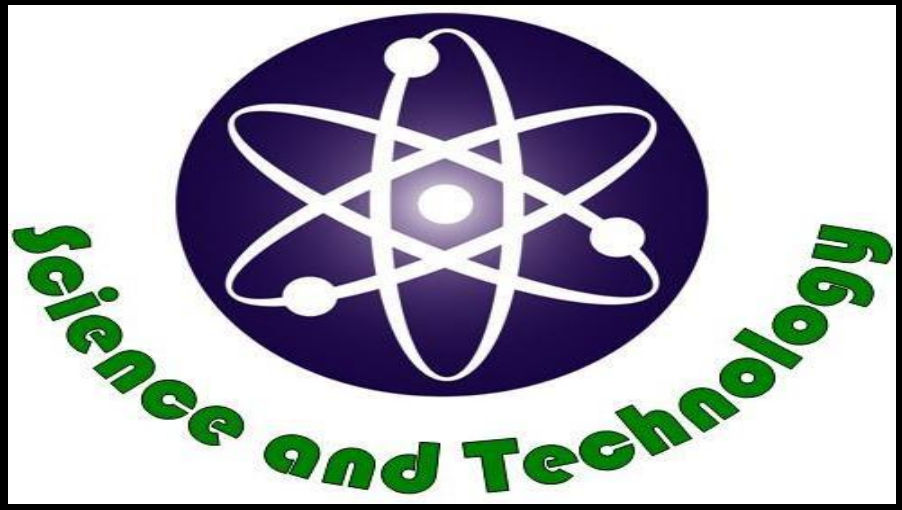
Two forces shaped the development of American science and technology: internal logic and external circumstance.

-The first, in the United States as elsewhere, led from individual, small-scale, amateur efforts to organized, large-scale, professional undertakings.

-The second, arising from the physical and social environment, gave a distinctive national character to those pursuits.



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NASA spin-off technologies are spin-offs of technology that have been commercialized through NASA funding, research, licensing, facilities, or assistance. NASA also publishes an annual journal titled Spinoff which features products whose development can be linked to NASA, for example through NASA funding (such as SBIR or STTR awards), licensing (from NASA patents), facilities (such as product testing at NASA facilities), NASA assistance (such as former NASA scientists helping to design a product), or NASA research. A lot of the technology that came from space spin-off is an important part of today's world, for example the ultra sound is an important part of many births.

27 abstracts of products claimed to be NASA spin-offs

Health and medicine

Light-emitting diodes (LEDs) in medical therapies

After initial experiments using light-emitting diodes in NASA space shuttle plant growth experiments, NASA issued a small business innovation grant that led to the development of a hand-held, high-intensity, LED unit developed by Quantum Devices Inc. that can be used to treat tumors after other treatment options are exhausted. This therapy was approved by the FDA and inducted into the Space Foundation's Space Technology Hall of Fame in 2000.

Infrared ear thermometers

Diatek Corporation and NASA developed an aural thermometer that measures the Thermal Radiation emitted by the eardrum, similar to the way the temperature of stars and planets is measured. This method avoids contact with mucous membranes, and permits rapid temperature measurement of newborn or incapacitated patients. NASA supported the Diatek Corporation through the Technology Affiliates Program.

Ventricular assist device

Collaboration between NASA, Dr. Michael DeBakey, Dr. George Noon, and MicroMed Technology Inc. resulted in a heart pump for patients awaiting heart transplants. The MicroMed DeBakey ventricular assist device (VAD) functions as a “bridge to heart transplant” by pumping blood until a donor heart is available. The pump is approximately one-tenth the size of other currently marketed pulsatile VADs. Because of the pump’s small size, fewer patients developed device-related infections. It can operate up to 8 hours on batteries, giving patients the mobility to do normal, everyday activities.

Artificial limbs

Advancements such as Environmental Robots Inc.'s development of artificial muscle systems for use in NASA space robotic and extravehicular activities have been adapted to create more functionally dynamic artificial limbs. Other commercial uses of NASA's temper elephants include moldable materials offering the natural look and feel of flesh, as well as preventing friction between the skin and the prosthesis, and heat/moisture buildup.

Invisible braces

Invisible braces are a type of transparent ceramics called translucent polycrystalline alumina (TPA). A company known as Ceradyne developed TPA in conjunction with NASA Advanced Ceramics Research as protection for infrared antennae on heat-seeking missile trackers.

Scratch-resistant lenses

A sunglasses manufacturer called Foster Grant first licensed a NASA technology for scratch-resistant lenses, developed for protecting space equipment from scratching in space, especially, helmet visors.

Space blanket

So-called space blankets, developed in 1964, are lightweight and reflect infrared radiation. They are often included in first aid kits.

Public safety

Video enhancing and analysis systems

Intergraph Government Solutions developed its Video Analyst System (VAS) by building on Video Image Stabilization and Registration (VISAR) technology created by NASA to help FBI agents analyze video footage. Originally used for enhancing video images from nighttime videotapes made with hand-held camcorders, VAS is a tool for video enhancement and analysis offering support of full-resolution digital video, stabilization, frame-by-frame analysis, conversion of analog video to digital storage formats, and increased visibility of filmed subjects without altering underlying footage. Aside from law enforcement and security applications, VAS has also been adapted to serve the military for reconnaissance, weapons deployment, damage assessment, training, and mission debriefing.

Fire-resistant reinforcement

Built and designed by Avco Corporation, the Apollo heat shield was coated with a material whose purpose was to burn and thus dissipate energy during reentry while charring, to form a protective coating to block heat penetration. NASA subsequently funded Avco's development of other applications of the heat shield, such as fire-retardant paints and foams for aircraft, which led to intumescent epoxy material, which expands in volume when exposed to heat or flames, acting as an insulating barrier and dissipating heat through burn-off. Further innovations include steel coatings devised to make high-rise buildings and public structures safer by swelling to provide a tough and stable insulating layer over the steel for up to 4 hours of fire protection, ultimately to slow building collapse and provide more time for escape.

Firefighting equipment

Firefighting equipment in the United States is based on lightweight materials developed for the U.S. Space Program. NASA and the National Bureau of Standards created a lightweight breathing system including face mask, frame, harness, and air bottle, using an aluminum composite material developed by NASA for use on rocket casings. The broadest fire-related technology transfer is the breathing apparatus for protection from smoke inhalation injury.

Consumer, home, and recreation

Temper foam

As the result of a program designed to develop a padding concept to improve crash protection for airplane passengers, Ames Research Center developed what is now called memory foam. Memory foam, or "Temper Foam", has been incorporated into mattresses, pillows, military and civilian aircraft, automobiles and motorcycles, sports safety equipment, amusement park rides and arenas, horseback saddles, archery targets, furniture, and human and animal prostheses. Its high-energy absorption and soft characteristics offer protection and comfort.

Enriched baby food

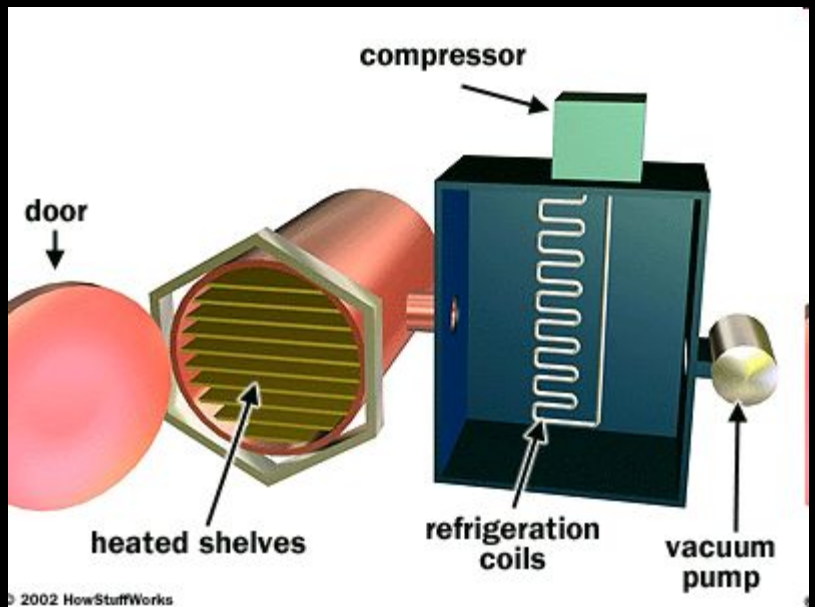
Commercially available infant formulas now contain a nutritional enrichment ingredient that traces its existence to NASA-sponsored research on bread mold as a recycling agent for long-duration space travel. The substance, formulated into the products life'sDHA and life'sARA and based on microalgae, can be found in over 90% of the infant formulas sold in the United States, and are added to infant formulas in over 65 other countries. Martek Biosciences Corporation's founders and principal scientists acquired their expertise in this area while working on the NASA program. The microalgae food supplement was inducted into the Space Foundation Space Technology Hall of Fame in 2009.

Portable cordless vacuums

For the Apollo space mission, NASA required a portable, self-contained drill capable of extracting core samples from below the lunar surface. Black & Decker was tasked with the job, and developed a computer program to optimize the design of the drill's motor and ensure minimal power consumption. That computer program led to the development of a cordless miniature vacuum cleaner called the Dustbuster.

Freeze drying

In planning for the long-duration Apollo missions, NASA conducted extensive research into space food. One of the techniques developed in 1938 by Nestle was freeze drying. In the United States, Action Products later commercialized this technique for other foods, concentrating on snack food resulting in products like Space ice cream. The foods are cooked, quickly frozen, and then slowly heated in a vacuum chamber to remove the ice crystals formed by the freezing process. The final product retains 98% of its nutrition and weighs much less than before drying. The ratio of weight before and after drying depends strongly on the particular food item but a typical freeze-dried weight is 20% of the original weight.



Environmental and agricultural resources

Water purification

NASA engineers are collaborating with qualified companies to develop systems intended to sustain the astronauts living on the International Space Station and future Moon and space missions. This system turns wastewater from respiration, sweat, and urine into drinkable water. Commercially, this system is benefiting people all over the world who need affordable, clean water, especially in remote locations. By combining the benefits of chemical adsorption, ion exchange, and ultra-filtration processes, this technology can yield safe, drinkable water from the most challenging sources, such as in underdeveloped regions where well water may be heavily contaminated.

Solar energy

Homes across the country are now being outfitted with high-performance single crystal silicon solar power cells that allow them to reduce their traditional energy expenditures and reduce pollution. The advanced technology behind these solar devices—which provide up to 50% more power than conventional solar cells—originated with the efforts of a NASA-sponsored 28-member coalition forming the Environmental Research Aircraft and Sensor Technology (ERAST) Alliance. ERAST's goal was to develop remotely piloted aircraft, intended to fly unmanned at high altitudes for days at a time and requiring advanced solar power sources that did not add weight. As a result, SunPower Corporation created advanced silicon-based cells for terrestrial or airborne applications.

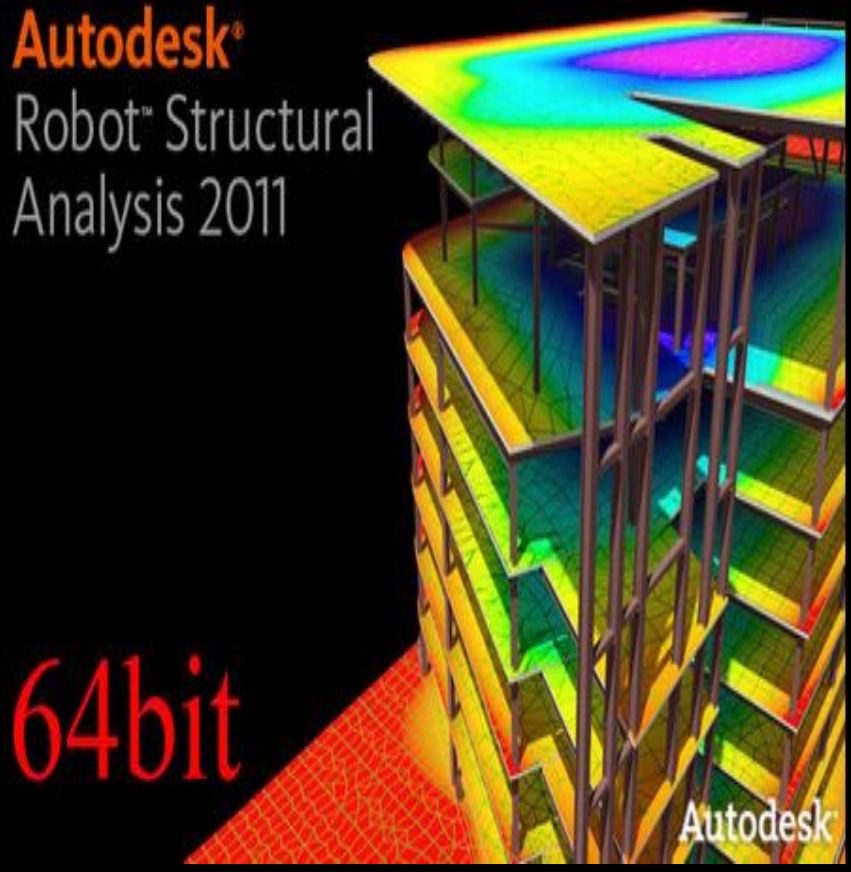
Pollution remediation

NASA's microencapsulating technology enabled the creation of a "Petroleum Remediation Product," which safely cleans petroleum-based pollutants from water. The PRP uses thousands of microcapsules—tiny balls of beeswax with hollow centers. Water cannot penetrate the microcapsule's cell, but oil is absorbed into the beeswax spheres as they float on the water's surface. Contaminating chemical compounds that originally come from crude oil (such as fuels, motor oils, or petroleum hydrocarbons) are caught before they settle, limiting damage to ocean beds.

Computer technology

Structural analysis software

NASA software engineers have created thousands of computer programs over the decades equipped to design, test, and analyze stress, vibration, and acoustical properties of a broad assortment of aerospace parts and structures. The NASA Structural Analysis Program, or NASTRAN, is considered one of the most successful and widely-used NASA software programs.

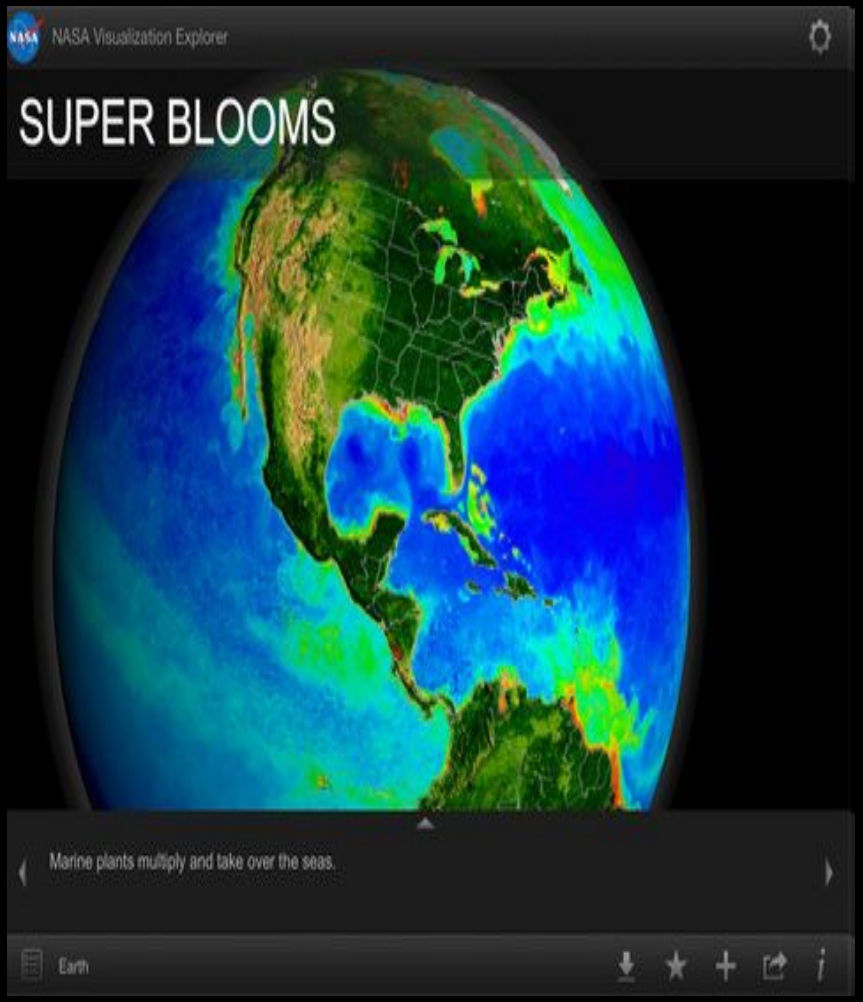


Remotely controlled ovens

Embedded Web Technology (EWT) software—originally developed by NASA for use by astronauts operating experiments on the International Space Station—lets a user monitor and/or control a device remotely over the Internet. NASA supplied this technology and guidance to TMIO LLC, which developed remote control and monitoring of a new intelligent oven product named “ConnectIo.” With combined cooling and heating capabilities, ConnectIo refrigerates food until a customized pre-programmable cooking cycle begins. The menu allows the user to simply enter the dinner time, and the oven automatically switches from refrigeration to the cooking cycle, so that the meal will be ready as the family arrives home for dinner.

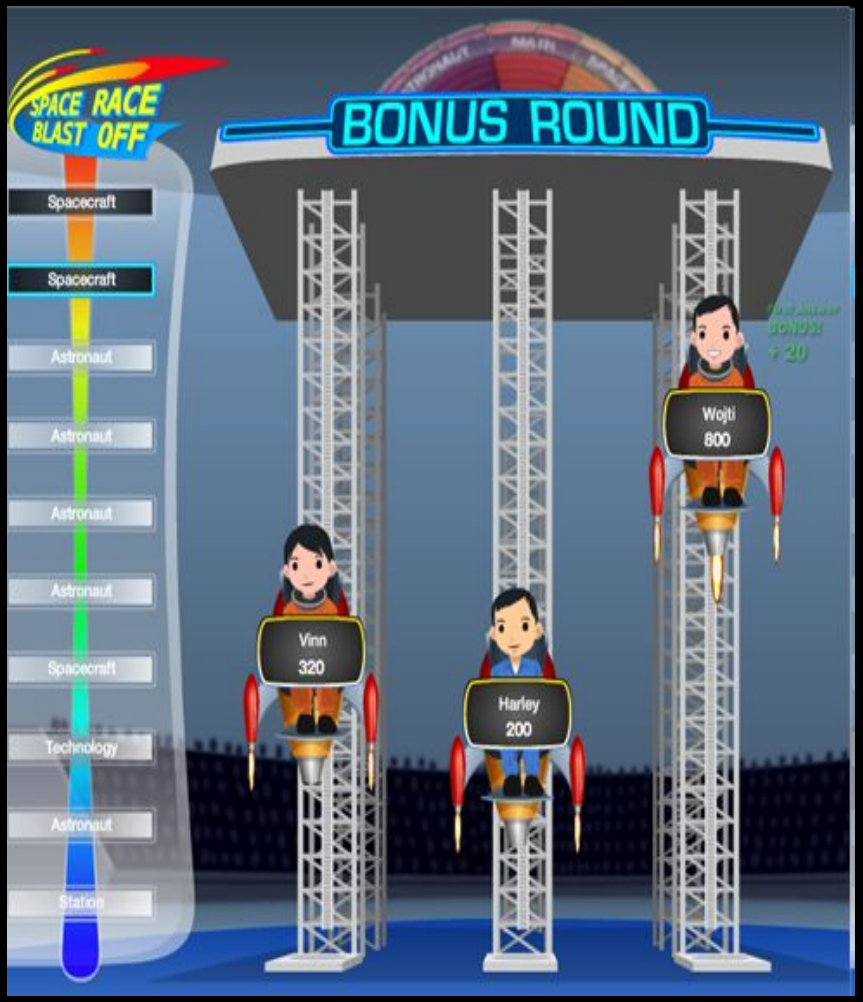
NASA Visualization Explorer

On July 26, 2011, NASA released the NASA Visualization Explorer app for the iPad. The application delivers real-time satellite data, including movies and stills, of Earth, that enable users to learn about subjects such as climate change, Earth's dynamic systems and plant life on land and in the oceans. The content is accompanied by short descriptions about the Data and why it is important.



Space Race Blastoff

NASA's first online game designed for social networks like Facebook. It is a trivia game that tests of their knowledge of NASA history, technology, science and pop culture.



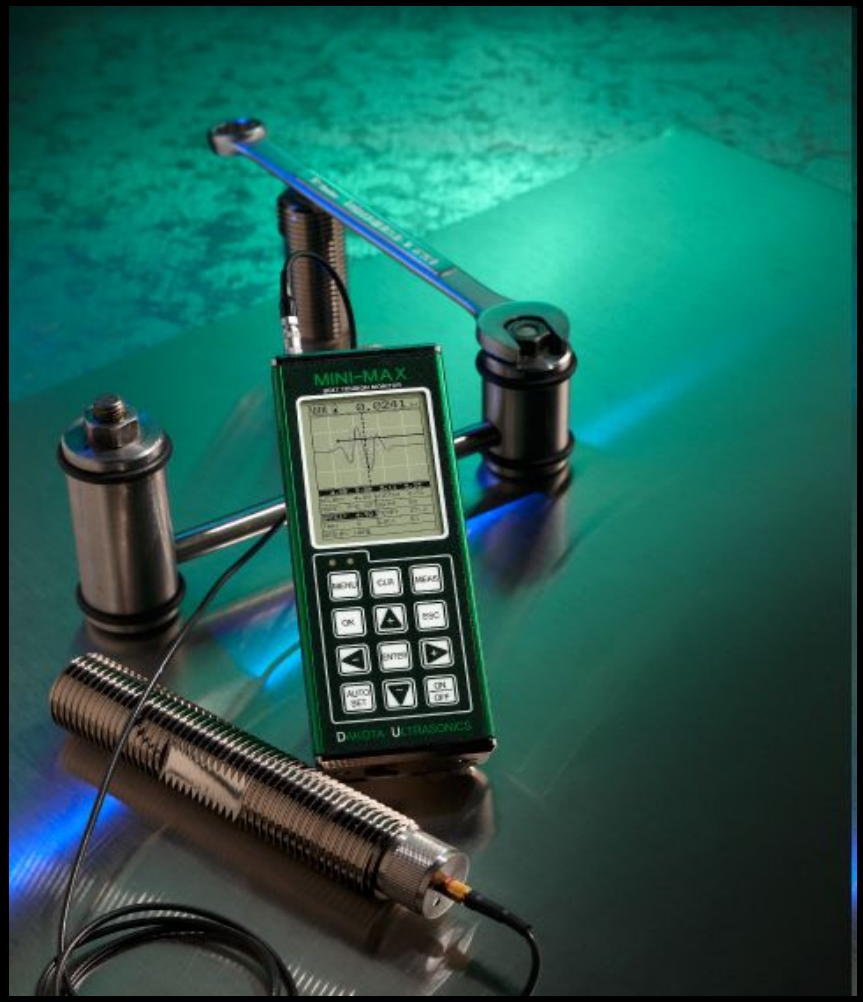
Industrial productivity

Powdered lubricants

NASA developed a solid lubricant coating, PS300, which is deposited by thermal spraying to protect foil air bearings. PS300 lowers friction, reduces emissions, and has been used by NASA in advanced aeropropulsion engines, refrigeration compressors, turbochargers, and hybrid electrical turbogenerators. ADMA Products has found widespread industrial applications for the material.

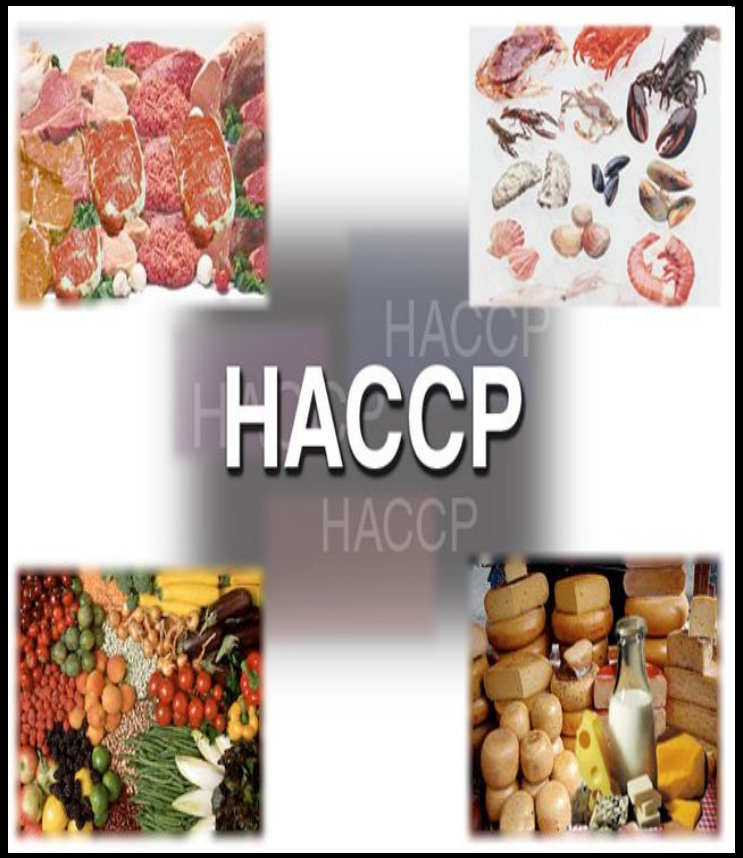
Improved mine safety

An ultrasonic bolt elongation monitor developed by a NASA scientist for testing tension and high-pressure loads on bolts and fasteners has continued to evolve over the past three decades. Today, the same scientist and Luna Innovations are using a digital adaptation of this same device for destructive evaluation of railroad ties, groundwater analysis, radiation, and as a medical testing device to assess levels of internal swelling and pressure for patients suffering from intracranial pressure and compartment syndrome, a painful condition that results when pressure within muscles builds to dangerous levels.



Food safety

Faced with the problem of how and what to feed an astronaut in a sealed capsule under weightless conditions while planning for human space flight, NASA enlisted the aid of The Pillsbury Company to address two principal concerns: eliminating crumbs of food that might contaminate the spacecraft's atmosphere and sensitive instruments, and assuring absolute absence of disease-producing bacteria and toxins. Pillsbury developed the Hazard Analysis and Critical Control Point (HACCP) concept to address NASA's second concern. HACCP is designed to prevent food safety problems rather than to catch them after they have occurred. The U.S. Food and Drug Administration has applied HACCP guidelines for the handling of seafood, juice, and dairy products.



Transportation

Aircraft anti-icing systems

NASA funding under the Small Business Innovation Research (SBIR) program and work with NASA scientists advanced the development of a thermoelectric deicing system called Thermawing, a DC-powered air conditioner for single-engine aircraft called Thermacool, and high-output alternators to run them both. Thermawing allows pilots to safely fly through ice encounters and provides pilots of single-engine aircraft the heated wing technology usually reserved for larger, jet-powered craft. Thermacool, an electric air conditioning system, uses a new compressor whose rotary pump design runs off an energy-efficient, brushless DC motor and allows pilots to use the air conditioner before the engine starts.

Improved radial tires

Goodyear Tire and Rubber Company developed a fibrous material, five times stronger than steel, for NASA to use in parachute shrouds to soft-land the Viking Lander spacecraft on the Martian surface. Recognizing the durability of the material, Goodyear expanded the technology and went on to produce a new radial tire with a tread life expected to be 10,000 miles (16,000 km) greater than conventional radials.

Chemical detection

NASA contracted with Intelligent Optical Systems (IOS) to develop moisture- and pH-sensitive sensors to warn of corrosive conditions in aircraft before damage occurs. This sensor changes color in response to contact with its target. After completing the work with NASA, IOS was tasked by the U.S. Department of Defense to further develop the sensors for detecting chemical warfare agents and potential threats, such as toxic industrial compounds and nerve agents. IOS has sold the chemically sensitive fiber optic cables to major automotive and aerospace companies, who are finding a variety of uses for the devices such as aiding experimentation with nontraditional power sources, and as an economical “alarm system” for detecting chemical release in large facilities.

Highway safety

Safety grooving, the cutting of grooves in concrete to increase traction and prevent injury, was first developed to reduce aircraft accidents on wet runways. Represented by the International Grooving and Grinding Association, the industry expanded into highway and pedestrian applications. Safety grooving originated at Langley Research Center, which assisted in testing the grooving at airports and on highways. Skidding was reduced, stopping distance decreased, and a vehicle's cornering ability on curves was increased. The process has been extended to animal holding pens, parking lots, and other potentially slippery surfaces.