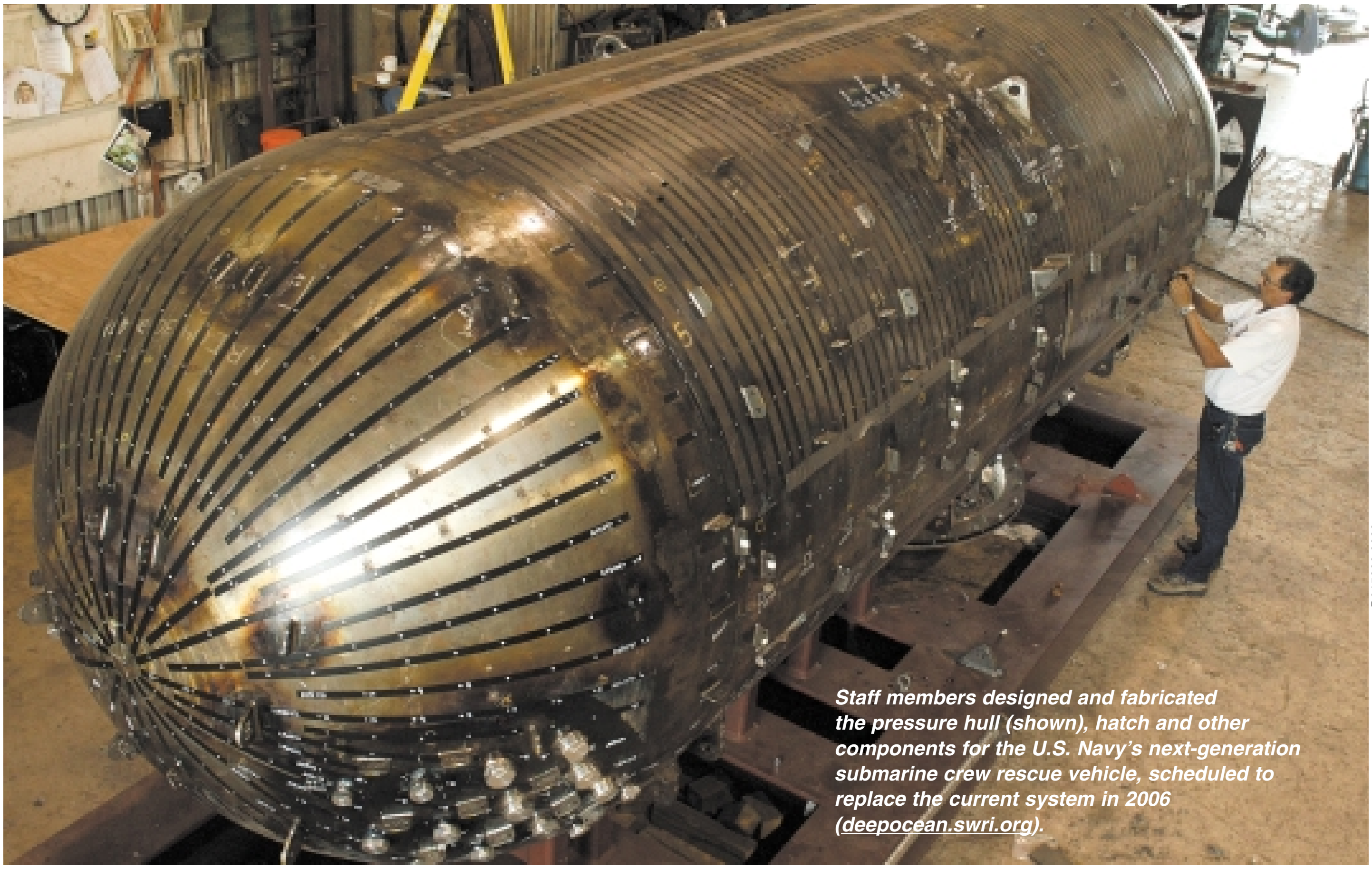
Mechanical & Materials Engineering



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Staff members designed and fabricated the pressure hull (shown), hatch and other components for the U.S. Navy's next-generation submarine crew rescue vehicle, scheduled to replace the current system in 2006 (deepocean.swri.org).

Skyrocketing energy costs are driving Southwest Research Institute and its government and industry clients to create new energy technologies, and extend the life and efficiency of the existing energy infrastructure (oilgas.swri.org).

To increase the domestic supply of energy, we are developing multiphase flow technology to improve the reliability and safety of deepwater subsea production systems. SwRI engineers are also creating the next generation of natural gas compressors to improve the reliability, integrity and efficiency of pipeline operations.

SwRI is also integrating analytical, numerical and experimental techniques with new sensor technologies to develop sophisticated software tools that evaluate and predict the structural integrity and reliability of mechanical systems (integrityandreliability.swri.org).

We continue to enhance our NASGRO®, DARWIN® and NESSUS® software to address new materials and operating conditions. These software tools have received numerous accolades; *R&D Magazine* recently named NESSUS one of the 100 most significant developments of the year. While NESSUS computes the probabilistic response and reliability of any engineered system, such as space shuttle components, DARWIN is focused on evaluating the risk of burst in aircraft engine rotors used in commercial aircraft. NASGRO assesses potential cracking in a structural or material system.

We are also developing new codes that predict the effects of sand and other debris

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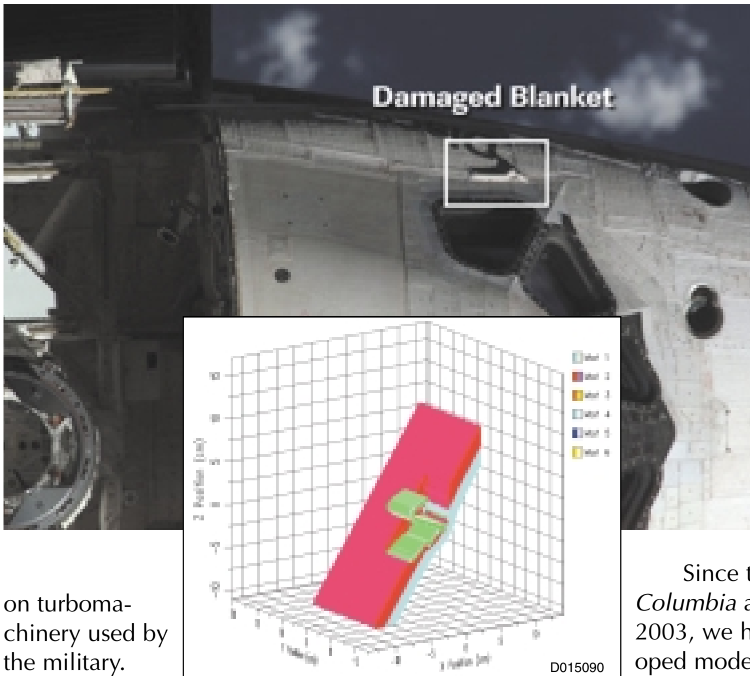
Using an isolation chamber to prevent contamination, scientists evaluate the ability of materials to absorb, store and release hydrogen (hydrogenstorage.swri.org). The Department of Energy designated SwRI as the core laboratory for evaluating the hydrogen storage potential of emerging materials in an effort to advance fuel cell technologies.

fatigue testing • computational fluid dynamics • deep ocean simulations • fracture mechanics • probabilistic failure analysis • environmental testing • flow measurement • surface engineering & coatings • pipeline compression & measurement • biomechanics & biomaterials • life prediction • acoustics •



Courtesy NASA

Following the space shuttle's return to flight ascent, inspections revealed a damaged thermal blanket near the crew cabin window of Discovery. *While the orbiter was still in flight, SwRI performed experiments and computations (inset) to determine the potential damage that could occur if the blanket tore free and struck the shuttle upon reentry.*

on turbomachinery used by the military. Other software enhancements are enabling us to predict the stability of large rotors used in centrifugal gas compressors and turbomachinery.

As the military is forced to operate in increasingly challenging environments, we apply models, experiments and sensors to increase reliability and performance. For example, we are improving processes and modernizing components of the CH-47 heavy-lift helicopter, as well as evaluating new coating and modeling technologies that will extend the life of helicopter blades in desert environments.

Our multidisciplinary approach to problem solving allows us to help the military evaluate and extend the life of aging military systems. We are conducting a full-scale fatigue test of the Air Force's T-38 advanced trainer and helping assess the structural integrity of the A-10 ground attack aircraft. (aerospacestructures.swri.org). We are also assisting a commercial aviation manufacturer to certify a new class of commercial jet to Federal Aviation Administration standards.

Since the *Columbia* accident in 2003, we have developed models for NASA to help predict the probability and consequence of debris impacts on the shuttle and other space systems (compmech.swri.org, mateng.swri.org). We are expanding this work to include new operating environments and fabricating new compressed-gas guns to accommodate different impactor shapes and sizes during experimental evaluations.

By coupling analytical tools with sensors, we can significantly improve the reliability and reduce the maintenance costs of major systems. For example, one of our new microsensors anticipates the onset of corrosion (corrosiontechnology.swri.org). The multielectrode array, funded by the Department of Energy and industrial clients, travels through pipelines to detect the presence of moisture, the first constituent of corrosion (mass.swri.org). A program for the Air Force Research Laboratory is integrating information from embedded sensors with advanced life and reliability predictions to forecast crack and damage growth in turbine engines with the goal of helping the military better manage fleet operations and improve aircraft performance.

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A team of SwRI engineers developed a low-cost centrifugal gas turbine, incorporating the turbine disk shown, that is simple to maintain and inexpensive to operate. The new turbine shows great potential for replacing older gas turbine engines, which are generally complex and difficult to maintain.

These programs are part of a broader initiative in integrated structural health management aimed at predicting and extending the lifetimes of the national infrastructure including air, space and ground vehicles, as well as bridges and power plants, through the integrated application of sensors, probabilistic methods and modeling of fatigue, fracture, corrosion and other degradation processes. ❖

Visit mechmat.swri.org for more information or contact Vice President Dr. Robert L. Bass at (210) 522-2326 or rbass@swri.org.

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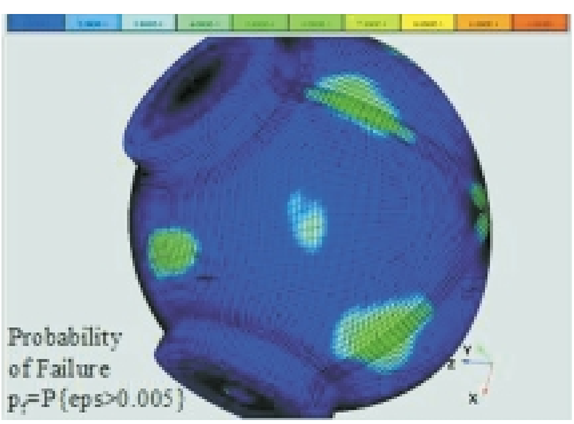

SwRI engineers are assisting Los Alamos National Laboratory with the design of containment vessels that confine high-energy detonation experiments. Our award-winning NESSUS® probabilistic analysis software, interfaced with several massively parallel hydrodynamic and structural response codes, is being used to validate numerical models of the containment vessel in support of the National Nuclear Security Administration Stockpile Stewardship Program.

thermal analysis • diagnostic software • corrosion analysis • impact modeling • NEBS qualification • computational mechanics • finite element analysis • structural mechanics • engineering dynamics • aerodynamics • mechanical testing • material integrity • failure analysis • terminal ballistics