



# Benefits from Apollo: *Giant Leaps in Technology*



The moon, a luminous object in the night sky that once inspired limitless speculation, afforded the inspiration for scientific discoveries in space and on Earth – thanks to the Apollo Program.

The world was captivated on July 20, 1969, when hundreds of millions watched through the lens of a compact camera built specifically for space as man planted his first step onto the lunar surface. Astronauts recorded details of the momentous occasion with special pens that allowed ink to flow freely in low gravity. Other technologies like breathing apparatuses, fabric structures, communications and protective coatings that made man's step on the moon possible, soon led to giant leaps in technology on Earth.

NASA's Office of Technology Transfer and Commercialization licenses space-age technologies and connects with the private sector through business-to-business partnerships for the creation of products that improve lives here on Earth. Below are a few of the many viable commercial products America enjoys today with roots that reach as far as the moon.

## Playing with the Pros

Sports and recreation manufacturers looked to NASA upon landing on the moon in pursuit of improving their game.

### Walk, jog or run like an astronaut

"Moon Boot" material has revolutionized athletic footwear, improving shock absorption and providing superior stability and motion control. Al Gross,

a NASA Apollo Program engineer, used his space expertise to improve athletic shoes. He substituted DuPont's Hytrel plastic for foam materials in the shoe's mid-sole to eliminate cushioning loss



caused by body weight. An external pressurized shell and stress-free "blow molding" process adapted from NASA spacesuit technology was also used. The resulting compression chamber mid-sole allowed the popular shoemaker,

AVIA Inc., to reconfigure designs for specific sports and provide a "first step" toward a durable, foamless, non-fatiguing mid-sole.

***Spinoff 1991***





### To the moon, through the roof

Houston's Reliant Stadium features the first retractable roof of its kind, made possible by NASA technology. NASA's spacesuit fabric has fostered many new innovations, including a permanent structure fabric developed for the Apollo Program and produced by New York-based Birdair, Inc. Pound for pound, the material is stronger than steel and weighs less than five ounces per square foot. Its translucency value, which ranges from four to 18 percent, reduces lighting needs and helps maintain the natural grass playing field. Its reflectivity lowers cooling costs, and the Teflon coating reduces maintenance costs by increasing the fabric's resistance to moisture, temperature extremes and deterioration. These factors combine to lower initial costs and speed construction.

There are two applications for Birdair's fabric; tension structures that are supported by a network of cables and pylons (used in the Reliant Stadium), or temporary air-supported structures that consist of an outer membrane and an inner liner. On average, the use of fabric covering, which can last up to 20 years, can help reduce building costs by as much as 30 percent. **Spinoff 1978 and 1990**

### Rearranging furniture in a stadium

Together, NASA and General Motors developed a way to move heavy loads more easily by lifting them onto a thin air cushion. Rolair Systems, Inc. was formed by former General Motors' engineers and has found commercial uses for the innovation. Hawaii's Aloha Stadium uses this technology to rearrange the stadium seating by moving an entire 7,000-seat section on a cushion of air. A single operator can reposition this huge section in just half an hour. **Spinoff 1978**

### Safeguarding You and the Environment

Technologies guarding astronauts on the moon now protect you and the environment on Earth.

### Astronaut flight suits fighting fires on Earth

Fire hazards are much greater in atmospheres containing a high percentage of oxygen under pressure. After the 1967 Apollo fire, NASA needed to find new ways to protect astronauts and their vessels. The Monsanto Company developed a chemically treated fabric called Durette that does not burn.

A National Bureau of Standards/ NASA project resulted in a lightweight breathing system including facemask, frame, harness and air bottle marketed by Scott Aviation. Aluminum composite material was used to reduce the weight of the overall apparatus, and the frame and harness were designed to be much easier to put on and take off. Today nearly every major manufacturer of breathing apparatus incorporates NASA technology in some form, helping to reduce the incidence of inhalation-related injuries.

**Spinoff 1982**



### Safety in security systems

Technology developed by NASA led to an intruder detector that helps prevent burglaries. Before prowlers can break in, vibration-sensing detectors pick up movements of anyone within range and relay warnings to portable radio receivers that alert guards or residents. Encased in a stainless-steel tube, the detectors are implanted in the ground outside the facility being protected – home, bank, industrial complex or other facility.

**Spinoff 1978**

### Solar Panels: more power, less pollution

Innovations developed with technology from NASA's Apollo lunar module program have created a renewable energy resource used on Earth and in space. Solar panels collect



electricity by absorbing light when it strikes the surface and transfers it to a semiconductor. These solar panels are used on calculators, streetlights, houses and the International Space Station. The solar array surface area currently on orbit is 12,925 square feet. The skyscraper-sized solar arrays harness energy from the Sun to power the space station. **Spinoff 1981**

### Chlorine-free pools

NASA's silver ion technology has been used to create an automatic pool purifier. Caribbean Clear Inc. system offers an alternative to chemicals, such as chlorine and bromine. Purifiers use silver ions, as used in Apollo Purification Systems, to kill bacteria, copper ions and algae. They produce spa or pool water that exceeds EPA Standards for drinking water.

**Spinoff 1994**

### Apollo innovation shakes up seismology

Through a contract with NASA, Wyle-3S built an enormously forceful shock and vibration system to simulate liftoff stresses



on the launch pad. In addition to earthquake testing, the company has adapted its shaking technology to evaluate railway cars, rail- or road-transported cargo, truck refrigeration units and highway pavements without destroying or harming its surroundings. **Spinoff 1979**

## Medical Marvels from the Moon

Apollo-based technologies launched major medical breakthroughs on Earth.



## Shocking heart monitors

NASA's Apollo technology was used by Medrad to develop the AID implantable automatic pulse generator, which monitors the heart continuously, recognizes the onset of a heart attack and delivers a corrective electrical shock. The pulse generator is, in effect, a miniaturized version of the defibrillator used by emergency squads and hospitals to restore rhythmic heartbeat after fibrillation. Once implanted, it needs no specially trained personnel or additional equipment and consists of a microcomputer, a power source and two electrodes that sense heart activity. **Spinoff 1980**

## Apollo sets the pace

St. Jude Medical's Cardiac Rhythm Management Division used Apollo technology to develop a programmable pacemaker system. A physician can communicate with a patient's pacemaker by means of wireless telemetry signals transmitted through the communicating head held over the patient's chest. Where earlier pacemakers delivered a fixed type of stimulus once implanted, this system enables "fine tuning" of the device to best suit the patient's changing needs. **Spinoff 1980**

## Easier treatments for dialysis patients

Using technology originally developed under NASA contract by Marquardt Corporation, a chemical process was developed to remove toxic waste from used dialysis fluid. This discovery led to the development of a kidney dialysis machine using "sorbent" dialysis, a method of removing urea from human blood by treating a dialysate solution. The process saves electricity and gives the patient greater freedom of movement during treatment. **Spinoff 1992**

## Cool ideas from Apollo

NASA's Cool Suit technology – originally designed to keep astronauts cool during launch using a water circulation system – is now used by hazardous materials workers, armored vehicle crews, firefighters and NASCAR drivers. Multiple sclerosis patients



and children born without sweat glands and a disorder that causes extreme Sun sensitivity wear built-in water circulation vests that provide them cool comfort. A surgical personal cooling system has also been developed for medical personnel working in hot operating room environments. And, horse saddle pads made with this technology can lower the horse's temperature by 4 to 6 degrees. Another innovation includes a liquid-cooled bra that aids in the detection of cancer using infrared thermography. By increasing the temperature difference between normal and cancerous tissue through cooling, differentiation becomes more apparent on a thermograph.

**Spinoff 1979, 1982 and 1989**

## Precise prescription doses

Under one of the earliest contracts awarded during the Apollo lunar landing program, Parker Hannifin Corporation developed and produced equipment for controlling the flow of propellants into the mammoth engines of the Saturn moonbooster. Today, Parker is supplying the huge valves that control propellant flow from the space shuttle's external fuel tank to the engines of the shuttle orbiter as well as the "peanut valve," named for its small size. In 1977, NASA and Parker created the Programmable Implantable Medication System for continuous, computer-directed delivery of precisely metered medication – insulin, for example – within a patient's body.

**Spinoff 1988**

## At Home with Apollo

Many everyday home and consumer products today trace their roots to technologies born during Apollo missions.

## No cords attached

Utilizing NASA's cordless innovations, Black & Decker created cordless, lightweight battery-powered precision instruments designed to give surgeons optimum freedom and versatility in the operating room. It also led to today's electric screwdrivers, drills and other portable and chargeable devices. Cordless power tools are also used to help build the International Space Station on orbit.

**Spinoff 1981**



## Clocks with rocks

To keep missions on time, General Time Corp. developed electrically stimulated quartz crystals. Quartz provides a stable time base, giving clocks an accuracy of one minute a year. By vibrating up to 4,194,304 times a second, these clocks keep millions of people on time around the globe.

**Spinoff 1976**

## Busting the dust

Apollo astronauts needed a portable self-contained drill capable of extracting core samples from 10 feet below the lunar surface. Black & Decker used a specially developed computer program to optimize the drill's motor and minimize power consumption. Refinement of the technology



eventually led to the cordless vacuum cleaner called the Dustbuster. It has no hose, no cord, is 14 inches long, and comes with a storage bracket that serves as a recharger.

**Spinoff 1981**

## Crossing Boundaries

Many technologies that began their journey to the moon have crossed boundaries here on Earth, reaching vast commercial markets for a kaleidoscope of uses.



## Digital enhancements

Estee Lauder uses digital image analyzers and software based on NASA lunar research to evaluate cosmetic products. Digital image processing brings out subtleties otherwise undetectable and allows better determination of product effectiveness. This process allows Estee Lauder to quantify changes in skin surface form and structure caused by application of cosmetic preparations. NASA's digital imaging technology has also been used for CAT scans, MRIs, radiography and microscopy in medicine as well as various industrial and manufacturing uses.

**Spinoff 1986, 1988 and 1990**

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## Metallic mania

Insulation barrier made of aluminum foil laid over a core of Mylar protected astronauts and their spacecraft's delicate instruments from radiation as they ventured to the moon nearly four decades ago. Today, the metallic material has found its way into numerous commercial products on Earth. Its reflective properties offer insulation and protection for cars, trucks, homes and even food. Woven into a metallic blanket, a shimmery shield now protects all walks of life, from outdoor adventurers exposed to extreme weather conditions to emergency medical patients who experience sudden body-temperature drops. The same barriers that block heat and cold have also been used to muffle engine and exhaust noise.



**Spinoff 1995**

## Fueling alternative energy

Liquid methane is becoming an energy alternative to expensive oil as a power source for automotive vehicles. Methane, which is the principal component of natural gas, costs less than half as much as gasoline, and its emissions are a lot cleaner than those from gasoline or diesel engines. During the Apollo program, Beech Aircraft Corporation's Boulder Division developed expertise in producing fuel storage tanks for liquid methane, a "cryogenic" fuel that must be supercooled to remain liquid. The company has since designed a system to convert cars and trucks to liquid methane operation. Liquid methane must be stored at a temperature of 260 degrees below zero Fahrenheit. An optional twin-fuel system allows operators to use either liquid methane or gasoline fuel. **Spinoff 1982**

## So you need a sow

In swine farming, 15 to 25 percent of piglets die before weaning, posing a serious economic problem for hog producers. Sometimes a sow will accidentally crush her piglets or she will reject or abuse a piglet. Frequently a litter is oversized and the sow cannot accommodate all her piglets for nursing or is just unable to lactate due to physical disorders. Farmatic Inc's Robotic Sow releases a prescribed amount of formula from a refrigerated compartment into a warming chamber, where milk is heated to the desired temperature. At feeding time a heat lamp simulating a sow's body warmth is automatically turned on, and the machine emits rhythmic grunts like a mother pig summoning her piglets. As piglets scamper to their mechanical mother, a panel across the front opens to expose the row of nipples. The automated sow incorporates NASA technology derived from miniature electronic heat pumps and heating/cooling systems originally designed for Apollo spacecraft. The mechanical mother comes in two models: 8 or 16 artificial nipples.

**Spinoff 1987**

For additional information about NASA's spinoffs, visit:  
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