National Aeronautics and Space Administration

# NASA technologies enhance our lives

## Health and Medicine

As NASA carries humans into space and expands our knowledge of the universe, the Agency's efforts also reach into another territory—the inner space of the human body. From experiments on the International Space Station to aeronautics research, NASA programs are resulting in spinoffs that improve health, treat disease, and save lives.

# improved nutrition

## Providing Essential Nutrients

Algae may not seem appetizing, but researchers working with NASA tested certain strains of microalgae as a food supply for long-duration space travel. They identified a strain that produces docosahexaenoic acid, or DHA, previously only found in human breast milk. The researchers founded Martek Bioscience Corporation to commercialize the algae-derived DHA as a nutritional supplement. DHA plays a key role in infant development and adult health, aiding mental development, vision, and the prevention and management of cardiovascular disease.

MARTEK'S NASA-DERIVED NUTRIENTS CAN BE FOUND IN OVER 95 PERCENT OF THE INFANT FORMULAS SOLD IN THE UNITED STATES AND ARE IN FORMULAS AVAILABLE IN OVER 65 COUNTRIES.


## Encouraging a Balanced Diet

It is easy to see the connection between robotics and healthy eating habits, right? Maybe not, but one engineer did. While working on a NASA project to create a robot capable of assisting astronauts in space, Joe Graves realized the intelligent software used to control the robot could also provide a tool for managing the vast amount of nutritional data available to everyday consumers. Vitabot, Graves' online nutrition company, now uses these robotics algorithms to build complete menus of favorite foods that match its customers' nutritional needs.

VITABOT COUNTS HBO, WARNER BROS., AND LOCKHEED MARTIN AMONG ITS COMPANY CLIENTS AND ALSO PROVIDES NUTRITIONAL GUIDANCE FOR THE YMCA, MEMBERS OF MAJOR HEALTH CLUB CHAINS, AND THE U.S. AIR FORCE.

## Treating Dehydration

Athletes and astronauts share a common health concern: dehydration. The conditions of microgravity cause significant fluid loss in astronauts, posing health risks when they return to Earth. An Ames Research Center scientist developed an electrolyte concentrate to help keep astronauts hydrated. Licensed by Wellness Brands Inc., the formula is now helping elite athletes avoid dehydration and perform at higher levels and may soon also provide hydration for victims of cholera, heat stroke, and altitude sickness.

ACCORDING TO WELLNESS BRANDS INC., THE NASA-DEVELOPED ELECTROLYTE FORMULA NOT ONLY EFFECTIVELY REHYDRATES USERS, BUT ALSO LEADS TO A 20-PERCENT INCREASE IN ENDURANCE.

# hospitals and facilities

## Enhancing Hospital Efficiency

Over 6,000 scientific articles have been published based on data from the Hubble Space Telescope. With plenty of researchers in line to use Hubble's multiple instruments—which cannot all operate simultaneously—NASA had to develop innovative scheduling software for efficiently managing the telescope's operations. Allocade Inc. uses the technology for another area where hectic schedules are the norm: health care. The company's NASA-derived On-Cue software helps hospital departments such as radiology handle dynamic rescheduling and optimize patient care efficiency. As a result, both patient satisfaction and hospital profit increase.

THANKS TO THE ON-CUE SOFTWARE, A UNIVERSITY HOSPITAL WITH 425 BEDS REDUCED THE WAIT TIME FOR INTERVENTIONAL RADIOLOGY PROCEDURES BY OVER 8 HOURS, AND A 600-BED HOSPITAL REDUCED THEIR AFTERHOURS MRI EXAMS BY 50 PERCENT.

## Improving Hygiene at Low Cost

The benefits of space exploration are all around you—even in your dentist's office. Through Small Business Innovation Research (SBIR) contracts with Johnson Space Center, Umpqua Research Company developed an iodine resin technology for disinfecting drinking water on space missions. MRLB International Inc. incorporated the innovation into its DentaPure waterline purification cartridges. The cost-effective, easy-to-install technology cleans and decontaminates water used for dental instruments, helping ensure hygienic conditions for patients in the dentist's chair.

FORTY PERCENT OF U.S. DENTAL SCHOOLS EMPLOY DENTAPURE SYSTEMS. THE UNIVERSITY OF MARYLAND DENTAL SCHOOL ESTIMATES THE TECHNOLOGY SAVES THE SCHOOL $274,000 PER YEAR THANKS TO BETTER FILTRATION, HIGHER CAPACITY, AND LONGER SERVICE INTERVALS.

## Reducing Error, Improving Patient Safety

During the now famous emergency landing of US Airways Flight 1549 on the Hudson River in 2009, the airplane's crew relied on specific training for safe, effective operations—including NASA Crew Resource Management (CRM) methods designed to enhance safety for both space missions and aviation on Earth. Two astronauts and their business partners formed LifeWings Partners LLC to apply CRM to medicine, another area with little margin for error. LifeWings provides CRM training for medical teams, helping enhance teamwork, improve efficiency, and—most importantly—reduce patient mortality.

LIFEWINGS DATA COLLECTED AFTER CRM TRAINING SHOWS A NEAR 50-PERCENT DROP IN RISK-ADJUSTED PATIENT MORTALITY, A 51-PERCENT INCREASE IN OPERATING ROOM TURNAROUND, AND A 40-PERCENT DECREASE IN POST-OPERATIVE INFECTIONS.

## Eliminating Airborne Pathogens

A NASA ethylene scrubber technology developed to preserve crops in space is cleaning the air of hospitals and doctors' offices. The device—also ideal for preserving fresh produce on Earth—eliminates virtually all airborne contagions. KES Science and Technology Inc. licensed the technology and partnered with Akida Holdings to market the innovation as AiroCide. With units in clinics, waiting areas, operating rooms, and neonatal wards, AiroCide maintains healthy air in medical settings at a low cost, averaging less than $1 per day to operate in the United States.

AIROCIDE IS ALSO USEFUL IN OFFICES, WHERE ILLNESSES CAUSED BY AIRBORNE ORGANISMS CAN LOWER PRODUCTIVITY, AND IN HOMES, WHERE THE UNITS HELP ELIMINATE MOLD AND ALLERGENS.

# life-saving technology

## Giving a Boost to CPR

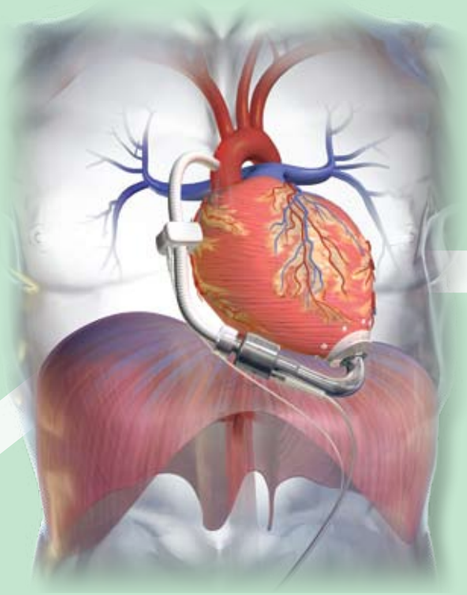
According to the American Heart Association, about 900 Americans suffer sudden cardiac arrest each day; about 95 percent die before reaching the hospital. NASA research into blood pressure—a health issue for astronauts returning to Earth's gravity—supported the development of a device that provides a 50-percent boost in blood flow to the brain during CPR. Manufactured by Advanced Circulatory Systems Inc., the ResQPOD increases the chances of survival following cardiac arrest and reduces the likelihood of neurological disorders resulting from a lack of oxygen to the brain.

IN SOME CITIES, RESQPOD HAS REPORTEDLY INCREASED THE NUMBER OF CARDIAC ARREST PATIENTS DELIVERED ALIVE TO THE HOSPITAL BY AS MUCH AS 50 PERCENT.

## Keeping Hearts Pumping

Johnson Space Center engineer David Saucier received a heart transplant following a severe heart attack. Working with the doctors who saved his life, including the late renowned heart surgeon Michael DeBakey, Saucier and Johnson engineers developed an implantable heart pump, or ventricular assist device (VAD), optimized using the computational fluid dynamics modeling employed when designing rocket engines. NASA licensed the heart pump to MicroMed Technology Inc., and the tiny MicroMed DeBakey VAD (now called the HeartAssist 5) has since been implanted in more than 440 patients around the world.

THE NASA-DERIVED HEART PUMP'S SMALL SIZE MAKES IT IDEAL FOR YOUNG PATIENTS. THE HEARTASSIST 5 PEDIATRIC VAD IS THE ONLY APPROVED IMPLANTABLE PEDIATRIC VAD IN THE UNITED STATES AND THE EUROPEAN UNION.



## Improving Implantable Devices

When performing tests and experiments, researchers come to expect the unexpected. For Langley engineer Robert Bryant, testing advanced composites for high-speed aircraft led to the discovery of a compound called Langley Research Center's Soluble Imide (LaRC-SI). Licensed by Medtronic Inc., LaRC-SI is used as insulation on the thin metal wires that connect to an implantable therapy device for patients experiencing heart failure. The devices use tiny electrical impulses to resynchronize the contractions of the heart's ventricles, helping the heart pump blood throughout the body more efficiently.

MEDTRONIC'S THIN WIRE LEADS WITH THE NASA-DEVELOPED COATING HAVE BEEN PLACED IN PATIENT HEARTS WITH A 96-PERCENT SUCCESS RATE.

*"This partnership validates the belief we had that LaRC-SI needed to be introduced in the private sector. Lives can be saved and enhanced because we were able to … provide public access to the material."—Robert Bryant, Langley engineer and developer of the LaRC-SI compound*

*Photo courtesy of Medtronic*

# imaging and diagnostics

## Detecting Cardiovascular Disease

Age is often cited as "just a number," but now it is being used as an indicator of heart health. After Medical Technologies International Inc. licensed NASA software originally developed for analyzing spacecraft imagery, the company incorporated the technology into a carotid intima-media thickness (CIMT) test called ArterioVision. By using an ultrasound procedure with advanced image-analysis software, it noninvasively measures the thickness of the carotid artery wall to provide an approximate "age" of a patient's arteries. Results provide valuable information about a person's risk for heart attack and stroke.

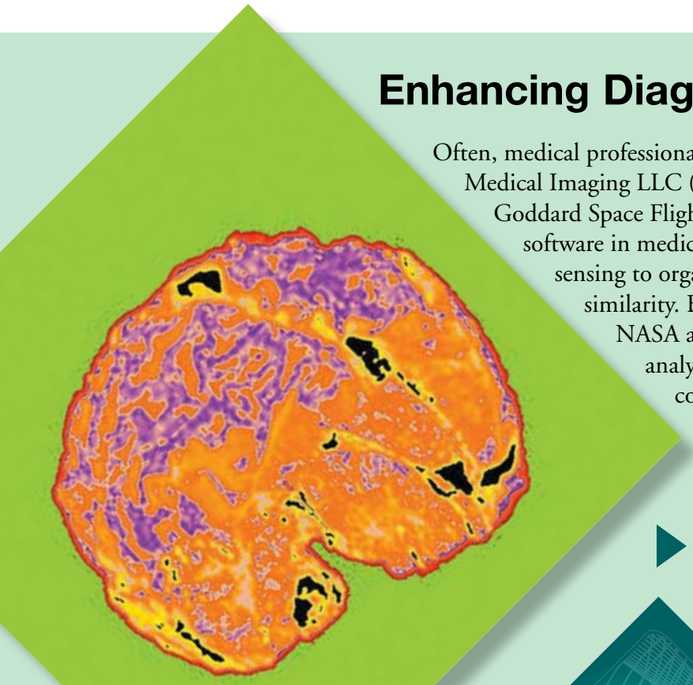
FOR STEVEN COHEN, VICE PRESIDENT AT A LARGE MEDICAL CARE PROVIDER, RESULTS FROM THE NASA-BASED ARTERIOVISION TEST HELPED TO SAVE HIS LIFE. THE TEST SHOWED ARTERY THICKENING, AND COHEN UNDERWENT TRIPLE BYPASS HEART SURGERY. IF LEFT UNTREATED, COHEN SAYS, HIS CONDITION WOULD HAVE "UNDOUBTEDLY LED TO A FATAL HEART ATTACK."

## Extending Medicine's Reach

A medical emergency room does not exist on the International Space Station (ISS). This fact led to an experiment that developed medical ultrasound techniques for long-distance use. Mediphan, a Canadian company with U.S. operations, drew on NASA expertise to create technology that sends diagnostic-quality ultrasound images and video to medical professionals via the Internet in near-real time. The technology has been used more than 425 times to diagnose musculoskeletal injury in Olympians and professional athletes, and more than 500 athlete evaluations have been conducted at U.S. Olympic training facilities.

THE NASA-DERIVED INNOVATIONS ARE PROVIDING MEDICAL EXPERTISE TO AREAS LIKE THE ARCTIC CIRCLE, WHERE REMOTE EVALUATIONS HAVE HELPED MONITOR PREGNANCIES AND DIAGNOSE INJURIES AMONG THE INUIT POPULATION.

## Enhancing Diagnostic Images



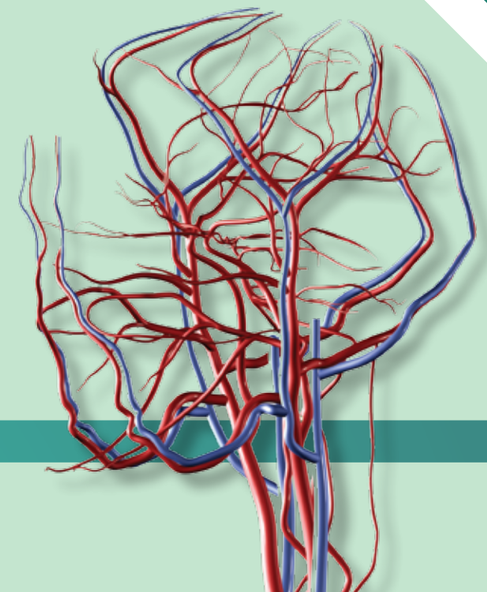
Often, medical professionals need to "get a closer look." To this end, Bartron Medical Imaging LLC (BMI) obtained a nonexclusive license from Goddard Space Flight Center to use Hierarchical Segmentation (HSEG) software in medical imaging. Originally, HSEG was used in remote sensing to organize an image's pixels based on their spectral similarity. BMI licensed additional software programs from NASA and now offers hardware and software to process and analyze and mine data from medical imagery, including computed tomography scans, digitized X-rays and mammographies, and dental X-rays.

USING THE NASA-DERIVED TECHNOLOGY, HEALTH CARE PRACTITIONERS CAN TAKE ANY UNMANIPULATED MEDICAL IMAGE AND SEGMENT IT TO SEE FEATURES THAT WERE NOT PREVIOUSLY VISIBLE TO THE NAKED EYE.

## Monitoring Cranial Pressure

A set of algorithms called the Hilbert-Huang Transform (HHT) for analyzing signals for structural health monitoring and damage detection for the space shuttle orbiters is now being put to use for human health. After Goddard Space Flight Center's Dr. Norden Huang invented HHT, an auction managed by Ocean Tomo Federal Services LLC sold a portfolio of licenses related to HHT. DynaDx Corporation 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.

*"NASA and DynaDx stand to benefit from our unique partnership, but the long-term benefits will be much broader." —Darryl Mitchell, technology transfer manager at Goddard*



# physical rehabilitation

*"I enjoy being able to do the things that I could not easily do before, like mowing the yard, or walking for long periods of time on concrete, because my knee is now more at ease. I like being able to walk each day without having to worry about falling." —Paul J. Ellis, on the SCOKJ knee brace featuring NASA technology*

## Regaining Mobility

The simple act of sharing information can have remarkable effects. Gary Horton of Horton's Orthotic Lab Inc. was visiting Marshall Space Flight Center when he learned about a lockable joint with a hinge brake. Horton applied the concept to a new type of orthotic, a knee brace that automatically unlocks during the swinging phase of walking, but then reengages for stability upon heel strike. Today, Horton provides the Stance Control Orthotic Knee Joint (SCOKJ) for patients with weak or absent quadriceps and varying degrees of knee instability.

## Helping Patients Walk

Robots are made to assist humans, and their parts can lend a helping hand as well. Enduro Medical Technology used Goddard Space Flight Center's cable-compliant joint (CCJ) technology (from robotics research) and compliant walker to develop the Secure Ambulation Module (SAM), a revolutionary rehabilitative walker that helps patients stand and walk without aid from a physical therapist. Patients at Walter Reed Army Medical Center use SAM to gain strength to stand and walk on their own. SAM is also helping overweight patients support their body weight for exercise programs.

*"Bariatric patients in long-term acute facilities like ours are bedridden and have not used their legs for quite some time...SAM helps us to help them strengthen their whole lower body. The technology has a lot of promise." —Mark Castleberry, director of rehabilitation services at Kindred Hospital in Greensboro, North Carolina*

## Adding Comfort to Recovery

Physical exercise is always important—even in space. Ames Research Center engineer Robert Whalen invented a treadmill that used air pressure to add weight to an astronaut's body during exercise in the low gravity of space. Whalen licensed his patent to Alter-G Inc., which created a treadmill that uses air pressure for the opposite effect—to help patients feel up to 80-percent lighter, easing discomfort during rehabilitation. The G-Trainer is in use in 22 countries, and military veterans, professional athletes, and other patients have benefited from the NASA-derived technology.


IN 2010, ALTER-G WON A GOLD AWARD IN THE MEDICAL DESIGN EXCELLENCE AWARDS COMPETITION, THE PREMIER AWARDS PROGRAM FOR THE MEDICAL TECHNOLOGY COMMUNITY. IN THE SAME YEAR, ALTER-G MORE THAN DOUBLED ITS NUMBER OF EMPLOYEES, FROM 25 TO 65.

IN ADDITION TO PROVIDING LOW PLASTICITY BURNISHING IN ITS OWN FACILITY, LAMBDA HAS EIGHT SYSTEMS OPERATING IN CUSTOMER FACILITIES AND IS CURRENTLY DEVELOPING OTHERS.

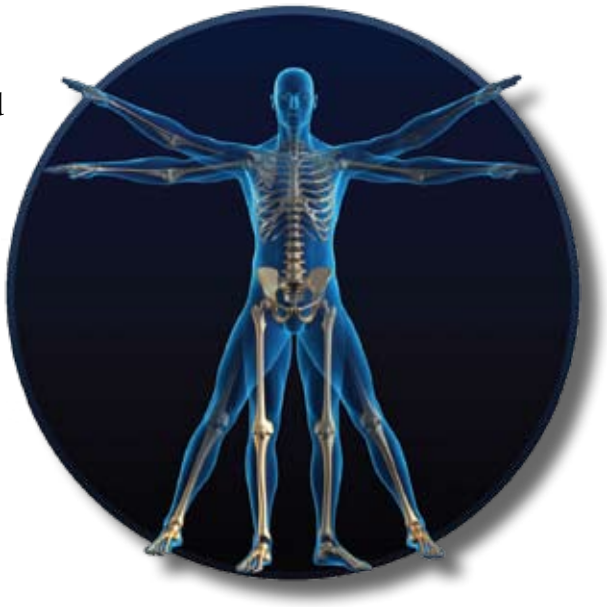
## Strengthening Hip Implants

It might seem counterintuitive, but stress can actually make materials sturdier. In the late 1990s, Lambda Research Inc. 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 the components. After Lambda patented the process, data confirmed that LPB completely eliminated the occurrence of fretting fatigue failures in modular hip implants and increased the lifespan by 100 times.

# 230+

THE NUMBER OF HEALTH AND MEDICINE SPINOFFS DOCUMENTED SINCE 1976.

Since its founding, NASA has nurtured partnerships with the private sector to facilitate the transfer of NASA-developed technologies. The benefits of these partnerships have reached throughout the economy and around the globe, as the resulting commercial products contributed to the development of services and technologies in the fields of health and medicine, transportation, public safety, consumer goods, environmental resources, computer technology, and industry. Since 1976, more than 1,700 of the most compelling partnerships and innovations have been documented in NASA's *Spinoff* publication. Building on this dynamic history, NASA partnerships with the private sector continue to seek avenues by which aerospace technologies can be brought down to benefit our lives on Earth. You can learn more by visiting us online at **www.sti.nasa.gov/tto**, or:



National Aeronautics and Space Administration

**Office of the Chief Technologist**
**NASA Headquarters**
**Washington, DC 20546**

**www.nasa.gov**

NP-2011-01-701-HQ