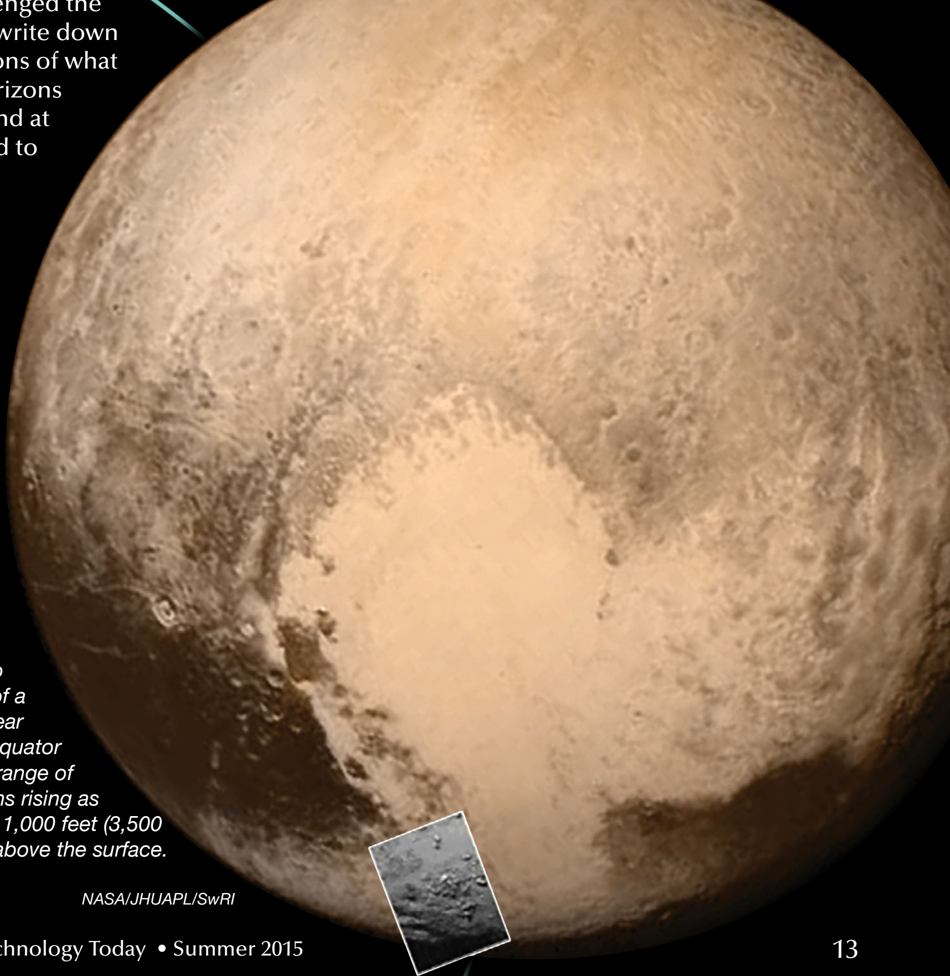
Traveling at 31,000 miles per hour, the tiny New Horizons spacecraft is now millions of miles beyond Pluto and its five moons. It is heading into the solar system's "third zone," the dark, icy realm of Kuiper Belt Objects (KBOs), pristine leftovers from the formation of the solar system 4.6 billion years ago.

The New Horizons team has identified two KBOs as potential flyby targets for an extended mission. If the extended mission is approved, New Horizons will be re-targeted for a KBO encounter to occur in late 2018 or early 2019. For now and the months to come, however, the focus is on Pluto and on processing and analyzing the cornucopia of data that New Horizons acquired during its transit of the Pluto-Charon system.

Stern recounted a story about how, early in the mission, he challenged the team to write down predictions of what New Horizons would find at Pluto and to put their predictions into a sealed envelope. His own prediction consisted of two words: "Something wonderful." New Horizons has already confirmed Stern's prediction. And the Pluto revealed by this historic mission may be even more wonderful than Stern dared to dream.

Questions about this article? Contact Lewis at (210) 522-5261 or william.lewis@swri.org. Look for more detailed stories about the Pluto system as scientists dig in and analyze the data slowly making its way back to Earth.

For the latest images of Pluto and Charon, visit nasa.gov/newhorizons.



Close-up images of a region near Pluto's equator reveal a range of mountains rising as high as 11,000 feet (3,500 meters) above the surface.

NASA/JHUAPL/SwRI

Advancing Jet Engine Design

An SwRI-led NPSS consortium helps design next-generation propulsion systems

The NPSS consortium membership comprises leading engine manufacturers and airframe companies that design and build today's advanced aircraft.

By David L. Ransom, P.E.

Air travel has been a safe and largely accepted part of our worldwide transportation system for several decades. For the most part, we take it for granted and probably give little consideration to the technologies involved in the various systems such as the airframe, the engines, or the cabin air supply and conditioning machinery. We may pay even less attention to the increased level of difficulty in designing high-performance military aircraft. Our main concern is usually regarding our on-time arrival, the availability of Wi-Fi on the flight, and how we can get that aisle seat so we can move about the cabin freely when we want.

Fortunately, engineers pay great attention to all of the systems required to achieve reliable air transportation and national air defense systems. Designing and building these complex systems requires powerful software tools in our modern information age. We need software that allows for rapid evaluation of various design options early in the design of a new aircraft. There are important decisions to be made regarding the power of the engine, the configuration of the engine, and how the engine will be integrated into the airframe. We also need software that improves communication of key performance parameters between the manufacturers of engines and airframes. Engineers in Southwest Research Institute's Mechanical Engineering Division are helping to advance the state of the art through a lead role in the Numerical Propulsion Systems Simulation (NPSS®) consortium and its engine design software package.

What is NPSS?

In 1991, engineers at NASA's Glenn Research Center (GRC) created NPSS to take advantage of that era's emerging parallel computing technologies and scientific computing advances. The idea was to develop an engine simulation that could serve as a virtual test stand for detailed development of specific jet engine components, such as the compressor. The concept is referred to as "zooming," in which a detailed, three-dimensional fluid dynamics model is coupled to an engine performance model to create a "computational test cell."

Today, engineers use the NPSS software to develop engine performance models and integrate them into vehicle system models. Primary application areas include thermodynamic system analyses for jet engines and rockets, but NPSS can also be used for other energy

David L. Ransom, P.E., is manager of the Propulsion and Energy Machinery Section in the Fluids and Machinery Engineering Department of SwRI's Mechanical Engineering Division. At SwRI, Ransom specializes in the design, analysis, and testing of machinery systems for the aerospace and energy industries.

systems including power-generating gas and steam turbines. NPSS also supports industry standardization for model sharing and integration. The software has other industrial fluid/thermal applications such as multi-phase heat transfer systems, refrigeration cycles, variations of common power cycles, and vehicle emission analyses.

By the time NASA's development role ended in 2007 with Version 1.6.5, the NPSS software had many major industrial aerospace companies as devoted users. Engine and airframe manufacturers alike found success in sharing engine models and studying combined engine-vehicle performance. However, the industrial user base wanted further development with more features and improved functionality. NASA GRC transferred control of code maintenance and development to an industrial consortium organized and operated by the NPSS members and managed by an organization local to NASA GRC. For the first few years, NPSS members performed much of the administrative work, but the governing board later decided to look for a technical organization to manage the consortium. SwRI officially assumed this role May 1, 2013.

SwRI and NPSS

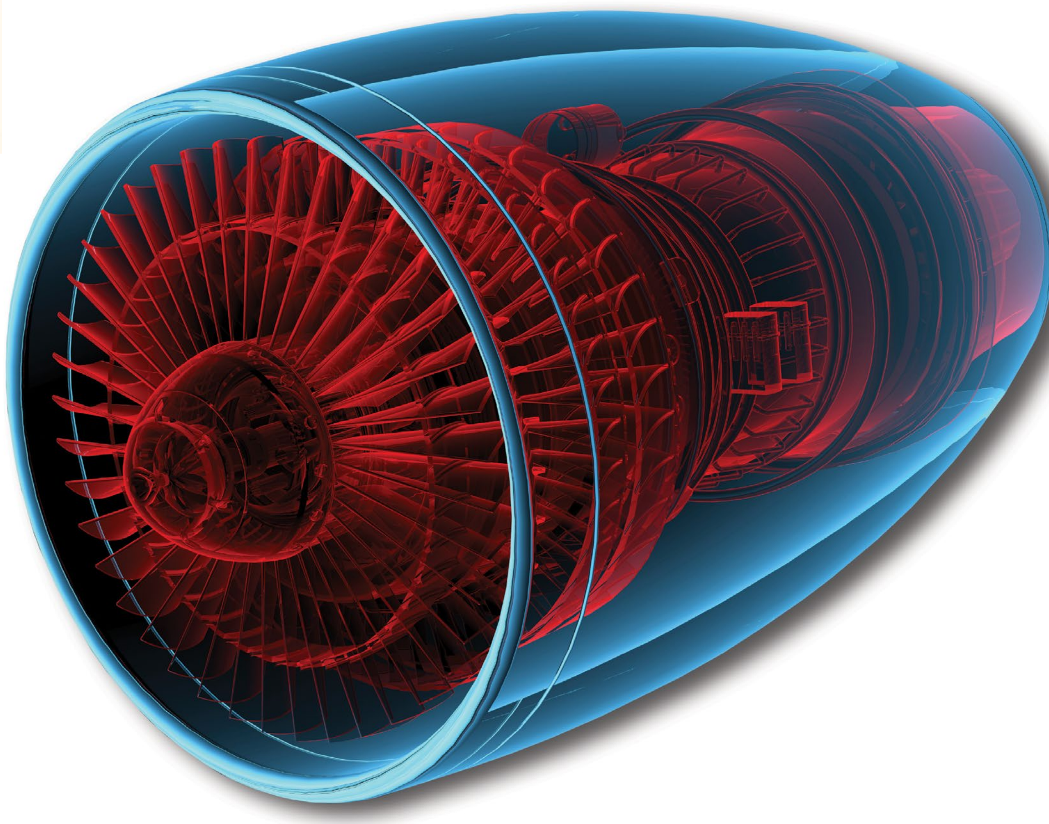
As consortium manager, SwRI is responsible for planning the future of NPSS, addressing users' current needs, and managing the multiple projects under development. The governing board of the consortium provides direction, and SwRI proposes project plans to meet them. Some of those projects include developing a new capability for handling multiple fluid types, such as jet fuels and refrigerants, improving the capability of the solver for difficult transient, or fast-changing, problems, developing a graphical user interface (GUI), and developing reliable interfaces between NPSS and other engineering design tools.

How NPSS works

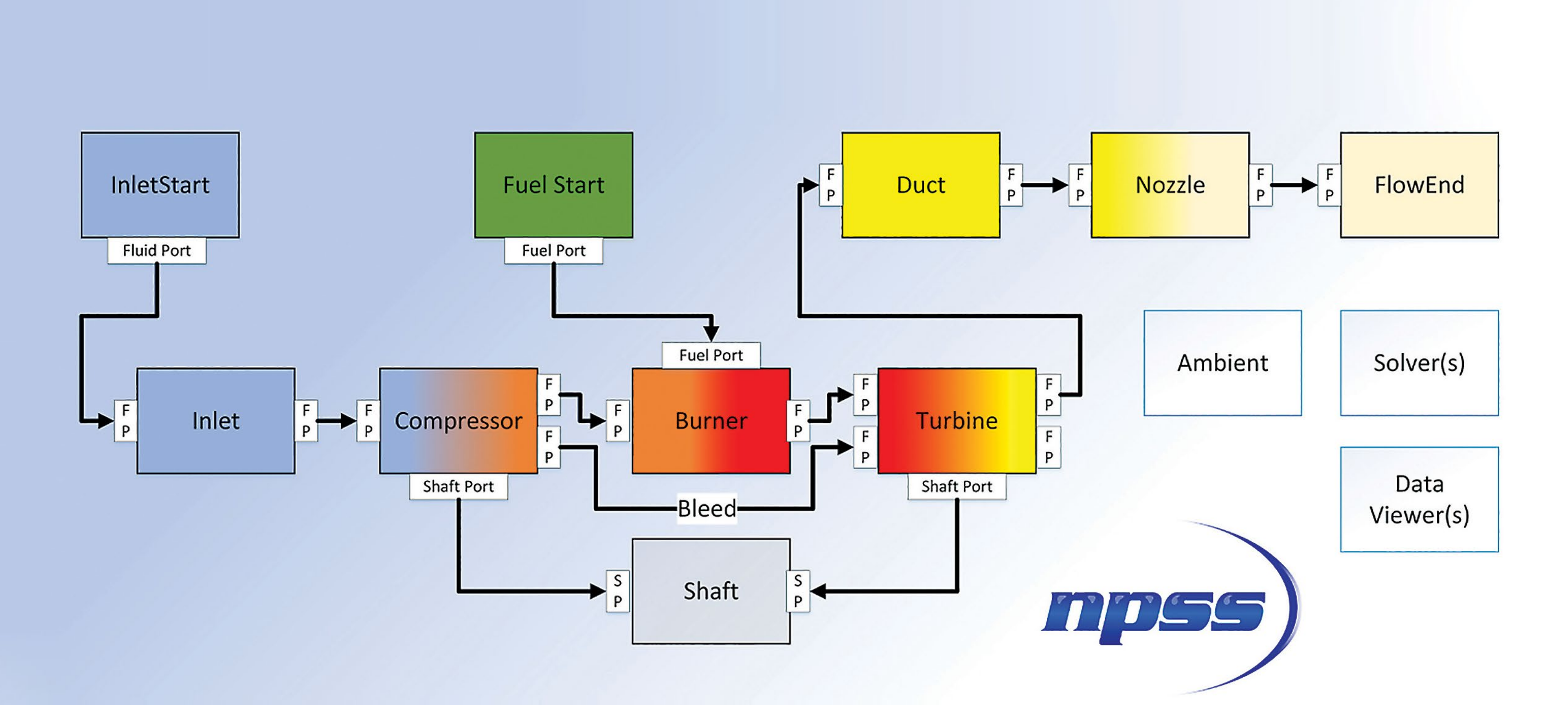
To develop a model in the NPSS environment, an engineer first specifies the type and order of engine components (referred to as "elements") and provides the technical data that describes their individual performance. NPSS has a library of thermodynamics databases and standard elements used in engine cycle models. Once the models are defined through input files, simulations are launched using a system-command window. Most users select a programming text editor that supports language-specific highlighting, coloring, and autocomplete features.

Model development

Basic elements of the jet engine are specified in a user-defined input file based on the generic elements already included in NPSS, such as "Compressor," "FuelStart," and "Burner." The engineer selects the appropriate elements and then assigns to each the known physical parameters needed to solve the problem. The elements are then connected through further software commands made by the engineer.



Engineers use the NPSS software as a design tool for developing jet engines.



NPSS has a library of thermodynamic databases and standard elements used in engine cycle models.

In addition to its standard library of elements, NPSS allows engineers to define new elements or modify or customize the NPSS-provided elements. This powerful feature provides significant flexibility in the capabilities of the elements of an NPSS model.

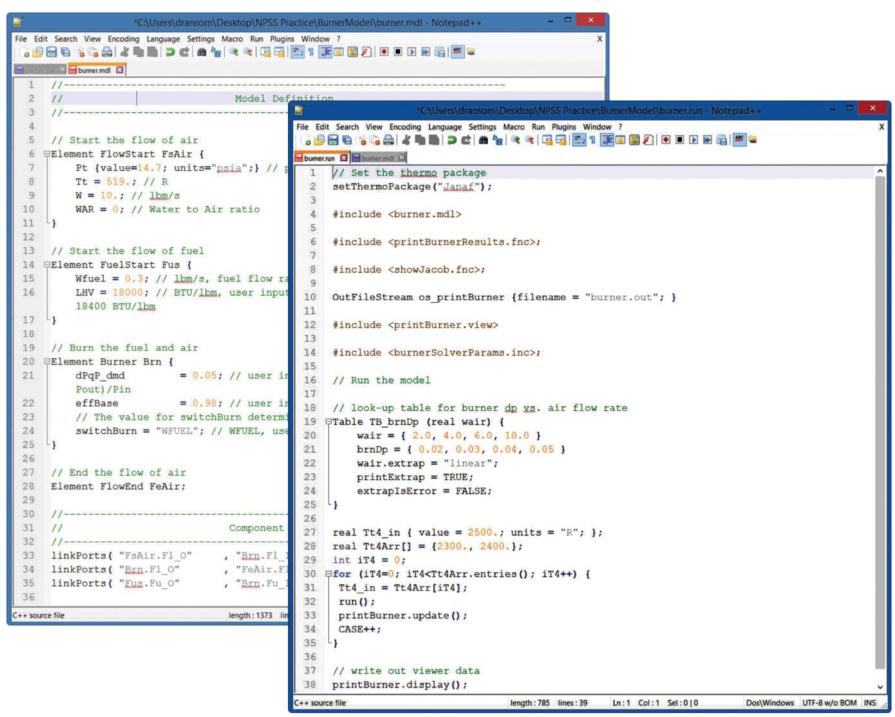
Problem setup and solution

Once a model is developed, the engineer sets up a problem and defines the solution goals and constraints. Although NPSS is organized to use various input files, there are no formal rules regarding their number, type, or organization. In the simplest models, such as a small gas turbine with a single compressor and turbine stage used for auxiliary power, for example, the engineer can define an entire simulation in a single file. For larger, more complicated systems, such as a multi-stage compressor or turbine system, the engineer can use a variety of file types and link them to form a simulation.

An important aspect of defining a problem is how one specifies the settings for solving it. NPSS is unique in that it enables the engineer to use the same model to solve a multitude of problems. NPSS has a built-in solver that drives the model to a valid solution. The solver receives a run command and then iteratively adjusts the values of the specified independent variable in order to satisfy the dependent conditions.

Suppose an engineer wants to know the fuel flow rate required to achieve a specific burner temperature. Fuel flow is identified as an independent variable and some user-defined limits are placed on the solver. Burner temperature, meanwhile, is a dependent variable, with a model parameter for monitoring and targeting temperature. The solver determines the fuel flow rate associated with each temperature value. Solving the problem requires only a simple command for NPSS to complete the solution.

Many more options are available for controlling a simulation, and the solver can handle many independent and dependent pairs in a single solution.



NPSS is file-based and typically runs through the system command window.

In fact, multiple solvers can be used to improve overall solution performance for models with subsystem assemblies. Solutions can be derived in three different modes. The design mode determines the performance characteristics needed to meet the design objective; the off-design mode determines how the selected design will perform away from the design point. Finally, the transient mode evaluates the system's response to time-dependent conditions, such as changing power levels. Once the solution sequence is complete, the output data can be sent straight to the screen or to an output file.

Data can be imported into other plotting tools to generate graphs as needed, and an engineer can easily update the plots with new data. Other data output formats can be defined, such as an overall performance summary, or a series of messages to monitor progress.

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NPSS serves as a virtual test stand for developing specific jet engine components, such as the combustor shown here.

Current development efforts

SwRI is continuing to develop the NPSS core program, the graphical user interface, and also new elements, models, and interfaces. The core work will add more thermodynamic capabilities as well as additional features to the transient solver. GUI development is scheduled for completion in May 2016. Work on the models, elements, and interfaces is focused on upgrading models for new users and streamlining the process for interfacing NPSS to other engineering tools.

Outside the consortium, SwRI is leveraging NPSS to explore other technology areas such as a power-generation application that uses NPSS to study component performance and degradation in power-generating gas turbines. Energy companies are interested in developing NPSS models of their commercial gas turbine engine systems to support their condition-based maintenance programs. SwRI engineers are working with industry to determine the accuracy expected of such models and how they can be used to convert some measured gas turbine performance parameters (pressure, temperature, power, and fuel flow) into decision-making material regarding the health of the individual subsystems such as the compressor, the combustor, or the turbine.

The team is also investigating using NPSS in real-time simulations, such as hardware-in-the-loop simulations, in which an NPSS model simulates the response of the engine system to conditions experienced in a test environment. This is important for developing engine control systems because the transient response of the engine can influence the ability of the control system to perform properly. In such an experimental setup, an actual engine control system, complete with processor, data systems, and actuators would be coupled to a sensor and actuator system that represents the engine response. The NPSS model would be used to determine how the actual engine would respond to the sensed inputs, thus driving the engine response actuators. Testing the control system in this manner is much more affordable, flexible, and lower risk when compared to testing with an actual engine.

NPSS in the future

NPSS will continue to be relevant to the aerospace community for the foreseeable future, as evidenced by the continued financial support from existing consortium members and the recent addition of a new member. NPSS-demonstrated capabilities for studying coupled system performance will continue to be crucial as the aerospace industry trends toward more coupled power-propulsion and thermal systems.

Conclusion

Because NPSS is essentially a fluid-thermal modeling environment, it can model many variations of power cycles, including supercritical CO_2-based cycles, which is of major interest to the U.S. Department of Energy.

The NPSS consortium continues to develop new features based on member feedback, and SwRI's management of the consortium provides full-time professional project management, product development, and user support.

Questions about this article? Contact Ransom at (210) 522-5281 or david.ransom@swri.org.

TECHNICS

Brief notes about the world of science and technology at Southwest Research Institute

SwRI's Stern named Honorary Fellow of Royal Astronomical Society, selected for *Smithsonian* American Ingenuity Award

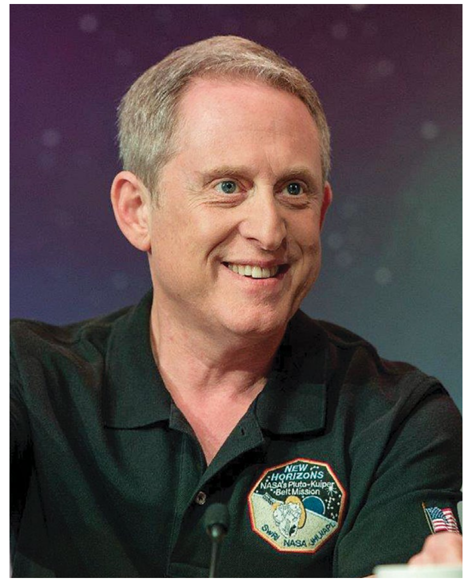
Dr. Alan Stern, an associate vice president in SwRI's Space Science and Engineering Division, has been named an Honorary Fellow of the Royal Astronomical Society (RAS).

The designation honors individuals who are not citizens of the United Kingdom for their services to astronomical and geophysical sciences through distinguished leadership of a school, observatory, or laboratory; outstanding services to national or international scientific organizations; exceptionally important work in editing scientific publications; influential work in education and public outreach in these sciences; or especially outstanding distinguished work in the history of these sciences.

Stern was formally recognized by the RAS at the National Astronomy Meeting, July 5–9 in Llandudno, Wales, although he could not attend the meeting. He was in Maryland at the Johns Hopkins University Applied Physics Laboratory preparing to make history as the New Horizons spacecraft made its closest encounter with Pluto on July 14.

He also has been selected to receive a 2015 American Ingenuity Award, given by *Smithsonian* magazine. Stern, who for the past 14 years has been involved as principal investigator of NASA's $723 million New Horizon's Pluto system mission, is being honored by *Smithsonian* in the Physical Sciences category for his "dedication to and ingenuity in exploring the solar system's third zone."

Stern joined the SwRI staff in 1991. He left SwRI in 2007 to serve as associate administrator of NASA's Science Mission Directorate, and then rejoined SwRI in 2009. While at NASA, he led its Earth and space science program, consisting of 93 flight missions and more than 3,000 grants with a budget of $5.4 billion.



Credit: NASA/Bill Ingalls

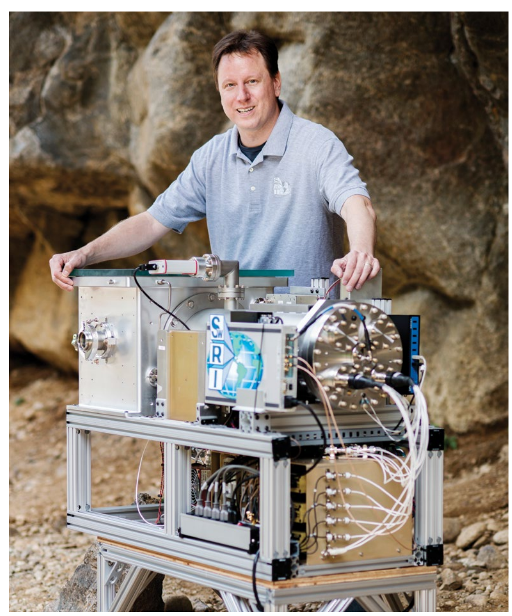
Contact Stern at (303) 546-9670 or alan.stern@swri.org.

NASA funds SwRI instrument to date Moon and Mars rocks

NASA has approved $2.6 million to advance development of Southwest Research Institute's (SwRI) Chemistry, Organics, and Dating Experiment (CODEX) instrument. The device will allow unmanned rovers to analyze the decay of radioactive elements to determine the age of rocks on the Moon and Mars. "CODEX will provide unprecedented *in-situ* age information about surface samples, which is not only critically important to planetary science but also can be used to select which samples will be returned to Earth for more detailed analysis," said Dr. Scott Anderson, a principal scientist in the SwRI Space Science and Engineering Division. The CODEX instrument uses a laser-desorption, time-of-flight mass spectrometer to detect elements and isotopes, including organics that could provide clues in the search for life in our solar system in addition to determining the age of rocks.

The new funding, under NASA's Maturation of Instruments for Solar System Exploration (MatISSE) program, will enhance the laser subsystem and calibrate the instrument's dating capability using terrestrial rocks, planetary analogs, and meteorites from the Moon and Mars. A similar instrument for lunar dating and chemistry, called CDEX (the Chemistry and Dating EXperiment), is under consideration for funding for a Discovery Program lunar mission that could fly in 2021, known as MARE (Moon Age and Regolith Explorer).

"Current research shows that our dating of significant events in the history of the Moon after it was formed — say, between 1 billion and 3.2 billion years ago — could be incorrect by up to a billion years." Anderson said. "This has major implications for understanding the duration of bombardment and volcanism in the inner solar system, the era of water and possibly life on Mars, and the evolution of life on Earth. Using this technology, low-cost space missions can achieve significantly more accurate understanding, filling a crucial gap in our knowledge of the inner solar system."



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Dr. F. Scott Anderson displays a field prototype of the Chemistry, Organics, and Dating Experiment (CODEX) instrument.

Contact Anderson at (303) 546-9670 or scott.anderson@swri.org.

Particle sensor consortium's new phase aims at California's emissions deadlines

The Particle Sensor Performance and Durability (PSPD) Consortium will begin a second phase to evaluate heavy-duty engine exhaust particle sensors to meet two looming deadlines set by the California Air Resources Board (CARB).

Southwest Research Institute (SwRI) organized the consortium in 2012 to investigate the concept of highly accurate and durable particle sensors, the size of a spark plug, for various engine emissions applications. Since then, the seven-member PSPD consortium has amassed more than 520,000 equivalent miles of accelerated testing on three particle sensor technologies.

This work will prove useful in the near future, as automotive industry stakeholders prepare for CARB regulations that call for particulate matter sensors for onboard diagnostics (OBD) on 2016 model-year trucks.

"It is important to evaluate these technologies and understand their performance and durability before they become widespread," said Dr. Imad Khalek, PSPD manager. "It is equally important to understand what metric of particulate matter they measure, because interest is shifting from just particle mass to both the mass and the number of particles."

Khalek, a senior program manager in SwRI's Engine, Emissions, and Vehicle Research Division, said particle sensors could have applications in engine emissions performance, development, and control. They also could be useful for emissions inspection and maintenance, aftertreatment quality control, retrofit applications, smoke-meter replacement, and many others. SwRI subjected the three sensors to accelerated durability testing using a 2010 emissions-compliant, heavy-duty highway diesel engine equipped with a diesel oxidation catalyst, a catalyzed diesel particulate filter, a selective catalytic reduction catalyst, and an ammonia slip oxidation catalyst.

PSPD-II research topics include studying the performance, accuracy, variability, and sensitivity of particle sensors near the OBD threshold detection limit. Other topics include the measurement of soot conductivity and particle natural charge from different engine technologies, investigating leakage of soot into engine exhaust, and using particle sensors for feedback emissions control.

SwRI also is considering expanding PSPD-II to include onboard sensors for NO_x, ammonia, and other compounds addressed by onboard emissions monitoring and control. CARB will require full implementation of NO_x reduction systems by the 2017 model year.

SwRI has many years of experience with consortium-based research. Participants gain access to shared, pre-competitive research at a fraction of the cost of financing it themselves.

PSPD-II is scheduled to begin in September and continue through August 31, 2019. The annual membership fee is $75,000 for sensor makers and $45,000 for other stakeholders.

Contact Khalek at (210) 522-2536 or imad.khalek@swri.org.

SwRI's McComas awarded NASA's Exceptional Public Service Medal

NASA has awarded Dr. David McComas, assistant vice president of the Space Science and Engineering Division at Southwest Research Institute (SwRI), an Exceptional Public Service Medal. The award recognizes "exemplary leadership, dedication, and commitment to NASA as a member of the NASA Advisory Council."

Presented by NASA Administrator General Charles F. Bolden, the award recognizes McComas' contributions as a member of the NASA Advisory Council. The citation states: "Your contributions will benefit the Nation for generations to come."

McComas is a leading researcher in heliophysics, which is the study of the Sun and its interactions with the Earth, the solar system, and interstellar space. The heliosphere is a giant bubble inflated by the solar wind and extending far beyond the orbit of Pluto.

McComas is the principal investigator of NASA's Interstellar Boundary Explorer (IBEX) mission, which is mapping the interactions between the solar wind and the interstellar medium at the edge of our solar system. McComas is also the principal investigator of NASA's Two Wide-angle Imaging Neutral-atom Spectrometers (TWINS) mission and scientific instruments onboard the Ulysses, Advanced Composition Explorer, New Horizons, Juno, and Solar Probe Plus missions. Data from his instrument on New Horizons just revealed that Pluto has a giant tail of heavy charged particles, as its nitrogen-based atmosphere stretches out behind the planet.

McComas served on the NASA Advisory Council's Science Committee from 2010–13 and served as chairman of that Committee and directly on the NASA Advisory Council from 2013–15. He was a primary developer of the graduate program in physics, jointly sponsored by SwRI and The University of Texas at San Antonio, and serves as an adjoint professor. He received the COSPAR (Committee on Space Research) Space Science Award in 2014 and the American Geophysical Union's James B. Macelwane Medal in 1993.

McComas also has received numerous NASA and European Space Agency group achievement awards. He has published more than 500 scientific papers that collectively have been cited more than 19,000 times and is a Fellow of the American Physical Society, the American Geophysical Union, and the American Association for the Advancement of Science.

Contact McComas at (210) 522-5983 or david.mccomas@swri.org.

Publications

Altwegg, K., H. Balsiger, A. Bar-Nun, J.J. Berthelier, A. Bieler, P. Bochsler, C. Briois, U. Calmonte, M. Combi, J. De Keyser, P. Eberhardt, B. Fiethe, **S. Fuselier**, S. Gasc, T.I. Gombosi, K.C. Hansen, M. Hässig, A. Jäckel, E. Kopp, A. Korth, L. LeRoy, U. Mall, B. Marty, O. Mousis, E. Neefs, T. Owen, H. Rème, M. Rubin, T. Sémon, C.-Y. Tzou, **H. Waite** and P. Wurz. "67P/Churyumov-Gerasimenko, a Jupiter Family Comet with a High D/H Ratio." *Science*, Vol. 347, No. 6220 (2015): doi:10.1126/science.1261952.

Bartley, G.J. "Identifying Limiters to Low Temperature Catalyst Activity." *SAE International*, Paper No. 2015-01-1025 (2015): doi:10.4271/2015-01-1025.

Basagaoglu, H., J.T. Carrola, C.J. Freitas, B. Basagaoglu and S. Succi. "Lattice Boltzmann Simulations of Vortex Entrapment of Particles in a Microchannel with Curved and Flat Edges." *Microfluidics and Nanofluidics*, Vol. 18, No. 5-6 (2015): pp. 1165-1175.

Bayless, A., J.W. Even, L.H. Frey, C.L. Fryer, **P.W.A. Roming** and P.A. Young. "The Effects on Supernova Shock Breakout and Swift Light Curves Due to the Mass of the Hydrogen-rich Envelope." *The Astrophysical Journal*, Vol. 805, Issue 2, Article id. 98 (2015): doi:10.1088/0004-637X/805/2/98.

Brun, K., T.A. Grimley, W. Foiles and R. Kurz. "Experimental Evaluation of the Effectiveness of Online Water-washing in Gas Turbine Compressors." *Journal of Engineering for Gas Turbines and Power*, Paper No. GTP-14-1411, Vol. 137, No. 4, 042605-042605-15 (2015): doi:10.1115/1.4028618.

Brun, K., M.B. Nored and R. Kurz. "Impact of Piping Impedance and Acoustic Characteristics on Centrifugal Compressor Surge and Operating Range." *Journal of Engineering for Gas Turbines and Power*, Paper No. GTP-14-1393, Vol. 137, No. 3, 032603-032603-9 (2014): doi:10.1115/1.4028464.

Caspi, A., T.N. Woods and H.P. Warren. "New Observations of the Solar 0.5-5 keV Soft X-ray Spectrum." *The Astrophysical Journal Letters*, Vol. 802, No. 1 (2015): pp. 1-6, doi:10.1088/2041-8205/802/1/L2.

Cheng, X.G., J. Yoo and R. Hale. "Bio-mask for Skin Regeneration." *Regenerative Medicine*, Vol. 9, No. 3 (2014): pp. 245-248, doi:10.2217/rme.14.22.

Cheng, X.G., J. Yoo, R. Hale, M. Davis, H.W. Kang and S.J. Lee. "3D Printed Biomaterials for Maxillofacial Tissue Engineering and Reconstruction – A Review." *Open Journal of Biomedical Materials Research*, Vol. 1, No. 3 (2014): pp. 34-39, doi:10.12966/ojbmr.07.02.2014.

Coogan, J.S., T.D. Eliason, D.P. Nicolella, H. Hibri and J. Lutz. "Finite Element Modeling of a Disc Nucleus Replacement Drive." *Journal of Vascular and Interventional Radiology*, Vol. 26, No. 2, Supplement (2015): pp. S41, doi:10.1016/j.jvir.2014.12.115.

Dayeh, M.A. "Coronal Mass Ejections." *Handbook of Cosmic Hazards and Planetary Defense*, Vol. 1, No. 3 (2015): pp. 81-98, doi:10.1007/978-3-319-03952-7_9.

Dayeh, M.A., S.A. Fuselier, H.O. Funsten, **D.J. McComas, K. Ogasawara**, S.M. Petrinec, N.A. Schwadron and **P. Valek**. "Shape of the Terrestrial Plasma Sheet in the Near-Earth Magnetospheric Tail as Imaged by the Interstellar Boundary Explorer (IBEX)." *Geophysical Research Letters*, Vol. 42, Issue 7 (2015): pp. 2115-2155, doi:10.1002/2015GL063682.

Desai, M.I., M.A. Dayeh, F. Allegrini, H. Funsten, J. Heerikhuisen, **D.J. McComas, S.A. Fuselier**, N. Pogorelov, N.A. Schwadron, G.P. Zank and **E.J. Zirnstein**. "Latitudinal and Energy Dependence of Energetic Neutral Atom Spectral Indices Measured by the Interstellar Boundary Explorer." *The Astrophysical Journal*, Vol. 802, No. 2, 100 (2015): doi:10.1088/0004-637X/802/2/100.

Desai, M.I., K. Ogasawara, R.W. Ebert, D.J. McComas, F. Allegrini, S.E. Weidner, N. Alexander and **S.A. Livi**. "An Integrated Time-of-Flight Versus Residual Energy Subsystem for a Compact Dual Ion Composition Experiment for Space Plasmas." *Review of Scientific Instruments*, Vol. 86 (2015): pp. 054501 1-12, http://dx.doi.org/10.1063/1.4921706.

Frisch, P.C., B.-G. Andersson, A. Berdyugin, V. Piirola, H.O. Funsten, A.M. Magalhaes, D.B. Seriacopi, **D.J. McComas**, N.A. Schwadron, J.D. Slavin and S.J. Wiktorowicz. "Evidence for an Interstellar Dust Filament in the Outer Heliosheath." *The Astrophysical Journal*, Vol. 805, No. 1, 60 (2015): doi:10.1088/0004-637X/805/1/60.

Frisch, P.C., M. Bzowski, C. Drews, T. Leonard, **G. Livadiotis, D.J. McComas**, E. Möbius, N. Schwadron and J.M. Sokól. "Correcting the Record on the Analysis of IBEX and STEREO Data Regarding Variations in the Neutral Interstellar Wind." *The Astrophysical Journal*, Vol. 801, No. 1, 61 (2015): doi:10.1088/0004-637X/801/1/61.

Gamage, T., **Y. Liu**, T. Nguyen, Q. Xin, B. McMillin and M. Crow. "A Novel Flow Invariants-based Approach to Microgrid Management." *IEEE Transactions on Smart Grid*, Vol. 6, Issue 2 (2015): pp. 516-525, doi:10.1109/TSG.2014.2375064.

Grava, C., J.-Y. Chaufray, **K.D. Retherford, G.R. Gladstone, T.K. Greathouse**, D.M. Hurley, R.R. Hodges, **A.J. Bayless, J.C. Cook** and **S.A. Stern**. "Lunar Exospheric Argon Modeling." *Icarus*, Vol. 255, pp. 135-147 (2015): doi:10.1016/j.icarus.2014.09.029.

Hässig, M., K. Altwegg, H. Balsiger, A. Bar-Nun, J.J. Berthelier, A. Bieler, P. Bochsler, C. Briois, U. Calmonte, M. Combi, J. De Keyser, P. Eberhardt, B. Fiethe, **S.A. Fuselier**, M. Galand, S. Gasc, T.I. Gombosi, K.C. Hansen, A. Jäckel, H.U. Keller, E. Kopp, A. Korth, E. Kührt, L. Le Roy, U. Mall, B. Marty, O. Mousis, E. Neefs, T. Owen, H. Rème, M. Rubin, T. Sémon, C. Tornow, C.-Y. Tzou, **J.H. Waite** and P. Wurz. "Time Variability and Heterogeneity in the Coma of 67P/Churyumov-Gerasimenko." *Science*, Vol. 347, No. 6220 (2015): doi:10.1126/science.aaa0276.

Hayne, P.O., A.R. Hendrix, E. Sefton-Nash, P.G. Lucey, **K.D. Retherford**, J-P. Williams, M.A. Siegler, B.T. Greenhagen and D.A. Paige. "Evidence for Exposed

Technical Staff Activities

Water Ice in the Moon's South Polar Regions from Lunar Reconnaissance Orbiter Ultraviolet Albedo and Temperature Measurements." *Icarus*, Vol. 255, pp. 58-69 (2015): doi:10.1016/j.icarus.2015.03.032.

Huebner, W.F. and **J. Mukherjee**. "Photoionization and Photodissociation Rates in Solar and Blackbody Radiation Fields." *Planetary and Space Science*, Vol. 106 (2015): pp. 11-45, doi:10.1016/j.pss.2014.11.022.

Hurley, D.M., M. Sarantos, **C. Grava**, J-P. Williams, **K.D. Retherford**, M. Siegler, B. Greenhagen and D. Paige. "An Analytic Function of Lunar Surface Temperature for Exospheric Modeling." *Icarus*, Vol. 255 (2015): pp. 159-163, doi:10.1016/j.icarus.2014.08.043.

Leonard, T.W., E. Möbius, M. Bzowski, **S.A. Fuselier**, D. Heirtzler, M.A. Kubiak, H. Kucharek, M. Lee, **D.J. McComas**, N.A. Schwadron and P. Wurz. "Revisiting the ISN Flow Parameters, Using a Variable IBEX Pointing Strategy." *The Astrophysical Journal*, Vol. 804, No. 1, 42 (2015): doi:10.1088/0004-637X/804/1/42.

Lin, J. and I. Dahan. "Nanostructured Chromium Coatings with Enhanced Mechanical Properties and Corrosion Resistance." *Surface and Coatings Technology*, Vol. 264 (2015): pp. 154-159.

Lin, J., I. Dahan, B. Valderrama and M.V. Manuel. "Structure and Properties of Uranium Oxide Thin Films Deposited by Pulsed DC Magnetron Sputtering." *Applied Surface Science*, Vol. 301 (2014): pp. 475-480.

Lin, J., W.D. Sproul, **R. Wei** and R. Chistyakov. "Diamond-like Carbon Films Deposited by HiPIMS Using Oscillatory Voltage Pulses." *Surface and Coatings Technology*, Vol. 258 (2014): pp. 1212-1222.

Livadiotis, G. "Statistical Background and Properties of Kappa Distributions in Space Plasmas." *Journal of Geophysical Research: Space Physics*, Vol. 120, Issue 3 (2015): pp. 1607-1619, doi:10.1002/2014JA020825.

Luspay-Kuti, **A.**, V.F. Chevrier, D. Cordier, E.G. Rivera-Valentin, S. Singh, A. Wagner and F.C. Wasiak. "Experimental Constraints on the Composition and Dynamics of Titan's Polar Lakes." *Earth and Planetary Science Letters*, Vol. 410 (2015): pp. 75-83, doi:10.1016/j.epsl.2014.11.023.

Luspay-Kuti, A., K.E. Mandt, S. Plessis and **T.K. Greathouse**. "Effects of Nitrogen Photoabsorption Cross Section Resolution on Minor Species Vertical Profiles in Titan's Upper Atmosphere." *Astrophysical Journal Letters*, Vol. 801, No. 1 (2015): doi:10.1088/2041-8205/801/1/L14.

Lynch, K., B. Horgan, J. Munakata Marr, **J. Hanley**, R. Schneider, K. Rey, J. Spear, W.A. Jackson and S. Ritter. "Near-infrared Spectroscopy of Lacustrine Sediments in the Great Salt Lake Desert: An Analog Study for Martian Paleolake Basins." *Journal of Geophysical Research: Planets*, Vol. 120, Issue 3 (2015): pp. 599-623, doi:10.1002/2014JE004707.

McComas, D.J., M. Bzowski, P. Frisch, **S.A. Fuselier**, M.A. Kubiak, H. Kucharek, T. Leonard, E. Möbius, N.A. Schwadron, J.M. Sokól, P. Swaczyna and M. Witte. "Warmer Local Interstellar Medium: A Possible Resolution of the Ulysses-IBEX Enigma." *The Astrophysical Journal*, Vol. 80, No. 1, 28 (2015): pp. 1-7, doi:10.1088/0004-637X/801/1/28.

McFarland, J.M. "Variance Decomposition for Statistical Quantities of Interest." *Journal of Aerospace Information Systems*, Vol. 12, Special Section on Uncertainty (2015): pp. 204-218, doi: 10.2514/1.I010261.

Melo-Maximo, L., M. Perez, **J. Lin**, O. Salas, D. Melo-Maximo, J. Oseguera, V.M. Lopez-Hirata, R.D. Torres and R.M. Souza. "Performance of MPPMS Cr/Cr_2O_3 Films in Protection Against Metal Dusting." *Surface Engineering*, Vol. 3, Issue 2 (2015): pp. 166-172, doi:10.1179/1743294414Y.0000000378.

Morgan, P.J., P.E. Lobato, V. Premnath and **S. Kroll**. "Determination and Evaluation of New Prep Cycle on the Fuel Effects of Gaseous and Particulate Emissions on SIDI In-use Vehicles." *Coordinating Research Council*, CRC Paper E-94-1a (2015).

Nicolaou, G., **D.J. McComas**, F. Bagenal, **H.A. Elliott** and **R.W. Ebert**. "Jupiter's Deep Magnetotail Boundary Layer." *Planetary and Space Science*, Vol. 111 (2015): pp. 116-125, doi:10.1016/j.pss.2015.03.020.

Nicolella, D.P., T.L. Bredbenner, L.M. Havill, J.G. Tamez-Pena, P. Gonzalez, E. Schreyer, S. Totterman and C. Kwoh. "Variation in Knee Shape Predicts the Future Onset of Radiographic Knee Osteoarthritis (RKOA) and this Variation is Different in Males Compared to Females." *Osteoarthritis and Cartilage*, Vol. 23, Supplement 2 (2015): pp. A208-A209, doi:10.1016/j.joca.2015.02.406.

Ogasawara, K., M.A. Dayeh, T.W. Broiles, K.E. Coulter, M.I. Desai, S.A. Livi, D.J. McComas and **B.C. Walther**. "Single Crystal Chemical Vapor Deposit Diamond Detector for Energetic Plasma Measurement in Space." *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment*, Vol. 777 (2015): pp. 131–137, doi:10.1016/j.nima.2014.12.098.

Ogasawara, K., M.A. Dayeh, H.O. Funsten, **S.A. Fuselier, G. Livadiotis** and **D.J. McComas**. "Interplanetary Magnetic Field Dependence of the Suprathermal Energetic Neutral Atoms Originated in Subsolar Magnetopause." *Journal of Geophysical Research: Space Physics*, Vol. 120, Issue 2 (2015): pp. 964-972, doi:10.1002/2014JA020851.

Patrick, E.L., K.E. Mandt, S.M. Escobedo, G.S. Winters, J.N. Mitchell and **B.D. Teolis**. "A Qualitative Study of the Retention and Release of Volatile Gases in JSC-1A Lunar Soil Simulant at Room Temperature Under Ultrahigh Vacuum (UHV) Conditions." *Icarus*, Vol. 255 (2015): pp. 30-43, doi:10.1016/j.icarus.2015.03.015.

Payan, A.P., C.S. Paty and **K.D. Retherford**. "Uncovering Local Magnetospheric Processes Governing the Morphology and Variability of

Ganymede's Aurora Using Three-dimensional Multifluid Simulations of Ganymede's Magnetosphere." *Journal of Geophysical Research Space Physics*, Vol. 120, Issue 1 (2015) pp. 401-413, doi:10.1002/2014JA020301.

Rhoden, A.R., T. Hurford, **L. Roth** and **K.D. Retherford**. "Linking Europa's Plume Activity to Tides, Tectonics, and Liquid Water." *Icarus*, Vol. 253 (2015): pp. 169-178, doi:10.1016/j.icarus.2015.02.023.

Rigney, M.P. "Object Recognition Technology Assessment for Transmission Line Component Recognition." *CEATI International*, Project Report T133700 3252, http://www.ceati.com/publication-details/?pid=3252, November 2014.

Rubin, M., K. Altwegg, H. Balsiger, A. Bar-Nun, J.-J. Berthelier, A. Bieler, P. Bochsler, C. Briois, U. Calmonte, M. Combi, J. De Keyser, F. Dhooghe, P. Eberhardt, B. Fiethe, **S.A. Fuselier**, S. Gasc, T.I. Gombosi, K.C. Hansen, M. Hässig, A. Jäckel, E. Kopp, A. Korth, L. Le Roy, U. Mall, B. Marty, O. Mousis, T. Owen, H. Rème1, T. Sémon, C.-Y. Tzou, **J.H. Waite** and P. Wurz. "Molecular Nitrogen in Comet 67P/Churyumov-Gerasimenko as an Indicator of its Low Formation Temperature." *Science*, Vol. 348, No. 6231 (2015): pp. 232-235, doi:10.1126/science.aaa6100.

Sarlashkar, J., S. Rengarajan, R. Roecker, R. Huron and **D. Bidault**. "Ignition Control of a Spark-ignited Dedicated-EGR™ Engine." *JSAE*, Paper No. 20155006, No. 1-15 (2015): pp. 28-33.

Saur, J., S. Duling, **L. Roth**, X. Jia, D.F. Strobel, P.D. Feldman, U.R. Christensen, **K.D. Retherford**, M.A. McGrath, F. Musacchio, A. Wennmacher, F.M. Neubauer, S. Simon and O. Hartkorn. "The Search for a Subsurface Ocean in Ganymede with Hubble Space Telescope Observations of its Auroral Ovals." *Journal of Geophysical Research Space Physics*, Vol. 120, Issue 3 (2015): pp. 1715-1737, doi:10.1002/2014JA020778.

Simons, S.B., J. Johnson and **E.L. Broerman**. "A Case Study: Best Practices for Pulsation Bottle Design to Reduce Horsepower Losses." *COMPRESSORtech2*, April 2015, pp. 78-82.

Smith, I.B., A. Spiga and J.W. Holt. "Aeolian Processes as Drivers of Landform Evolution at the South Pole of Mars." *Geomorphology*, Vol. 240 (2015): pp. 54-69, doi:10.1016/j.geomorph.2014.08.026.

Supak, K.R. and **D.L. George**. "Best Practices for Mitigating Flow Measurement Errors Associated with Hydrate Formation." *Pipeline & Gas Journal*, Vol. 242, No. 7, July 2015.

Sybouts, E.H., E.E. Quillen, T.E. Macrini, M.C. Mahaney, L.A. Cox, **D.P. Nicolella** and L.M. Havill. "Presence of Knee Osteophytes is Heritable and Linked to CHR. 19 and 2 that Contain TGFBI and SPP2." *Osteoarthritis and Cartilage*, Vol. 23, Supplement 2 (2015): pp. A193, doi:10.1016/j.joca.2015.02.978.

Trattner, K.J., T.G. Onsager, S.M. Petrinec and **S.A. Fuselier**. "Distinguishing Between Pulsed and Continuous Reconnection at the Dayside Magnetopause." *Journal of Geophysical Research Space Physics*, Vol. 120, Issue 3 (2015): pp. 1684-1696, doi:10.1002/2014JA020713.

Wilder, F.D., S. Eriksson, K.J. Trattner, P.A. Cassak, **S.A. Fuselier** and B. Lybekk. "Observation of a Retreating X-line and Magnetic Islands Poleward of the Cusp During Northward Interplanetary Magnetic Field Conditions." *Journal of Geophysical Research Space Physics*, Vol. 119, Issue 12 (2014): pp. 9643-9657, doi:10.1002/2014JA020453.

Zirnstein, E.J., M.A. Dayeh, J. Heerikhuisen, N.V. Pogorelov and **D.J. McComas**. "Simulations of a Dynamic Solar Cycle and its Effects on the Interstellar Boundary Explorer Ribbon and Globally-distributed Energetic Neutral Atom Flux." *The Astrophysical Journal*, Vol. 804, No. 1 (2015): doi:10.1088/0004-637X/804/1/5.

Zirnstein, E.J., J. Heerikhuisen and **D.J. McComas**. "Structure of the Interstellar Boundary Explorer Ribbon from Secondary Charge-exchange at the Solar-Interstellar Interface." *The Astrophysical Journal Letters*, Vol. 804, No. 1, L22 (2015), doi:10.1088/2041-8205/804/1/L22.

Presentations

Allegrini, F., F. Bagenal, **R.W. Ebert**, P. Louarn, **D.J. McComas**, M. Reno, **P. Valek, S. Weidner** and R. J. Wilson. "Jovian Auroral Distributions Experiment–Electrons (JADE–E) on the Juno Mission to Jupiter." Presented at the Magnetospheres of the Outer Planets (MOP) 2015 Meeting, Atlanta, June 2015.

Allegrini, F., K. Coulter, R. Ebert, G. Nicolaou and **V. Zorbas-Poenitzsch**. "Carbon Foils Improvements for Energetic Neutral Atom Sensors." Presented at the 40th Committee for Space Research (COSPAR) Scientific Assembly, Moscow, August 2014.

Allegrini, F., M.I. Desai, R.W. Ebert and **K. Ogasawara**. "A Comprehensive Suprathermal Ion Sensor Suite." Presented at the Measurement Techniques in Solar and Space Physics (MTSSP) Conference, Boulder, Colo., April 2015.

Allegrini, F., R.W. Ebert, S. Fuselier, G. Nicolaou and **D.J. McComas**. "Thin Carbon Foils: A Critical Subsystem for Plasma, Energetic Particle and Energetic Neutral Atom Instruments in Space." Presented at the MTSSP Conference, Boulder, Colo., April 2015.

Andrew, D., S. Carlson, R. Pilarczyk and M. Thomsen. "The Nuts and Bolts: Should They Stay or Should They Go Now?" Presented at the Airworthiness and Sustainment (AA&S) 2015 Conference, Baltimore, March-April 2015.

Armas, I., **M. Necsoiu**, D.A. Mendes, M. Gheorghe and D. Gheorghe. "Ground Displacement Trends in an Urban Environment Using Multi-temporal InSAR Analysis and Two Decades of Multi-sensor Satellite-based SAR Imagery." Presented at the 9th International Workshop Fringe 2015 Advances in the Science and Applications of SAR Interferometry and Sentinel-1 InSAR Workshop, Frascati, Italy, March 2015.

Avery, P. "National Highway Traffic Safety Administration (NHTSA) Decision to Move Towards Regulation on V2V – What's the Real Impact." Presented at the 3rd International Conference on Connected Vehicles and Expo (ICCVE) 2014, Vienna, November 2014.

Technical Staff Activities

Bartley, G.J. "Identifying Limiters to Low Temperature Catalyst Activity." Presented at the Society of Automotive Engineers (SAE) 2015 World Congress & Exhibition, Detroit, April 2015.

Benke, R., T. Oxenberg and J. Webb. "Soluble Uranium Definition for Regulatory Compliance." Presented at the Baltimore-Washington Chapter of the Health and Physics Society Technical Dinner Meeting, Vienna, Va., December 2014.

Blount, Ju.L., M.A. Koets, Ja.L. Blount, J.R. Dickenson and **D.C. Varner**. "Toward a Practical Cognitive Communication Network for Satellite Systems." Presented at the 2015 Institute of Electrical and Electronics Engineers (IEEE) Aerospace Conference, Big Sky, Mont., March 2015.

Broerman, E.L. "API 688 – 784/675-Type Pumps – Positive Displacement Pumps." Presented at the American Petroleum Institute (API) 2015 Spring Refining and Equipment Standards Meeting, Seattle, April 2015.

Broerman, E.L. "Basics, Rules of Thumb, and Case Studies for Pulsation and Vibration Control of Compressor or Pump Piping Systems." Presented at the 2015 Gulf South Rotating Machinery Symposium (GSRMS), Baton Rouge, La., April 2015.

Brown, M., P. Avery and **P. Sturgeon**. "Enhanced Work Zone Safety Through Cooperative Autonomous Vehicle Systems." Presented at the 3rd ICCVE 2014, Vienna, November 2014.

Bryner, E.B., D.L. Ransom and **J.S. Bishop**. "A Small Scale Gas Turbine Engine for Electrical Generation in a Hybrid Propulsion System for Unmanned Aerial Vehicles (UAVs)." Presented at the Joint Army-Navy-NASA-Air Force (JANNAF)/46th Combustion (CS)/34th Airbreathing Propulsion (APS)/34th Exhaust Plume and Signatures (EPSS)/28th Propulsion Systems Hazards Subcommittee (PSHS) Joint Subcommittee Meeting, Albuquerque, N.M., December 2014.

Bryner, E.B., D.L. Ransom and **J.S. Bishop**. "Design, Build and Test of a Small Scale Gas Turbine for UAV Power Generation." Presented at the JANNAF Liquid Propulsion Subcommittee (LPS)/ Advanced Materials Panel (AMP)/ Additive Manufacturing for Propulsion Applications Technical Interchange Meeting (TIM), Huntsville, Ala., September 2014.

Carlson, S. "A Defect… When Finite Life Becomes Infinite Life — Managing Munition Parts within the United States Air Force (USAF) Procurement Paradigm." Presented at the Holistic Structural Integrity Process (HOLSIP) 14 Conference, Snowbird, Utah, February 2015.

Carlson, S. "Sensitivity Study of Parameters Influencing Broad Application for Modeling Failure (BAMF) Predictions within a Deep Residual Stress Field Caused by Cold Expansion." Proceedings of the 2014 Air Force Grow (AFGROW) Workshop, Layton, Utah, September 2014.

Carlson, S., P. Clark, J. Hodges and R. Pilarczyk. "21st Century Crack Growth Analysis Methods & Tools — Building New Damage Tolerance Capabilities in the USAF Aircraft Structural Integrity Program (ASIP) Environment." Proceedings of the 2014 North Atlantic Treaty Organization (NATO) Applied Vehicle Technology (AVT)-222 Workshop on Continuing Airworthiness of Ageing Aircraft Systems, Brussels, October 2014.

Carlson, S., D. Hoeppner, R. Pilarczyk and M. Thomsen. "Durability Assessment for Non-legacy Manufacturing Methods." Proceedings of the 2014 ASIP Conference, San Antonio, December 2014.

Cheng, X.G. "Collagen-based Biomask as a Promising Skin Graft for Facial Burn." Presented at the 2014 Military Health System Research Symposium (MHSRS) Craniofacial Trauma and Face Regenerative Research–Trauma Care Session, Ft Lauderdale, Fla., August 2014.

Cheng, X.G. "Novel Magnetic Calcium Phosphate (MCaP) Nanoparticles (NPs) for Biomedical Applications." Presented at the San Antonio Nano-technology Forum (SANTF) Networking Lunch Series, San Antonio, December 2014.

Cheng, X.G. and J. Salcido. "Novel Magnetic Calcium Phosphate Nanoparticles for Cancer Treatment." Presented at the Biomedical Engineering Society (BMES) 2014 Annual Meeting, San Antonio, October 2014.

Clark, P., S. Carlson, R. Crowther and M. Thomsen. "Weibull Analysis of Fatigue Data from Aircraft Paint Removal Techniques — Lessons Learned." Proceedings of the 2014 ASIP Conference, San Antonio, December 2014.

Cobb, A.C., S.A. Vinogradov, J.L. Fisher and **G.M. Light**. "Magnetostrictive Sensor Guided Wave Pipeline Inspection Technology Capable of Defect Depth Sizing." Presented at the "Unpiggable" Pipeline Solutions Forum, Houston, May 2015.

Corbo, M., **J.R. Hollingsworth**, M. Leader and B. Pettinato. "Torsional Rotordynamics of Machinery Equipment Strings." Short course presented at the 2015 Middle East Turbomachinery Symposium (METS III), Doha, Qatar, February 2015.

Dannemann, K.A. "IMPACT: The Dynamic Behavior of Materials." Presented at the North Texas Chapter of ASM International, Dallas, March 2015.

Dannemann, K.A., R.P. Bigger, N.L. Scott, C.E. Weiss and **A.J. Carpenter**. "Application of Digital Image Correlation for Comparison of Deformation Response in Fusion vs. Friction Stir Welds." Presented at the 2015 Society for Experimental Mechanics (SEM) Annual Conference and Exposition on Experimental and Applied Mechanics, Costa Mesa, Calif., June 2015.

Dayeh, M.A. "From the Sun to the Heliospheric Boundaries: Solar Transients and Space Weather." Presented at the Third Middle East and Africa International Astronomical Union (IAU) Regional Meeting (MEARIM 2014), Beirut, Lebanon, September 2014.

Dayeh, M.A. "Seeing What We Hear: The First Images of Thunder from Triggered Lightning." Presented at the Department of Physics and Astronomy, Notre Dame University, Louaize, Lebanon, May 2015.

Dayeh, M.A. "The Magnetospheric Multiscale (MMS) Mission: Understanding the Microphysics of Magnetic Reconnection." Presented at the Department of Physics, American University of Beirut, Lebanon, May 2015.

Dayeh, M.A. and N. Evans. "Acoustic Imaging of Thunder from Rocket-triggered Lightning." Presented at the 2015 Joint Assembly Meeting of American Geophysical Union (AGU)-Geological Association of Canada (GAC)-Mineralogical Association of

Canada (MAC)-Canadian Geophysical Union (CGU), Montreal, May 2015.

Dayeh, M.A., N. Evans, **S.A. Fuselier**, **J. Ramaekers**, **J. Trevino**, H. Rassoul, R. Lucia, J. Dwyer, M. Uman and D. Jordan. "Acoustic Properties of Triggered Lightning." Presented at the 2014 AGU Fall Meeting, San Francisco, December 2014.

Dayeh, M.A., N. Evans, **S.A. Fuselier**, **J. Ramaekers**, **J. Trevino**, H. Rassoul, R. Lucia, J. Dwyer, M. Uman and D. Jordan. "Seeing What We Hear: World's First Images of Thunder." Presented at the 2015 Joint Assembly Meeting of AGU-GAC-MAC-CGU, Montreal, May 2015.

Dayeh, M.A., **S.A. Fuselier**, H.O. Funsten, **D.J. McComas**, **K.O. Ogasawara**, S.M. Petrinec, N.A. Schwadron and **P.W. Valek**. "Shape of the Terrestrial Plasma Sheet in the Near-Earth Magnetospheric Tail as Imaged by the Interstellar Boundary Explorer (IBEX)." Presented at the 2015 Joint Assembly Meeting of AGU-GAC-MAC-CGU, Montreal, May 2015.

Desai, M.I., G.M. Mason, **M.A. Dayeh**, **R.W. Ebert**, **D.J. McComas**, G. Li, C.M.S. Cohen, R.A. Mewaldt, N.A. Schwadron and C.W. Smith. "Systematic Behavior of Heavy Ion Spectra in Large Gradual Solar Energetic Particle Events." Presented at the 14th Annual International Astrophysics Conference (AIAC), Tampa Bay, Fla., April 2015.

Desai, M.I., **D.J. McComas**, **F. Allegrini**, **S. Livi**, **K. Ogasawara**, **R.W. Ebert**, **N. Alexander** and **S.E. Weidner**. "CoDICE: A Compact, Dual Ion Composition Experiment for Planetary Missions." Presented at the MTSSP Conference, Boulder, Colo., April 2015.

DeWald, A., **D. Andrew**, **S. Carlson**, M. Hill, D. Marosok, R. Pilarczyk and M. Thomsen. "Residual Stress from Cold Working on Aircraft Fastener Holes." Proceedings of the AA&S 2014 Conference, Baltimore, April 2014.

Dinwiddie, C.L. and **D.M. Hooper**. "Parameterization of Finite-element Cryo-Hydrologic Sand Dune Model to Constrain Debris-flow-initiating Subsurface Temperatures and Pore-water Pressures, Great Kobuk Sand Dunes, Alaska." Presented at the Fourth International Planetary Dunes Workshop, Boise, Idaho, May 2015.

Domyancic, L. "Methods of Determining Equivalent Initial Flaw Size (EIFS) Distributions Containing Suspended Data." Presented at the American Institute of Aeronautics and Astronautics Science and Technology Forum and Exposition (AIAA SciTech 2015), Kissimmee, Fla., January 2015.

Duncan, T. "Commercial Vehicle Information Systems and Networks (CVISN) and Connected Vehicles." Presented at the 2015 CVISN Workshop, Arlington, Va., May 2015.

Ebert, R.W., **F. Allegrini**, F. Bagenal, P. Louarn, **D.J. McComas**, **M. Reno**, **P. Valek**, **S. Weidner** and R.J. Wilson. "Science Opportunities for the Jovian Auroral Distributions Experiment (JADE)." Presented at the MOP 2015 Meeting, Atlanta, June 2015.

Edwards, N. and **X.G. Cheng**. "*In Vivo* Analysis of Collagen Constructs for Tendon Repair and Regeneration in an Achilles Tendon Gap Defect Model." Presented at the 2nd Annual Biomedical Research Symposium at The University of Texas at San Antonio (UTSA), San Antonio, April 2015.

Evans, P.T. "Advancements Guiding the Future of Robotics for Manufacturing Applications." Presented at the Automation in Manufacturing (AIM) 2015 Conference, Detroit, June 2015.

Evans, P.T. "The Challenges and Opportunities for Integrated Robotics." Presented at the AIM 2015 Conference, Detroit, June 2015.

Fehr, W., S. Gopalakrishna, A. Donaldson and **M. Brown**. "Connected Vehicles Pilot Certification Testing." Presented at the SAE 2015 World Congress & Exhibition, Detroit, April 2015.

Feng, M. "Selective Non-catalytic Reduction (SNCR) Technology for NO_x Removal — the Past, the Present and the Future." Presented at the 2015 American Institute of Chemical Engineers (AIChE) Spring Meeting and 11th Global Congress on Process Safety, Austin, Texas, April 2015.

Feng, M. and **D. Daruwalla**. "Kraft Lignin Depolymerization Under Hydrothermal Conditions." Presented at the 2015 AIChE Spring Meeting and 11th Global Congress on Process Safety, Austin, Texas, April 2015.

Feng, M., J. Moran and Z. Feng. "Biochar Production and Application on Treatment of Flowback Water from Hydraulic Fracturing." Presented at the 2015 AIChE Spring Meeting and 11th Global Congress on Process Safety, Austin, Texas, April 2015.

Feng, M. and **R. Zhan**. "Application of Non-thermal Plasma on SO_2 Removal from Synthesis Gas." Presented at the 2015 AIChE Spring Meeting and 11th Global Congress on Process Safety, Austin, Texas, April 2015.

Flores, E. III, **H. Lai** and **M. Medrano**. "Evaluation of Technology Development for Direct Replacement Biofuels Using Thermochemical Processes." Presented at the 2015 AIChE Spring Meeting and 11th Global Congress on Process Safety, Austin, Texas, April 2015.

Garcia-Hernandez, A.J., **A. Alvarado** and **B.L. Ridens**. "Impact of Gas Composition on Pipeline and Compressor Operating Conditions." Presented at the Pipeline Simulation Interest Group (PSIG) 2015 Conference, New Orleans, May 2015.

Garcia-Hernandez, A.J. and **J.A. Bennett**. "Tutorial: Transient Modeling and Analysis of Centrifugal Compressors." Presented at the 2015 METS III, Doha, Qatar, February 2015.

Grava, C., **K.D. Retherford**, P.D. Feldman, D.M. Hurley, **G.R. Gladstone**, **T.K. Greathouse**, **J.C. Cook**, **S.A. Stern**, **D.E. Kaufmann**, W.R. Pryor, J.S. Halekas and the Lyman Alpha Orbiter/Lyman Alpha Mapping Project (LRO/LAMP) Team. "LRO-LAMP Observations of the Lunar Exospheric Helium Coordinated with Lunar Atmospheric and Dust Environment Explorer (LADEE)." Presented at the 46th Lunar and Planetary Sciences Conference (LPSC), The Woodlands, Texas, March 2015.

Hansen, G. and **P. Lee**. "Correlation of Pump Test and High Frequency Reciprocating Rig (HFRR) Results by Modification of HFRR Contact Geometry and Parameters." Presented at the Society of Tribology and Lubrication Engineers (STLE) 70th Annual Meeting and Exhibition, Dallas, May 2015.

Hansen, G. and **P. Lee**. "Developing a High Pressure HFRR for Lubricity of Volatile Fluids." Presented at the STLE 70th Annual Meeting and Exhibition, Dallas, May 2015.

Heller, R. "Demonstration of Select Connected Vehicle Use Cases."

Presented at the 2015 New England Intelligent Transportation Systems (ITS) Annual Interchange, Boston, May 2015.

Hendrix, A.R., **T.K. Greathouse**, **K.D. Retherford**, **K.E. Mandt**, **G.R. Gladstone**, **D.E. Kaufmann**, D.M. Hurley, P.D. Feldman, W.R. Pryor, **M.A. Bullock** and **S.A. Stern**. "Far-Ultraviolet Characteristics of Lunar Swirls." Presented at the 46th LPSC, The Woodlands, Texas, March 2015.

Hodges, J. and **S. Carlson**. "Integration of Incremental Crack Front Evolution into the Structural Integrity Process: Examples, Experimental Comparisons and Lessons Learned." Proceedings of the 2014 ASIP Conference, San Antonio, December 2014.

Hubbard, B., J. Mars, R. Kokaly and **D. Hooper**. "Comparative Mineral Mapping of Alluvial Fans and Associated Aeolian and Lacustrine Deposits Around the Salton Sea, California Using MICA: A New Tool for Rapid Classification of Hyperspectral Infrared Imager (HyspIRI) VSWIR Imagery." Presented at the 2014 HyspIRI Science and Application Workshop, Pasadena, Calif., October 2014.

Hudak Jr., S.J. and **J.H. Feiger**. "Corrosion-fatigue Crack Growth in Ti-6A1-4V-0.1% Ru Exposed to Seawater and Sour Brine Environments." Presented at the 2015 NASA Engineering and Safety Center: Material Team Annual Meeting, San Jose, Calif., April 2015.

Hurley, D.M., M. Benna, **J.C. Cook**, J. Halekas, **C. Grava**, **K.D. Retherford**, P.D. Feldman, P. Mahaffy, R.R. Hodges and R.C. Elphic. "Comparing LAMP Polar Measurements to LADEE Equatorial Measurements of Helium in the Lunar Exosphere." Presented at the 46th LPSC, The Woodlands, Texas, March 2015.

James, M. and **R.C. McClung**. "Validation of New Experimental and Analytical Tools to Address Residual Stress Effects Accurately in the Design Cycle." Presented at the International Committee on Aeronautical Fatigue (ICAF) Symposium, Helsinki, June 2015.

Jessup, K.L., R.A. Woodruff, **M. Davis**, **C. Beebe**, **T. Finley**, E. Marcq, F. Mills and J.L. Bertaux. "High Spectral Resolution Mid-UV Spectrograph for Venus Observing." Presented at the 2015 Venus Science Priorities for Laboratory Measurements and Instrument Definition Workshop, Norfolk, Va., April 2015.

Johnson, J. "Data Sharing Across Jurisdictions." Presented at the Intelligent Transportation Society of Tennessee (ITS TN) 2015 Annual Meeting, Memphis, Tenn., April 2015.

Johnson, J. "Using Big Data as a Tool for Managing Customer Relationships." Presented at the Texas Technology Task Force (TTTF), Austin, Texas, May 2015.

Klar, R. and **S. Miller**. "The Cyclone Global Navigation Satellite System (CYGNSS) Mission: Science Processing on a Microsatellite with Limited Resources." Presented at the 2014 Flight Software Workshop (FSW), Pasadena, Calif., December 2014.

Kouame, S. "Assessment of the Deposit Inhibiting Properties of Diamond Like Coatings (DLC) on Metallic Surfaces." Presented at the STLE 70th Annual Meeting and Exhibition, Dallas, May 2015.

Lecocke, M., **Ja.L. Blount** and **Ju.L. Blount**. "Use of Formal Modeling to Automatically Generate Correct Fault Detection and Response Methods." Presented at the IEEE Aerospace Conference, Big Sky, Mont., March 2015.

Lee, P., **C. Wall**, **C. Wileman** and **G. Bailey**. "Detecting Ring Instability/ Scuffing in a Fired Engine." Presented at the STLE 70th Annual Meeting and Exhibition, Dallas, May 2015.

Light, G.M., **S.A. Vinogradov** and M. Garcia. "Use of Guided Wave Technology for Inspection of Guy Wire Anchors for Communication Towers." Presented at the 24th American Society for Nondestructive Testing (ASNT) Research Symposium, Anaheim, Calif., March 2015.

Lin, J., **R. Wei**, **R. Castillo** and **K.E. Coulter**. "A Comparative Study of Titanium Silicon Carbon Nitride (TiSiCN) Nanocomposite Coatings Deposited Using DC Magnetron Sputtering (DCMS), Pulsed DC Magnetron Sputtering (PDCMS), Plasma Enhanced Magnetron Sputtering (PEMS) and Deep Oscillation Magnetron Sputtering (DOMS) Techniques." Presented at the 42nd International Conference on Metallurgical Coatings and Thin Films (ICMCTF), San Diego, April 2015.

Lin, J., **R. Wei**, **K.E. Coulter**, **D.C. Bitsis** and **P. Lee**. "Development of Low Friction Nanocomposite Coatings for Diesel Engine Piston Rings." Presented at the American Vacuum Society 61st International Symposium and Exhibition, Baltimore, November 2014.

Mandt, K.E., **T.K. Greathouse**, **K.D. Retherford**, **G.R. Gladstone**, A.R. Hendrix, **A.F. Egan**, D.M. Hurley, P.D. Feldman and W.R. Pryor. "LRO-LAMP Observations of the South Pole Permanently Shaded Regions." Presented at the 46th LPSC, The Woodlands, Texas, March 2015.

Martinez, J. "Automated Vehicles: State of the Practice and Applications." Presented at the Florida International University (FIU) Institute of Transportation Engineers (ITE) Meeting, Miami, October 2014.

Martinez, J. "Connected Vehicle and Vehicle-to-Infrastructure (V2I) Data Exchange and General Overview of Automated Driving." Presented at the FDOT District 6 Traffic Operations Quarterly Meeting, Miami, Fla., February 2015.

Martinez, J. "Connected Vehicle and V2I Data Exchange." Presented at the 2014 Gulf Region Intelligent Transportation Society (GRITS), the Intelligent Transportation Society of Florida (ITSFL) and the Intelligent Transportation Society of Georgia (ITSGA)/ (ITS 3C) Summit, Mobile, Ala., September 2014, and at the 2014 Intelligent Transportations Society of New Jersey (ITSNJO) Annual Meeting, New Brunswick, N.J., October 2014.

Martinez, J. "General Overview of Automated Driving." Presented at the 2014 ITS 3C Summit, Mobile, Ala., September 2014.

McClung, R.C. "Integrating Fracture Mechanics into the Material and Structural Design Process." Presented at the 15th International American Society for Testing and Materials (ASTM)/European Structural Integrity Society (ESIS) Symposium on Fatigue and Fracture Mechanics (40th ASTM National Symposium on Fatigue and Fracture Mechanics), Anaheim, Calif., May 2015.

McClung, R.C., **C.F. Popelar**, **J.M. McFarland**, **V. Bhamidipati**, M. James, J. Watton, M. Hill, A. DeWald and D. Ball. "Validation of New Experimental and Analytical Tools to Address Residual Stress Effects Accurately in the Design Cycle: Part 2 — Design Analysis Validation." Presented at the ICAF Symposium, Helsinki, June 2015.

Technical Staff Activities

McClung, R.C., **B.H. Thacker** and **V. Bhamidipati**. "A Framework for Verification and Validation Models for Laser Printing." Presented at the 5th International Conference on Laser Peening and Related Phenomena, Cincinnati, May 2015.

McComas, D.J. "IBEX Discoveries Over a Half Decade of Observing the Outer Heliosphere." Invited talk at the Workshop on Reconnection, Turbulence, and Particles in the Heliosphere, Queenstown, New Zealand, February 2015.

McComas, D.J. "The Interstellar Boundary Explorer." Presented at The UTSA Physics and Astronomy Department Seminar, San Antonio, March 2015.

McComas, D.J., **F. Allegrini**, F. Bagenal, **R.W. Ebert**, P. Louarn, M. Reno, **P. Valek**, **S. Weidner** and R.J. Wilson. "JADE on the Juno Mission to Jupiter." Presented at the MOP 2015 Meeting, Atlanta, June 2015.

McFarland, J.M., **B.J. Bichon**, S. Clarkson, G. Dillingham, B. Hanson, B. Oakley, M.J. Palmer, **C.F. Popelar** and **M.D. Weatherston**. "Modeling and Characterization of DCB Test Results for TRUST." Presented at the Society for the Advancement of Materials and Process Engineering (SAMPE) Technical Conference, Baltimore, May 2015.

Megel, A. and **G. Bailey**. "Development of Relative Analysis Methods to Determine Fatigue Durability in Aluminum Cylinder Heads." Presented at the 2015 Simulia Community Conference, Berlin, May 2015.

Megel, A. and **G. Bailey**. "Relative Analysis Method to Determine Durability in Aluminum Cylinder Heads." Presented at the 2015 ANSYS Automotive Simulation World Congress, Detroit, June 2015.

Mintz, T.S., **L.J. Caseres**, **F. Bocher** and **J.F. Dante**. "Development of Corrosion Sensor Technology for Buried Piping." Presented at the 2015 National Association of Corrosion Engineers (NACE) CORROSION Conference, Dallas, March 2015.

Mintz, T.S. and **K.L. Shannon**. "Corrosion of Aluminum Finer Copper-Tube Heat Exchanger Coils." Presented at the 2015 NACE CORROSION Conference, Dallas, March 2015.

Mitchem, S. "Frito Lay Electric Vehicle Fleet: Fast Responding Regulation Service (FRRS)." Presentation at the Electric Reliability Council of Texas (ERCOT) Emerging Technologies Working Group (ETWG) Meeting, Austin, February 2015.

Moneer, M., **P. Lee**, **G. Hansen** and **E. Liu**. "Developing a Screening Method for the Sequence IVA Cam Lobe Wear Test." Presented at the STLE 70th Annual Meeting and Exhibition, Dallas, May 2015.

Morgan, P.J., **P.E. Lobato**, **V. Premnath** and **S. Kroll**. "CRC E-94-1a Determination and Evaluation of New Prep Cycle on the Fuel Effects of Gaseous and Particulate Emissions on SIDI In-Use Vehicles." Presented at the 25th Coordinating Research Council Real World Emissions Workshop in Long Beach, Calif., March 2015.

Musacchio, F., J. Saur, **L. Roth**, **K.D. Retherford**, P.D. Feldman, M.A. McGrath, D.F. Strobel and S. Duling. "The Spatial Structure and Temporal Variability of Ganymede's Auroral Ovals from Hubble Space Telescope Observations." Presented at the MOP 2015 Meeting, Atlanta, June 2015.

Musacchio, F., J. Saur, **L. Roth**, P.D. Feldman, D.F. Strobel, **K.D. Retherford** and M.A. McGrath. "The Spatial Structure and Variability of Ganymede's Auroral Ovals from Hubble Space Telescope Observations." Presented at the German Physical Society Annual Meeting of the DPG and DPG Spring Meeting, Berlin, March 2015.

Necsoiu, M. "Rock Glaciers Dynamics and Permafrost Degradation Using Optical and SAR Satellite Imagery. Case Study: Retezat Mountains, Romania." Presented at the Mountain Research Initiative Key Contact Workshop, San Francisco, December 2014.

Necsoiu, M., **D. Hooper** and **R. McGinnis**. "Landslide Investigations at Salmon Falls Creek Canyon in Idaho Using Satellite-based Multitemporal Interferometric Synthetic Aperture Radar Techniques." Presented at the 2014 AGU Fall Meeting, San Francisco, December 2014.

Necsoiu, M. and **G.R. Walter**. "Detection of Uranium Mill Tailings Cover Erosion Rates and Settlement Using Satellite-Based Radar Interferometry," 9th International Workshop Fringe 2015 Advances in the Science and Applications of SAR Interferometry and Sentinel-1 InSAR Workshop, Frascati, Italy, March 2015.

Nicholls, A.E., **D.E. Moravits**, J. Harris, S. Levine, M. Allen, J. Nyman and **T.L. Bredbenner**. "Females and Males Achieve Equivalent Cortical Bone Mechanical Properties through Different Combinations of Bone Traits." Presented at the Orthopaedic Research Society (ORS) Meeting, Las Vegas, March-April 2015.

Nicolaou, G., **D.J McComas**, F. Bagenal, **H.A. Elliott** and **R.W. Ebert**. "Boundary Regions in the Deep Jovian Magnetotail as Observed by the Solar Wind Around Pluto (SWAP) Instrument on New Horizons." Presented at the MOP 2015 Meeting, Atlanta, June 2015.

Nicolella, D.P., **T.L. Bredbenner**, L. Havill, J. Tamez-Pena, P. Gonzalez, E. Schreyer, S. Totterman and C. Kwoh. "Variation in Knee Shape Predicts the Future Onset of Radiographic Knee Osteoarthritis (RKOA) and this Variation is Different in Males Compared to Females." Presented at the Osteoarthritis Research Society International (OARS), Seattle, April-May 2015.

Ogasawara, K., **F. Allegrini**, **T.W. Broiles**, **M.A. Dayeh**, **M.I. Desai**, **R.W. Ebert**, **S.A. Livi** and **D.J. McComas**. "Comparison of Next-generation Solid-state Detectors for Measuring Energetic Particles in Space." Presented at the MTSSP Conference, Boulder, Colo., April 2015.

Owston, R.A. "Benefits and Challenges of ESP Testing Under Expected Downhole Conditions." Presented at the Multiphase Pump User Roundtable, Houston, May 2015.

Oxley, J. "A Guide to Encapsulation Applications." Presented at the 18th Microencapsulation Industrial Convention, Eindhoven, Netherlands, April 2015.

Pensado, O. "Relevance of Radionuclide Transport Assisted by Colloids in a KBS-3 Repository." Presented at the 2015 American Nuclear Society (ANS) International High-level Radioactive Waste Management Conference (IHLRWM), Charleston, S.C., April 2015.

Popelar, C.F., **B.J. Bichon**, S. Clarkson, G. Dillingham, B. Hanson, **J.M. McFarland**, B. Oakley, M.J. Palmer and **M.D. Weatherston**. "TRUST Informatics Baseline Bond Process Double

Cantilever Beam and Edge Notch Flexure Test Procedures and Results." Presented at the SAMPE Technical Conference, Baltimore, May 2015.

Ransom, D.L., **M.A. Poerner** and **C.S. Cunningham**. "Flat Plate Experiments to Measure Temperature and Strain Response to Fill Transient of a Cryogenic Propellant Tank Wall." Presented at the 62nd JANNAF Propulsion Meeting, Nashville, Tenn., June 2015.

Retherford, K.D., **T.K. Greathouse**, **G.R. Gladstone**, A.R. Hendrix, **K.E. Mandt**, **A.F. Egan**, **D.E. Kaufmann**, P.O. Hayne, **M.A. Bullock**, **S.A. Stern**, **J.W. Parker**, **M.W. Davis**, D.M. Hurley, W.R. Pryor, P.D. Feldman, **C. Grava**, **J. Mukherjee**, **P. Mokashi**, **C.M. Seifert**, **C.J. Seifert** and **M.H. Versteeg**. "The Far-UV Albedo of the Moon as a Probe of the Lunar Cryosphere: LRO/LAMP Latest Results." Presented at the 46th LPSC, The Woodlands, Texas, March 2015.

Retherford, K.D., **L. Roth**, L.M. Feaga, **C.C.C. Tsang**, **K.L. Jessup** and **C. Grava**. "Io's SO_2 Atmosphere Silhouetted by Jupiter Lyman-α During Transit Events." Presented at the MOP 2015 Meeting, Atlanta, June 2015.

Retherford, K.D., **L. Roth**, J. Saur, D.F. Strobel, M.A. McGrath, F. Nimmo, P.D. Feldman, **J.R. Spencer** and A. Bloecker. "An Update on the HST Cycle 22 Campaign to Investigate Europa Water Vapor Plumes." Presented at the Workshop on the Potential for Finding Life in a Europa Plume, Mountain View, Calif., 2015.

Ridens, B.R., **A. Alvarado**, **A.J. Garcia-Hernandez** and **E.L. Broerman**. "The Impact of Changing Pipeline Conditions on Compressor Efficiency." Presented at the 2015 Gas/Electric Partnership Conference XXIII, Houston, February 2015.

Rutherford, J. "Protecting Large Organizations and Communities Through the Use of a Honey Community." Presented at the 2015 Cyber Security Symposium, Coeur d'Alene, Idaho, April 2015.

Salcido, J., **X.G. Cheng**, L.Z. Sun and A. Bandyopadhyay. "An *In Vivo* Study of Combinatorial Tumor Hyperthermia Therapy Using Novel Magnetic Calcium Phosphate Nanoparticles and Tumor Suppressive Agents." Presented at the 2nd Annual Biomedical Research Symposium at UTSA, San Antonio, April 2015.

Sarlashkar, J.V., **S.B. Rengarajan**, **R.C. Roecker**, **R.S. Huron** and **D.E. Bidault**. "Ignition Control of a Spark-ignited Dedicated-EGR™ Engine." Presented at the 2015 JSAE Annual Congress, Yokohama, Japan, May 2015.

Siebenaler, S.P. "Detecting Leaks in Offshore Pipelines." Presented at the Marine Technology Society Subsea Leak Detection Symposium, Houston, November 2014.

Siebenaler, S.P. "Detecting Small Leaks in Liquid Pipelines." Proceedings of the 9th Pipeline Technology Conference, Berlin, May 2014.

Siebenaler, S.P. "External Leak Detection, Testing, and Research." Presented at the 14th International Pipeline Conference, Calgary, Alberta, Canada, October 2014.

Siebenaler, S.P., *et al.* "Characterization of Thermal and Acoustic Profiles of Potential Underwater Pipeline Leaks." Proceedings of the 14th International Pipeline Conference, Calgary, Alberta, Canada, October 2014.

Siebenaler, S.P., *et al.* "Field Testing of Negative-wave Leak Detection Systems." Proceedings of the 14th International Pipeline Conference, Calgary, Alberta, Canada, October 2014.

Siebenaler, S.P., *et al.* "Thermal Characterization of Potential Leaks in Offshore Pipelines." Presented at the Arctic Technology Conference, Copenhagen, Denmark, March 2015.

Smith, L., **J. Feiger** and R. Pilarczyk. "Validation Testing and Analysis of Cracked Hole Continuing Damage Solutions." Presented at the 15th International ASTM/ESIS Symposium on Fatigue and Fracture Mechanics, Anaheim, Calif., May 2015.

Sturgeon, P., **P. Avery** and **R. Garcia**. "A Cooperative Vehicle Application for Dynamic Lane-level Model Generation." Presented at the 3rd ICCVE 2014, Vienna, November 2014.

Swain, L., D. Dean, **X. Cheng**, **D.P. Nicolella**, R. Srinivasan and V. Sylvia. "Synergistic Effects of Mechanical Stimulation and PDGF Nanoparticles on Tenocyte Differentiation of Adipose-derived Stem Cells on Aligned Collagen Scaffolds." Presented at the ORS Meeting, Las Vegas, March-April 2015.

Valek, P., **D.J. McComas**, **F. Allegrini**, F. Bagenal, **R.W. Ebert**, M. Reno, **S. Weidner** and R.J. Wilson. "Jovian Auroral Distributions Experiment (JADE-I) on the Juno Mission to Jupiter." Presented at the MOP 2015 Meeting, Atlanta, June 2015.

Wei, R., **C.A. Ellis-Terrell**, **C. Rincon** and **J. Lin**. "Plasma Immersion Ion Deposition (PIID) of Diamond-like Carbon (DLC) Coatings for Automotive and Petroleum Applications." Presented at the 2015 Society of Vacuum Coaters (SVC) Technical Conference, Santa Clara, Calif., April 2015.

Wei, R., **J. Lin**, **D.C. Bitsis** and **P.M. Lee**. "Development of Low Friction and Wear-resistant Nanocomposite Coatings for Piston Rings." Presented at the 42nd ICMCTF, San Diego, Calif., April 2015.

Wieland, D., **J. Cutshall** and M. Blinn. "Full-Scale Fatigue Testing of Two T-38 Wings." Presented at the ICAF Symposium, Helsinki, June 2015.

Wileman, C. and **P. Lee**. "Investigation into Engine Wear Map Development using Radioactive Tracer Testing." Presented at the STLE 70th Annual Meeting and Exhibition, Dallas, May 2015.

Zirnstein, E. "Distinguishing Tests of the IBEX Ribbon through Numerical Modeling: Current Results and Future Prospects." Presented at the 2014 AGU Fall Meeting, San Francisco, December 2014.

Zirnstein, E., H. Funsten, J. Heerikhuisen and **D.J. McComas**. "The Effects of Slow, Intermediate and Fast SW Speeds on the IBEX Ribbon." Presented at the 14th Annual International Astrophysics Conference, Tampa, Fla., April 2015.

Zorbas-Poenitzsch, V., S. Diepetro, **R. Wei** and **K.E. Coulter**. "Hybrid Processing Method for Fabrication for Nanocomposite Nacre-Lake Materials." Presented at the 42nd International Conference on Metallurgical Coatings and Thin Films (ICMCTF), San Diego, April 2015.

Technical Staff Activities

Internal Research

Funded April 1, 2015

Alvarez, J. and **P. Riley**. "Susceptibility of Processor Memory to Radiation-Induced Faults."

Alvarez, J. and **B. Walls**. "Viability of a Blended Redundancy Concept for Constrained Spacecraft Applications."

Araujo, M., **S. Baldor**, **E. DuPont**, and **S. Siebenaler**. "Automated Detection of Small Hazardous Liquid Pipeline Leaks."

Blount, J. and **K. Holladay**. "Using SequenceL to Improve Performance of CFD Code."

Chambers, D. and **S. Slocum**. "Unsupervised Cross-Modality Classification Training System."

Davidson, B. and **R. Reinhard**. "STORMFORCE Demonstration."

Couvillion, W. and **D. Chambers**. "Composite Reality™."

Dante, J., **T. Mintz**, **E. Macha**, **J. Feiger**, and **K. Schrader**. "Effect of Cyclic Relative Humidity on Environmentally Assisted Cracking."

DuPont, E. "Automatic Camera Calibration System."

Henry, C. "Detailed Characterization of Emissions from D-EGR Vehicle, and Evaluation of Synergistic Control Technologies."

Hoag, K. "Combustion Chamber Design Optimization for Advanced SI Engines."

Lin, J., **R. Wei**, **C. Bitsis**, **M. Amann**, and **P. Lee**. "Development and Evaluation of Low-Friction and Low-Wear Coatings for Automotive Valvetrain."

McFarland, Y.-L. and **S. Kouame**. "Fundamental Study of Internal Diesel Injector Deposits."

Mitchell, J., **M. Rivera Garcia**, and **J. Groff**. "Compound-Eye Based Ultra-Thin Cameras."

Moore, A. "Hybrid Virtual/Physical Test Bed Risk Reduction."

Musgrove, G., **S. Coogan**, **S. Saleh**, and **B. Bichon**. "Algorithms to Improve the Speed of the Numerical Model Based on the Lattice Boltzmann Method."

Nicolella, D. and **S. Chocron**. "Dynamic Characterization of Soft Biological Tissues."

Noonan, P., **A. Whittington**, and **B. Abbott**. "Telemetry System Manager Automatic Program Synthesis."

Reinhart, T. and **C. Chadwell**. "SwRI Heavy-Duty D-EGR Gasoline Engine: A Cost-Effective Alternative to Medium-Duty Diesel Engines."

Sarlashkar, J. "Enhancing SwRI Multidimensional Control Framework for D-EGR Engine."

Sauer, C. "Evaluation of High-Speed Interconnects to Support Next-Generation Solid State Recorder for Mission Critical Applications."

Vickers, D., **T. Brown**, **A. Van Horn**, and **K. Holladay**. "Traffic Profile Prediction."

Vickers, D., **J. Harwell**, **R. Klar**, and **B. Abbott**. "Computational Performance Enhancements Via Parallel Execution of Competing Implementations."

Walsh, K., **H. Levison**, **G. Mabey**, **D. Kaufmann**, **J. Salmon**, and K. Tsiganis. "Optimizing SyMBA's Algorithm Using Graphics Processing Units."

Westhart, P., **G. Willden**, and **B. Abbott**. "Platform-Independent Evolutionary-Agile Optimization of Planetary Formation Simulation."

Whittington, A., **A. Van Horn**, and **B. Abbott**. "Code Generation and Planning Engine for Self-Tuning Runtime Optimization."

Patents

Casey, R. and C. Smith. "Sensor Array Processor with Multichannel Reconstruction from Random Array Sampling." U.S. Patent No. 9,015,007. April 2015.

DeForest, C.E. "Systems and Methods for Hybrid Compression of Spectral Image Data." U.S. Patent No. 9,031,336. May 2015.

Dixon, H. and **J.A. McDonough**. "Processing of Heat-sensitive Active Agents." U.S. Patent No. 9,040,080. May 2015.

Feng, M. and **C-K. Tan**. "Fuels and Fuel Additives Production from Glycerol Conversion Using a Monohydric Alcohol and Heterogeneous Catalysis." U.S. Patent No. 8,986,400. March 2015.

Gingrich, J. and **T. Alger III**. "Catalyst Light-off for Turbocharged Internal Combustion Engine Having Dedicated EGR Cylinder(s)." U.S. Patent No. 8,996,281. March 2015.

Jones, G. and **A.J. Megel**. "EGR Pulse Mixer for Internal Combustion Engine Having EGR Loop." U.S. Patent No. 9,051,902. June 2015.

Ling, J., B. Antebi, **X. Cheng** and **J.N. Harris**. "Fabrication of Bone Regeneration Scaffolds and Bone Filler Material Using a Perfusion Flow System." U.S. Patent No. 9,044,530. June 2015.

McDonough, J. and **H. Dixon**. "Pharmaceutically Active Nanosuspensions." U.S. Patent No. 8,946,200. February 2015.

McDonough, J., **H. Dixon** and **L.A. Cabell**. "Nanoparticles for Drug Delivery to the Central Nervous System." U.S. Patent No. 9,028,873. May 2015.

McDonough, J., **D.W. Johnston** and P. Thompson. "Point of Use Generation of Amyl Nitrite." U.S. Patent No. 8,987,496. March 2015.

McFadden, M.J. and **J. Boehme**. "Portable 3-Dimensional X-ray Imaging System." U.S. Patent No. 8,976,926. March 2015.

Mehta, D., **C. Koci** and **C.E. Roberts Jr.** "Fuel Injection During Negative Valve Overlap for Stoichiometric Diesel Operations." U.S. Patent No. 8,948,999. February 2015.

Miller, M., **K. Chan**, **W. Liang** and C.K. Chan. "Clathrate Allotropes for Rechargeable Batteries." U.S. Patent No. 8,993,165. March 2015.

Nicolella, D.P., N. Nitin, H. Hanson and **K. Chan**. "Micro-structure Particles for Load Bearing Bone Growth." U.S. Patent No. 9,030,784. May 2015.

Phillips, A.J., **J. Nave**, **G. Bartlett**, **C. Porter** and **I.R. Meinzen**. "Apparatus and Method for Inspecting High Voltage Insulators." (Sponsored.) U.S. Patent No. 8,991,273. March 2015.

Sasaki, S., **V.N. Iyengar**, **J.V. Sarlashkar** and **G.D. Neely**. "Fueling Systems, Methods and Apparatus for an Internal Combustion Engine." U.S. Patent No. 8,996,282. March 2015.

Whipple, J.G., **T. Wilmes** and **B.K. Anderson**. "Autonomous Location of Objects in a Mobile Reference Frame." U.S. Patent No. 8,996,036. March 2015.

Zhan, R., **P. Weber** and **M.A. Chadwell**. "Particulate Oxidation Catalyst with Dual Pressure-drop Sensors. U.S. Patent No. 9,046,026. June 2015.

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