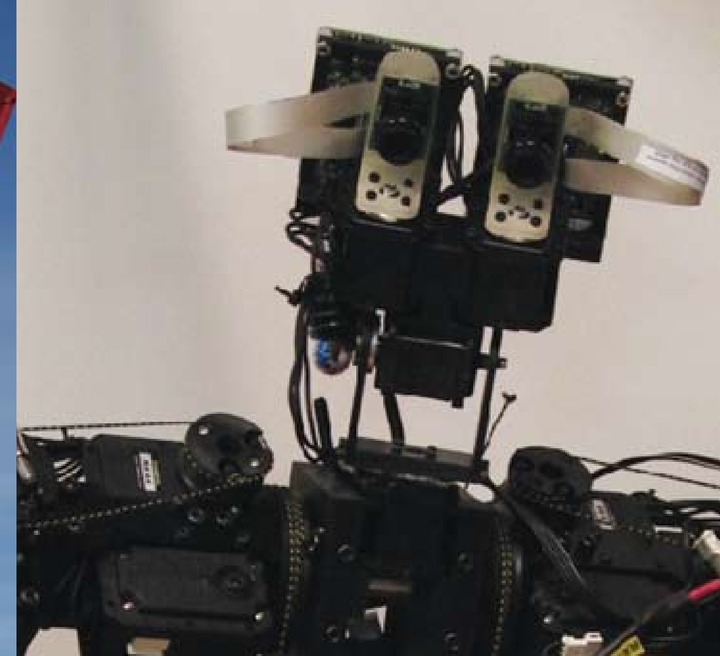
National Aeronautics and Space Administration

NASA Technologies Benefit Society

spinoff

2010





In accordance with congressional mandates cited in the National Aeronautics and Space Act of 1958 and the Technology Utilization Act of 1962, NASA has nurtured partnerships with the private sector to facilitate the transfer of Agency-developed technologies for the greater good of the public. These partnerships fuel economic and technological development nationally and globally, resulting in commercial products and services enabled on Earth by NASA's missions to the stars. Since 1976, NASA *Spinoff* has profiled the most compelling of these technologies, annually highlighting the best and brightest of partnerships and innovations in the fields of health and medicine, transportation, public safety, consumer goods, environmental resources, computer technology, and industrial productivity.

Executive Summary

NASA *Spinoff* highlights the Agency's most significant research and development activities and the successful transfer of NASA technology, showcasing the cutting-edge research being done by the Nation's top technologists and the practical benefits that come back down to Earth in the form of tangible products that make our lives better. The benefits featured in this year's issue include:

Health and Medicine

Burnishing Techniques Strengthen Hip Implants

In the late 1990s, Lambda Research Inc., of Cincinnati, Ohio, received Small Business Innovation Research (SBIR) awards from Glenn Research Center to demonstrate low plasticity burnishing (LPB) on metal engine components. By producing a thermally stable deep layer of compressive residual stress, LPB significantly strengthened turbine alloys. After Lambda patented the process, the Federal Aviation Administration accepted LPB for repair and alteration of commercial aircraft components, the U.S. Department of Energy found LPB suitable for treating nuclear waste containers at Yucca Mountain. Data from the U.S. Food and Drug Administration confirmed LPB to completely eliminate the occurrence of fretting fatigue failures in modular hip implants.
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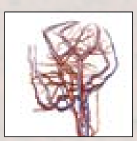

Signal Processing Methods Monitor Cranial Pressure

Dr. Norden Huang, of Goddard Space Flight Center, invented a set of algorithms (called the Hilbert-Huang Transform, or HHT) for analyzing nonlinear and nonstationary signals that developed into a user-friendly signal processing technology for analyzing time-varying processes. At an auction managed by Ocean Tomo Federal Services LLC, licenses of 10 U.S. patents and 1 domestic patent application related to HHT were sold to DynaDx Corporation, of Mountain View, California. DynaDx is now using the licensed NASA technology for medical diagnosis and prediction of brain blood flow-related problems, such as stroke, dementia, and traumatic brain injury.
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Ultraviolet-Blocking Lenses Protect, Enhance Vision

To combat the harmful properties of light in space, as well as that of artificial radiation produced during laser and welding work, Jet Propulsion Laboratory (JPL) scientists developed a lens capable of absorbing, filtering, and scattering the dangerous light while not obstructing vision. SunTiger Inc.—now Eagle Eyes Optics, of Calabasas, California—was formed to market a full line of sunglasses based on the JPL discovery that promised 100-percent elimination of harmful wavelengths and enhanced visual clarity. The technology was recently inducted into the Space Technology Hall of Fame.
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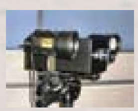

Hyperspectral Systems Increase Imaging Capabilities

In 1983, NASA started developing hyperspectral systems to image in the ultraviolet and infrared wavelengths. In 2001, the first on-orbit hyperspectral imager, Hyperion, was launched aboard the Earth Observing-1 spacecraft. Based on the hyperspectral imaging sensors used in Earth observation satellites, Stennis Space Center engineers and Institute for Technology Development researchers collaborated on a new design that was smaller and used an improved scanner. Featured in *Spinoff* 2007, the technology is now exclusively licensed by Themis Vision Systems LLC, of Richmond, Virginia, and is widely used in medical and life sciences, defense and security, forensics, and microscopy.
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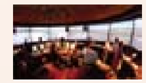
Transportation



Programs Model the Future of Air Traffic Management

Through Small Business Innovation Research (SBIR) contracts with Ames Research Center, Intelligent Automation Inc., based in Rockville, Maryland, advanced specialized software the company had begun developing with U.S. Department of Defense funding. The agent-based infrastructure now allows NASA's Airspace Concept Evaluation System to explore ways of improving the utilization of the National Airspace System (NAS), providing flexible modeling of every part of the NAS down to individual planes, airports, control centers, and even weather. The software has been licensed to a number of aerospace and robotics customers, and has even been used to model the behavior of crowds.
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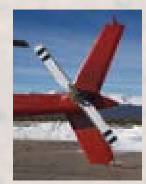

Tail Rotor Airfoils Stabilize Helicopters, Reduce Noise

Founded by former Ames Research Center engineer Jim Van Horn, Van Horn Aviation of Tempe, Arizona, built upon a Langley Research Center airfoil design to create a high performance aftermarket tail rotor for the popular Bell 206 helicopter. The highly durable rotor has a lifetime twice that of the original equipment manufacturer blade, reduces noise by 40 percent, and displays enhanced performance at high altitudes. These improvements benefit helicopter performance for law enforcement, military training, wildfire and pipeline patrols, and emergency medical services.
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Originating Technology/NASA Contribution

Given the eye-catching nature of space shuttle launches, deep-space imagery, and Mars exploration, it can be easy to forget NASA's aeronautics efforts, which have a daily impact on life within the bounds of Earth's atmosphere. Virtually every flying vehicle in operation today has benefited in some way from NASA advancements, and the helicopter is no exception. In fact, NASA's involvement in rotorcraft research can be traced back to its predecessor, the National Advisory Committee for Aeronautics (NACA). NACA was founded in 1915, less than a decade after the first successful piloted rotorcraft flight in 1907, and made a number of contributions to rotorcraft development—including a series of airfoils that are still employed in some modern vehicles.

The Rotor Systems Research Aircraft (RSRA) is seen here in flight over Ames Research Center. Former Ames engineer Jim Van Horn, founder of Van Horn Aviation (VHA), worked on the RSRA in the early 1980s.

NASA was formed in 1958, and within a little more than a decade the Agency had begun a collaborative rotorcraft research program with the U.S. Army, establishing laboratories at Ames Research Center, Glenn Research Center (then known as Lewis Research Center), and Langley Research Center. These labs focused on enhancing the performance and safety of helicopters for both military and civilian use. This research improved helicopter airfoil designs, flight control systems, aerodynamics, rotor blade and aircraft body composition, and cockpit configuration.

Partnership

Among the many outcomes of the NASA-Army research partnership are advanced airfoils designed and wind-tunnel tested at Langley. Two of these airfoil designs—the RC(4)-10 and the RC(3)-10—were licensed and commercialized by Carson Helicopters (*Spinoff* 2007) as a superior replacement main rotor for the Sikorsky S-61 helicopter, allowing the helicopter to fly faster and carry heavier loads while offering a service life twice that of the original rotor.

Carson's success with its NASA-derived airfoil caught the eye of Dean Rosenlof, general manager and aerospace engineer for Van Horn Aviation LLC (VHA), based in Tempe, Arizona. The company—founded by former Ames engineer Jim Van Horn, who worked on NASA rotorcraft research like the Rotor Systems Research Aircraft in the early 1980s—was looking for airfoil designs to expand its tail rotor blade product offerings, which include an aftermarket carbon composite tail rotor for the UH-1H ("Huey") military helicopter. Rosenlof brought the Langley RC series of airfoils—the low-speed RC(4)-10 and the high-speed RC(5)-10—to Van Horn's attention, and they determined these were precisely the designs the company was looking for.

The complex aerodynamics of a helicopter present a challenge to airfoil designers, who must consider a range of aerodynamic forces and how they influence the rotorcraft's flight capabilities. Among the chief concerns is pitching moment, the twisting force exerted by the airfoil that pushes the noses of the rotor blades up or down. Because this force can interfere with pilot control and rotor blade stability, designers aim to create airfoils with minimal to zero pitching moment.

"The RC airfoils were exactly what we needed," says Van Horn. "They are very attractive in that they are thin, light, laminar-flow airfoils with essentially zero pitching moment."

VHA contacted Langley and discovered that the airfoils' patent had expired, meaning the original NASA designs had entered the public domain.

"Langley encouraged us to take the designs, go forward, and be fruitful," says Van Horn.

Product Outcome

A helicopter tail rotor serves two essential functions. It provides a counteracting force to the helicopter's main rotor; without the sideways thrust produced by the tail rotor, the torque generated by the main rotor would spin the helicopter's body in the opposite direction. The tail rotor also allows the pilot to steer the helicopter around its vertical axis by adjusting the pitch of the rotor blades. Using the design for the NASA RC(4)-10 airfoil, VHA crafted an updated aftermarket tail rotor for the popular Bell 206 series of helicopters.

"It's an excellent airfoil, very stable, with very high stall margins," says Van Horn. The company built upon the RC(4)-10 airfoil, employing corrosion-resistant composite material with a titanium root fitting, a swept tip, a nickel abrasion strip that reduces wear on the blades' leading edges, and a new pitch bearing design. The result is a highly durable tail rotor blade—the Federal Aviation Administration (FAA) granted the VHA 206 tail rotor a 5,000-hour lifetime, twice that of the original equipment

VHA's NASA-derived 206 tail rotor is made of composite material with additional features like a titanium root fitting, swept tip, nickel abrasion strip, and new pitch bearing design.

Employing the NASA-developed RC(4)-10 airfoil design, the VHA 206 rotor blade provides a high-performance aftermarket option for the popular Bell 206 series helicopter.

manufacturer blade—with a number of enhanced features. The airfoil possesses zero pitching moment within typical operating speeds, Van Horn explains, and while the NASA airfoil's design already limits the turbulence that causes noise and drag, the inclusion of the swept tip further reduces these undesirable qualities. FAA-mandated testing demonstrated a 40-percent reduction in the overall sound exposure level (the amount of noise produced) for helicopters employing the VHA 206 tail rotor—a welcome improvement for pilots, passengers, and people on the ground. In addition, the airfoil's high stall margins enhance helicopter performance at high altitude; VHA flew helicopters with the new tail rotor at the Leadville Airport in Colorado, the highest elevation airport in North America, and determined the NASA-derived blade delivered superior high-altitude performance compared to the existing model. These improvements stand to benefit helicopter performance for a wide range of missions, including law enforcement and homeland security, military training, aerial patrol of wildfires and pipelines, mosquito control, and emergency medical services.

The tail rotor received FAA certification in 2009, and VHA delivered its first shipment of the NASA-derived blades to customers that same year. Now the company plans to use the NASA airfoils as its go-to design for all future projects aimed at advancing rotorcraft performance, Van Horn says. He adds that VHA has helped ensure a solid base for its future by taking advantage of NASA research.

"Given the market size and that we could capture a reasonable market share, this puts our company on very firm footing for the next 10 to 20 years and will provide a steady income to allow us to grow at a reasonable rate and develop new products," he says.

"I've been on both sides of the government-research-to-commercial-product equation, and it's a great system. It gives us an advantage that other companies don't have, because we were able to avail ourselves of this NASA technology." ❖