

Forty-Year-Old Foam Springs Back With New Benefits

Originating Technology NASA Contribution

The most recognized and widely used NASA spinoff is at it again. Temper foam, whose origins date back to 1966 when it was developed to absorb shock and, thus, offer improved protection and comfort in NASA's airplane seats, has paid its dividends to Earth repeatedly, and in many different ways. It has padded the helmets of the Dallas Cowboys throughout the 1970s and 1980s, protected bedridden patients from bedsores, and comforted the feet of thousands wearing stylish shoes that incorporate the cushioning material in their insoles.

Four decades later, the world has come to realize that there are no bounds to temper foam's benefits. Though the rights to the technology have been shared amongst various manufacturers, the original product maker is still going strong, pushing temper foam into new arenas, including automotives, amusement parks, prosthetics, and modern art.

Partnership

As an aeronautical engineer with the Systems Dynamics Group at North American Aviation, Inc., Charles Yost* helped to build a recovery system for the Apollo command module in 1962. His experience with this recovery system would come in handy 4 years later, as Yost was contracted by NASA, through Stencil Aero Engineering Corporation, in Asheville, North Carolina, to assist in the improvement of airline seating for crash and vibration protection, and the development of energy-absorbing techniques for increased survivability. During this time, Yost created an open-cell, polymeric "memory" foam material with unusual viscoelastic properties; that is, it possessed both high-energy absorption and soft characteristics.

NASA's Ames Research Center fit this cushion-like material into a new airplane seat design that not only

offered better impact protection in the event of an accident, but enhanced passenger comfort on long flights, due to an even distribution of body weight and pressure over the entire contact area. Initially referred to as "slow spring back foam," the material flowed to match the contour of the body pressing against it and returned to its original shape once the pressure was removed.

The outcomes of Yost's research were detailed in a NASA report entitled "Human Survival in Aircraft Emergencies." In 1969, he formed [Dynamic Systems, Inc.](#), to sell the technology as "temper foam." The Leicester, North Carolina-based company sold the rights to the technology in 1974, but later returned to market second- and third-generation derivatives that were less temperature-sensitive and more environmentally friendly than the original version.

Product Outcome

Dynamic Systems expanded temper foam technology from applications for aircraft seating to medical cushions and seating systems for the severely disabled. Eighty percent of the company's product sales come from the medical industry, where its SunMate open-celled, viscoelastic cushioning material is used for orthopedic seating pads, mattress pads, and the Foam-In-Place Seating (FIPS) system, a custom-molded seating solution for the severely disabled.

In addition, Dynamic Systems offers Pudgee. Like SunMate, Pudgee is an open-celled, viscoelastic foam; SunMate can support weight, whereas Pudgee's main function is to compress and conform, therefore providing relief to help alleviate skin breakdown. In other words, Pudgee generates less friction and pressure on tender areas of the skin. Pudgee also transfers moisture, wicking it away from the body.

For the ultimate balance of comfort and support, Dynamic Systems bonded the SunMate and Pudgee materials to create a cushion it calls Laminar. The Pudgee

layer on top flows to alleviate pressure and the SunMate layer underneath provides distributed support.

While Pudgee is extremely soft and squishy, SunMate is available in several different formulations, from



Initially referred to as "slow spring back foam," temper foam matches any pressure against it and slowly returns to its original form once the pressure is removed.

extra-soft to extra-firm. All products from Dynamic Systems are available for customization, and the company offers technical support throughout the application development and implementation stages.

The company's FIPS custom-molded seating system—featured prominently in *Spinoff* 1988—is intended for individuals with complex positioning needs, due to deformities or excessive muscle tone problems. Used primarily for wheelchairs, a FIPS-contoured insert provides advanced posture control by gently holding a person in position. By distributing seating pressure evenly, FIPS improves blood circulation and relieves pressure from pressure points. In short, FIPS helps slow progressive deformities, improves body functions, and eases the soreness and fatigue associated with confined or prolonged seating.

Producing a FIPS insert is an easy process that takes less than a day and does not require expensive equipment. The process involves liquid SunMate “Foam-In-Place” ingredients, which are mixed and poured into a molding bag by medical specialists who ensure that the resulting mold conforms to the patient's body and wheelchair to provide the most therapeutic body position. Within minutes, the liquid ingredients set. All that is left is trimming of any excess material and covering. For patients with less-severe debilitations where complex contouring is not required, Dynamic Systems offers a fabric finish molding bag that is pre-upholstered and ready for immediate use after the FIPS insert sets.

With slight modifications, the FIPS process is well-suited for prosthetic cosmesis. Prosthetic limbs incorporating SunMate materials have the natural feel of flesh and can be molded into a variety of muscle tones and dyed to match exact skin color. Otto Bock Healthcare PLC, a global supplier of innovative products for individuals with limited mobility, utilizes FIPS to develop prosthetic arms. The company's design is specifically intended for amputees missing an entire arm from the shoulder joint.

Once cured, the SunMate foam prevents friction between the shoulder skin and the prosthesis, creating



The Laminar cushion, a combination of SunMate and Pudgee materials, provides the extra pressure relief needed to counteract extreme soreness and fatigue. Customers can select from a wide range of cushion thicknesses and pressure supports to create a combination tailored to their requirements.

a soft, comfortable interface. Furthermore, the open-celled structure of the foam allows it to breathe, preventing heat buildup.

The same medical advances applied to the treatment of humans can be easily transferred to veterinary applications. When a large animal suffers a leg injury that requires bracing or splinting, healing can be a long, slow process. Using a layer of cushion material beneath an orthotic brace can speed up healing, however. Equine Prosthetics, Inc., of Ocala, Florida, uses SunMate padding in splints, braces, and prostheses for dogs and horses, including its “signature” horse, Thor.

Thor is a 16-year-old, thoroughbred gelding with a right hind foot prosthesis. The majority of his leg is

present, although completely nonfunctional from the fetlock down. An accident had caused trauma to the leg, severing his deep and superficial flexor tendons and his lateral suspensory, and breaking his lateral splint bone. Equine Prosthetics rescued him with the intention of putting him to sleep, because his condition was so unusual and extreme, but the company learned that he could be saved and kept comfortable if fitted with a special, customized prosthesis.

Equine Prosthetics needed a molding system that could accommodate complex contours and still provide impact resilience. FIPS met its requirements, mending Thor's leg so that he can now buck, play, and graze, happily and healthily. The horse's condition has improved

so much that he now travels to children's hospitals to visit with children who are facing amputation and prosthetic replacement of their own limbs. The goal is to help these children see that it is indeed possible to overcome such an obstacle.

The FIPS technology is also a catalyst to new viscoelastic foam applications extending far beyond the world of medicine.

In stock-car racing, a driver once said he used to feel like he had been "beaten to death" after races. Now that the driver's vehicle is outfitted with a FIPS shock-absorbing insert, he says a race now feels like "a trip around the block."

FIPS technology is now used in NASCAR, Formula 1, Champion Auto Racing Team (CART), and Indy Racing League racecars. One NASCAR driver, whose vehicle featured a custom FIPS insert, walked away from a serious crash unscathed.

Performance Analysis, a motorsports engineering and design firm that manufactures seat safety systems, uses FIPS in professional cars for, among other properties, its low level of toxic emission in the event of a fire. The SunMate product line traditionally does not contain fire retardants, but Dynamic Systems offers a fire-retardant additive for applications in which regulations require the material to pass specific tests. The additive does not detract from the SunMate cushion's impact energy-absorption properties.

Besides FIPS, other SunMate materials are being used in racecars. In Formula 1, SunMate materials have been selected for head and neck supports, due to their comfort, light weight, and versatility.

Motorcycle saddles are also being refurbished with Dynamic Systems's viscoelastic foam technology. The company is offering bikers hours of newfound riding comfort, since motorcycles are typically deficient in shock absorbers and lumbar supports. In 1998, it advertised comfortable, fatigue-reducing materials for "do-it-yourself" motorcycle-seating retrofits, in *Rider*

magazine. In just 3 months, it received 161 responses to its advertisement.

According to Dynamic Systems, motorcycle saddles are easy to refurbish with either SunMate or Laminar cushioning. Motorcyclists who have had their seats refurbished with these foams have reported reduction and elimination of backaches, stiffness, and numbness that result from prolonged riding. Additionally, they maintain that the improved saddles relieve them of pressures induced by seams and rivets on jeans, as well as items in pockets, such as wallets and change.

The SunMate and Pudgee technologies, as well as FIPS, are additionally being used to soften a saddle of a different kind. Salvisa, Kentucky-based Equine Environmental Consulting, Inc., has developed a highly specialized line of saddle pads and saddle-fitting products for racehorses using Dynamic Systems's foam materials. In addition, the Master Saddlers Association, of Woodbine, Maryland, and County Saddlery, Inc., of Lisbon, Maryland, have used SunMate shims under saddles to correct saddle fit and alleviate back and shoulder soreness in horses. The



Dynamic Systems, Inc.'s foam technology buffers bumps and bruises, making it a good fit for motorcycle saddles.

foam padding protects the horse's skin from rubbing against saddle leather, which can cause raw spots or calluses. Once a saddle fits the horse correctly, improvement becomes evident in the animal's skin, joint health, and behavior, leading to improved scores in competition. Yet another organization, Toklat Originals, Inc., of Lake Oswego, Oregon, used FIPS and SunMate for saddle shims that correct asymmetry and other irregularities in a horse's back. SunMate is also used to line the starting gates at racetracks, as well as areas in and around stables, to protect the often easily excitable horses from injury.

Dynamic Systems also dabbles in the arts with its foam products. SunMate and Pudgee cushions have appeared in several art exhibits featuring new and unusual materials applied in unconventional ways, from major shows at The Museum of Modern Art and the Smithsonian Cooper-Hewitt National Design Museum, to student exhibits at the Harvard Graduate School of Design, the Rhode Island School of Design, and the Royal College of Art.

At the Smithsonian Cooper-Hewitt National Design Museum, Pudgee was chosen for display in the "Skin: Surface, Substance, and Design" exhibit, due to its skin-like properties, the benefits it provides for skin, and the sensation it evokes upon feeling it for the first time. At the Rhode Island School of Design, a student created a contemporary lounge chair that incorporated a ball of Pudgee foam, for a course whose objective was to create a piece of furniture featuring novel or unconventional materials. The ball doubled as a spring-like structural support and a seat cushion. Other pieces of contemporary furniture have been

designed by art students, including a Pudgee-stacked bench and a Pudgee sofa lounge. Dynamic Systems's staff of project coordinators assists artists and designers with the technical details of transforming their cushion concepts into works of art.

In fashion and design, a gown-tailoring service and dress design company by the name of Design Studios is using full-size body casts made from FIPS foam to create customized dresses. The owner of Snohomish, Washington-based Design Studios started the company to fulfill consumer demand for custom dress forms that accommodate different sizes and shapes, and reduce the number of time-consuming fittings and alterations required for making tailored clothing. The owner experimented with a variety of pourable molds to create body casts, but quickly discovered that once set, they would either be too soft, too rigid, too powdery to work with, or otherwise incapable of withstanding the constant pinning and manipulation that are essential in tailoring.

Soon thereafter, the owner learned about the FIPS process from a nearby engineering laboratory. She contacted Dynamic Systems, and technicians helped her determine the appropriate formulations to successfully create body molds to fit her needs. According to Dynamic Systems, the molds turned out to be so accurate, that clients need only show up for two fitting sessions.

In recreation, U.S. Aqua Sport, Inc., of Arvada, Colorado, has designed an inflatable "bumper" raft that will not sink if punctured. The circular-shaped raft, intended for whitewater rapid attractions at theme parks, features an internal chamber filled with SunMate foam. This layer of cushioning enhances the safety of amusement park patrons who choose to confront the rugged rapids.

Recently, Dynamic Systems has seen increased interest in use of the firmest formulation of SunMate for archery targets. The material absorbs severe impact, weathers well, and is durable enough to withstand thousands of shots, allowing for longer use of a target. Another advantage of this material is that it is practically self-healing. Arrows



SunMate, Pudgee, and Laminar benefit both rider and horse, whether it be with a more comfortable riding saddle or a form-fitting prosthetic leg for injured animals.

from an 85-pound pull bow may penetrate up to 8 inches and be removed by hand with little or no effort (arrows are very difficult to remove from most target materials) and with very little damage to the material.

The firmest formulation also provides significant bullet impact pressure reduction when used as a backing in bulletproof vests and as a shock absorber to protect personnel in military vehicles that run over landmines.

Coming full circle to the initial NASA application, SunMate and Pudgee materials are making their way into the seats of private and commercial aircraft, as well as into the seats of helicopters. In Hendersonville, North Carolina, two helicopter pilots had a harrowing experience when their helicopter crash-landed because of engine failure. Fortunately, both pilots walked away with only minor injuries, due in part to the special high-impact absorption of the Dynamic Systems cushions in their seats.

The impact-absorption capabilities of SunMate make the material a good match for ejection seating in military aircraft. Recent tests by the U.S. Air Force showed that a 2-inch SunMate cushion performed "substantially better" than other proposed ejection seat cushions in reducing the force of impact in the catapult stage.

Spinning back to NASA, the Space Agency recently built a demanding obstacle course, placed over a special 4-inch-thick SunMate cushion floor, to evaluate astronaut post-flight performance.

Astronauts who return from space experience difficulty with balance and walking as they re-adapt to gravity on Earth. The special floor provides an unstable support surface that increases the challenge for astronauts regaining their equilibrium. Their physiological responses are monitored as they try to negotiate their way through the tricky obstacle course.

A total of three SunMate floors have been built for this purpose, one of which was sent to Russia for use by the astronauts returning from the International Space Station.

The list of applications and products goes on and on, as does Dynamic Systems's commitment to producing a low-cost, highly advanced cushion material for comfort and energy absorption. In the last 10 years, the company has been honored as an inductee in the U.S. Space Foundation's Space Technology Hall of Fame, presented with a certificate of recognition from NASA, and has received the prestigious "Governor's Cup" award as the top small business with less than 50 employees in the Southeast, all for inventing temper foam.

With all of these honors and a growing customer base, Dynamic Systems is sitting pretty comfortably these days. ♦

**In memory of Charles Yost, who passed away on March 29, 2005.*

SunMate® is a registered trademark of Dynamic Systems, Inc.