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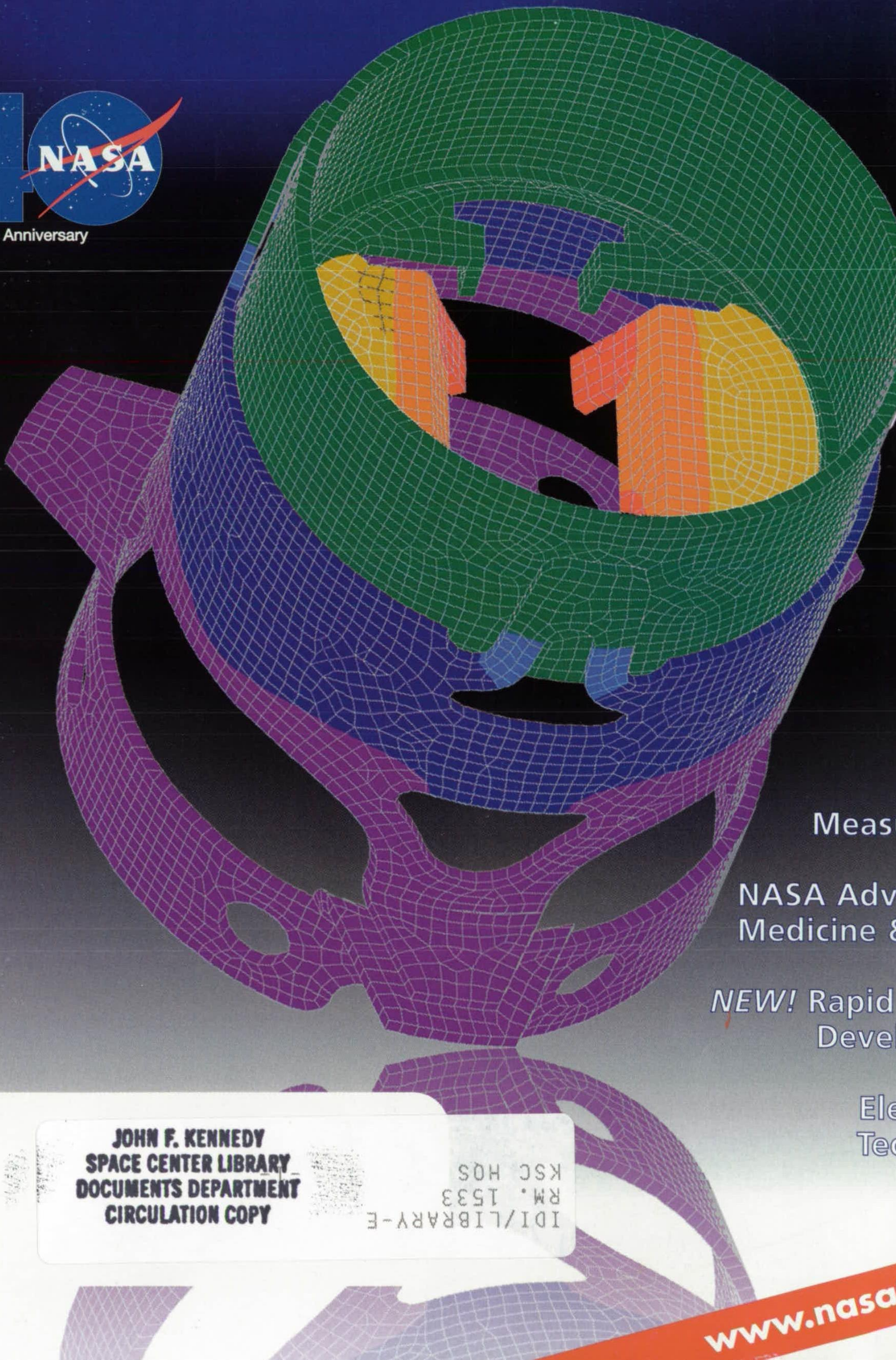
NASA TECH BRIEFS

ENGINEERING SOLUTIONS FOR DESIGN & MANUFACTURING

40 NASA Fortieth Anniversary



Test & Measurement

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This month, in our year-long celebration of NASA's 40th Anniversary, we take a look at successful spinoff products and new applications of NASA technologies in the Medical and Health areas.

1960s

A "Cool" Innovation

Multiple sclerosis (MS) is a chronic, progressively disabling disease of the central nervous system that strikes its victims in the prime of life. Wasting of the nerves is caused by loss of a body substance called myelin. This can affect thought processes, vision, dexterity, balance, and sensation. Myelin forms a coating around the nerves like insulation, allowing signals to be conducted through the nervous system. Its absence bars proper functioning of the nervous system. More than 30 years ago, it was discovered that by cooling the body, a dramatic improvement can be seen in MS symptoms. Conduction can be temporarily restored to demyelinated nerves by cooling the body's core temperature only one degree Fahrenheit. Therefore, doctors often use cold showers, pools, and air conditioning to lower body temperatures of MS patients. But such treatment can be uncomfortable, and patient immersion in a pool can sometimes be self-defeating. Body mechanisms such as shivering and constriction of blood vessels often work to prevent a drop in core temperature.


LSSI's Mark VII cooling/control unit (left photo) can be mounted on a patient's wheelchair; the unit feeds fluids to the cool suit through an umbilical tube. The photo at right shows an alternative type of vest cooled by a quick-change ice cartridge.

But many patients are now benefiting from a body cooling technique that does not require immersion, induce shivering, or cause blood vessel constriction. It involves using a "cool suit," previously known as the Mark VII MicroClimate® Medical Personal Cooling System. The MicroClimate technology, developed by Life Support Systems Inc. (LSSI) of Mountain View, CA, had its origin in a 1968 NASA development program at Ames Research Center that produced a spacesuit undergarment for cooling astronauts on the surface of the moon or during extravehicular walks outside the spacecraft. The system circulated a fluid, cooled by a heat exchanger and delivered by a battery-operated minipump, through a network of tubes in the garment. In 1980, LSSI was founded to pursue commercial uses for the technology.

Similarly, the updated suit consists of a head cap and torso vest. The system includes a fixed or portable control console, a cooling unit, and a pump, which circulates a water-based fluid, cooled to about 50°F, through veins or tubes in the vest and cap. It can lower a patient's core temperature 1°F in 30 to 40 minutes, with improvement in symptoms that continues for two to four hours after a cooling session. It is used to treat symptoms of MS and other illnesses where temperature regulation can be beneficial, such as spina bifida and cerebral palsy.

Unfortunately, the system is not a cure, nor does it help all MS patients. It has, however, helped many by improving their quality of life. The Multiple Sclerosis Association of America (MSAA) has bought and placed cool suits in more than 50 MS research care centers in the U.S., and it is estimated that, through such centers, more than 100,000 MS patients will be able to get cool suit treatment.

A Cushy Idea

One of the most widely used NASA spinoffs began 20 years ago at Ames Research Center, where a research program was conducted to improve crash protection for airline passengers. One innovation developed by a program contractor was an open-cell polymeric foam material intended for padding in aircraft seats. The material offered better impact protection in an accident and enhanced passenger comfort on long flights by distributing body weight and pressure evenly over the entire contact area. Called "slow springback foam," it flowed to match the contour of the body pressing against it, and returned to its original shape once the pressure was removed.

Foam-In-Place Seating is produced by mixing Sun-Mate ingredients, pouring the mixture into a plastic bag — which is later used as a mold — and contouring the mold to the most therapeutic body position. The seat is then upholstered and ready for use.

Initially marketed under the name Temper Foam®, the material is used for its originally-intended application as aircraft and helicopter seats, but also has found uses in a variety of medical applications. Originally manufactured by a company formed by the contractor's employee who had invented it, Dynamic Systems Inc. (DSI) of Leicester, NC, DSI subsequently sold the rights to the original formula. DSI returned to making slow springback foam products with different formulations. The rights to the original Temper Foam were acquired by Temper Foam Inc., jointly owned by Kees Goebel Medical Specialties (Cincinnati, OH) and AliMed® (Dedham, MA).

DSI markets a line of orthopedic support cushions for reducing fatigue and improving circulation. Available in various sizes, thicknesses, and pressure qualities, they are sold under the names Sun-Mate, Pudgee, and Laminar. DSI's Foam-In-Place Seating (FIPS), developed for severely disabled people to slow progressive deformities and ease soreness and fatigue due to long periods in wheelchairs, is a process wherein liquid Sun-Mate ingredients are mixed, poured, and contour-molded to the individual's body and chair.

AliMed markets the original Temper Foam and a fire-retardant formulation called T-Foam™, which happens to be used in Space Shuttle seats.

1970s

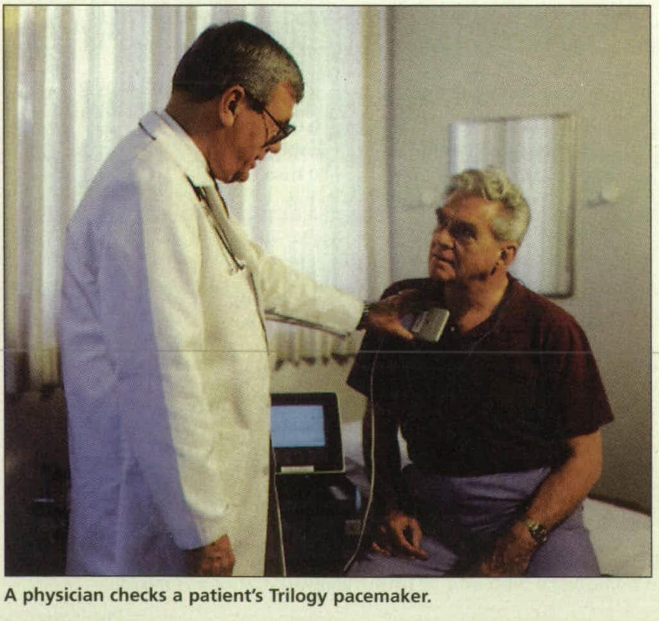
Keeping Pace

In the 1970s, Johns Hopkins Applied Physics Laboratory, NASA, and Pacesetter Systems of Sylmar, CA, developed a device later called Trilogy™ — a cardiac pacemaker that provides doctors with extensive programming capabilities, and detailed information on the patient's health and performance of the system. Introduced in 1995, Trilogy is the fourth generation of the original unit.

Pacesetter brought to the commercial market three advances based on the original collaboration in the late 70s. These were the first rechargeable, long-life pacemaker battery, based on spacecraft electrical power system technology; the first single-chip pacemaker, born out of space microminiaturization technology; and the first pacing system to utilize bi-directional telemetry, the NASA-developed technology for two-way communication with satellites that provided a means for doctors to communicate with an implanted pacemaker and program it without surgery.

In 1979, Pacesetter produced the first commercial bi-directional telemetry pacing system that would lead to their position as a world leader in the large bradycardia (slow heartbeat) market. The new system features a microprocessor that allows more functions to be automatic; a unit can adjust many of its settings on the basis of information it gathers about heart function.

Originally part of Siemens AG, Pacesetter became in 1994 St. Jude Medical, Cardiac Rhythm Management Division.



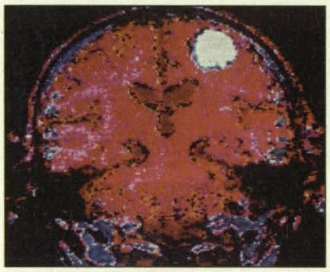
A physician checks a patient's Trilogy pacemaker.

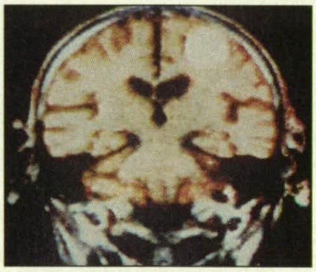
1980s

The Human Body's "Window"

Nuclear magnetic imaging (NMR) was an experimental technique in the 1980s for viewing the inner parts of the human body. Instead of x-rays, NMR employed a magnetic field and radio waves to create body images from which radiologists could extract diagnostic information. It also was non-evasive, and unlike x-rays, could penetrate bone. NMR images provided a vast amount of anatomical and physiological information.

In the early years of its development, however, a radiologist was required to analyze 50 or more images to make a proper diagnosis of a complex problem. Dr. Michael Vannier, a professor of radiology at Mallinckrodt Institute of Radiology, Washington University Medical Center, in St. Louis, MO, employed satellite image enhancement techniques to overcome this problem. Serving previously as a NASA engineer, he was familiar with such techniques. Vannier recognized the similarities between NMR imaging and the space technique of Earth resources imaging, in which the NASA-developed Landsat satellite takes electronic pictures in several segments of the light spectrum. Its detectors recognize "signatures" of various Earth features such as crops, water, and forests, and send the information to ground stations in a voluminous flow of data. Using NASA's computerized image processing technology, the vast amount of raw data can be analyzed easily. A computer program analyzes the data, sharpens the contrast, eliminates the confusing detail, and produces images in which the various features appear in different colors.





The image at left is a computer-processed color composite of an NMR head scan, showing a brain tumor (white area near the top). The image on the right shows how the enhancement process created a "theme map" in which each color corresponds to a different type of tissue, with the tumor sharply defined.

Vannier contracted NASA to see if the Landsat processing techniques could be applied to medical imagery. With the help of Bob Butterfield, manager of technology integration at Kennedy Space Center, and Douglas Jordan, engineering manager of the Remote Sensing and Image Processing Laboratory at the University of Florida, Vannier had a number of NMR scans processed by a computer program at the Florida lab. The program processed the images just as it would the Landsat images, combining multiple black-and-white images into a single, realistically colored composite picture. Said Vannier, " These pictures look real, just as if you lifted a slice right out of the human body."

The trio took the research a step further and learned how to make "theme maps" of the human body. In Earth resources observation, Landsat signature data is processed to create one thematic image; for example, one that separates wheat fields from all other crop areas. For medical imaging, the computer program searches the NMR images for a signature of interest to the radiologist — such as a blood clot — and colors any area that has that particular signature.

By incorporating these NASA satellite imaging techniques, the widely-used modern magnetic resonance imaging — MRI — technique was born.