Reduction of Spinal Impact with The MitiGator™ Technology

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Impact injuries are a continuing problem for military and civilian personnel in aircraft, trucks and armored vehicles. Spinal injuries occur from single impact events such as a crash in a helicopter or fixed-wing aircraft, as well as repetitive impacts in armored vehicles or trucks over rough terrain or the pounding of small boats into the waves. Protective seat cushions are engineered to dissipate some of the impact energy before it can be transmitted to the body. Not only can the use of foam cushions fail to provide the needed protection, but it can actually increase the potential for injury. Training of personnel in sophisticated military vehicles and aircraft is expensive, and many careers are shortened or ended by injuries sustained during either training or field operations.

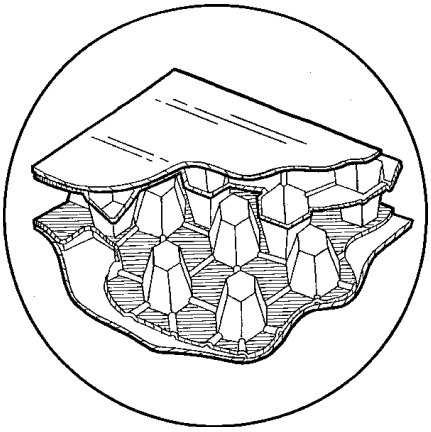


Figure 1. HACS Cushioning Structure Design

For the past 12 years under Small Business Innovation Research (SBIR) programs for HHS and DOD, investigators at have developed a Hybrid Air Cushioning System (HACS), now marketed as The MitiGator™ Technology, that shunts much of the impact energy laterally instead of through the protective cushion. Programs for HHS have investigated thin protective body padding and bicycle helmet liners. Programs for the Special Operations Command (SOCOM) demonstrated how HACS could reduce blunt injury trauma under body armor. Another program for SOCOM showed its utility in a helmsman's neck collar for small attack boats. In an SBIR program for the NAVY, a MitiGator™ seat cushion system was designed and tested which dissipates more than 40% of the vertical impact energy through a series of internal bleed ports and passages, thus significantly reducing the potential for spinal injury during single and even multiple impacts. Figure 1 shows a cross-section of The MitiGator™ cushioning structure with the interconnecting vents between the cells in which the impacted air is forced to choke. It is this choked airflow that bleeds the energy and redirects much of it laterally instead of through the cushion. Figure 2 is a close-up view of The MitiGator™ elastomer illustrating the hexagonal cells and interconnecting vents molded into the structure.

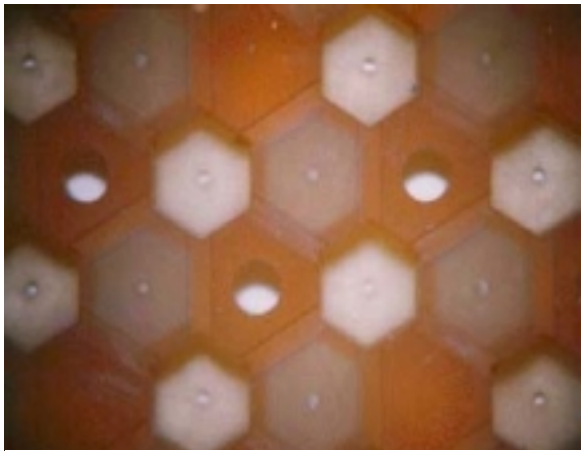


Figure 2. The MitiGator™ Elastomer with Interconected Cells

The AH-1W Cobra attack helicopter has no other built-in crashworthiness systems since it was introduced prior to the development of new safety technologies. The MitiGator™ Technology was specifically developed for the Cobra AH-1W helicopter and the Navy Air Systems Command (NAVAIRSYSCOM) because these aircraft do not have "stroking seats" to help dissipate the impact energy. While conventional seat cushions can actually exacerbate the force loading to the body, The MitiGator™ dissipates much of the energy. Current seat cushioning systems rely on foams and crushable materials for comfort and protection. In aircraft hard landings and crashes, injuries can occur when accelerations exceed specific limits. One method to provide protection is to extend the duration of the impact pulse. Tests have shown that most foams in cushioning actually increase the potential for spinal injury by allowing the body acceleration to overshoot.

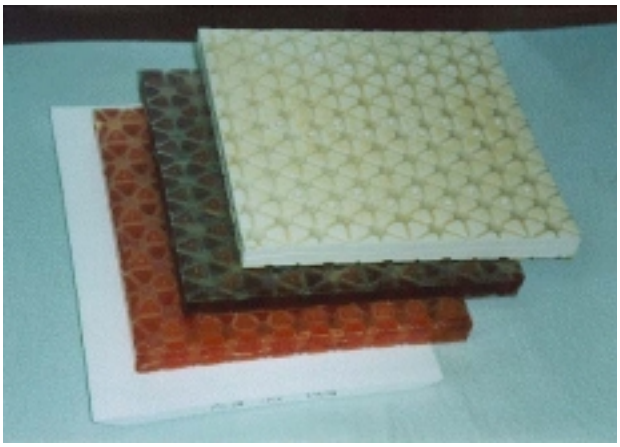


Figure 3. HACS Seat Cushion Components

Figure 3 illustrates the components of The MitiGator™ seat cushion, which consisted of three layers of different durometers. CAD/CAM designs were developed and used to produce prototype MitiGator™ components using the output from the computer model as a guide for cell and channel sizes as well as the hardness of the elastomers. The molds were produced from the CAD file using stereo-lithographic techniques. Figure 4 shows a conceptual design of The MitiGator™ seat cushion assembly. The upper layer is a low-shear foam that conforms to the body shape, The MitiGator™ layers are then sandwiched between the foam and the ventilation pan, which can introduce cooling air through the ports through The MitiGator™ elastomer. A unique computer model was developed by Dr. David Thompson, former Head of the Mechanical Engineering Department at the University of New Mexico in Albuquerque. This complex computer model of The MitiGator™ Technology cushion can help assess its 13 variables. The novel simulation program was used to help design prototype seat cushions that were fabricated with elastomers of varying durometers. A total of 200 experimental drop tests were conducted in the impact test laboratory at SEAS using a Hybrid III 5% female and GARD 50% male mannequins.

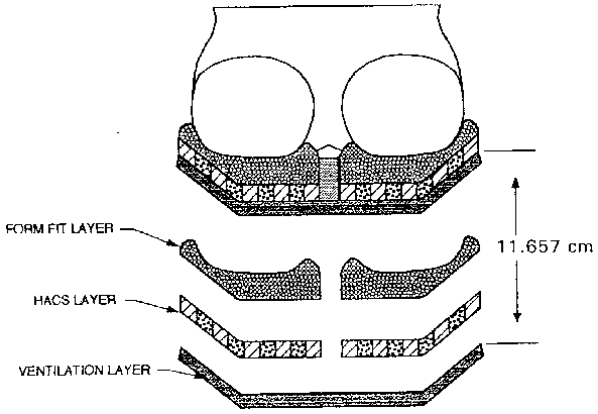


Figure 4. Conceptual Design for The MitiGator™ Technology Seat Cushion

Figure 5. Hybrid III Female Mannequin in Cobra Impact Test System

Figure 5 illustrates the Hybrid III female mannequin in a Cobra seat atop the AVCO Corporation pneumatic impact test system at SEAS. This impact test system can be programmed to provide impact acceleration to 200g on

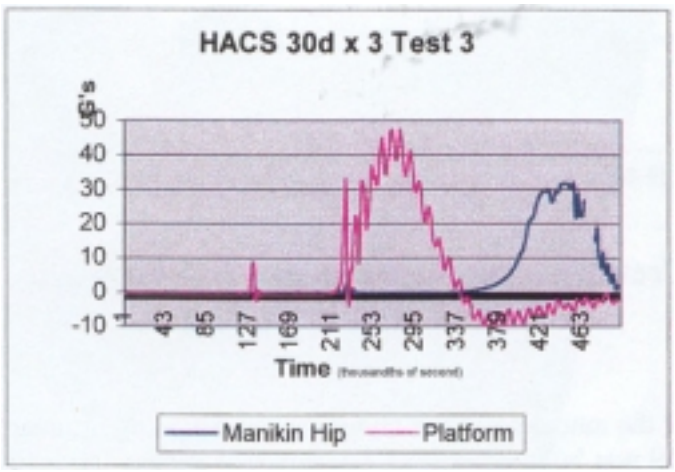


Figure 6. MitiGator™ Data Showing Acceleration Reduction

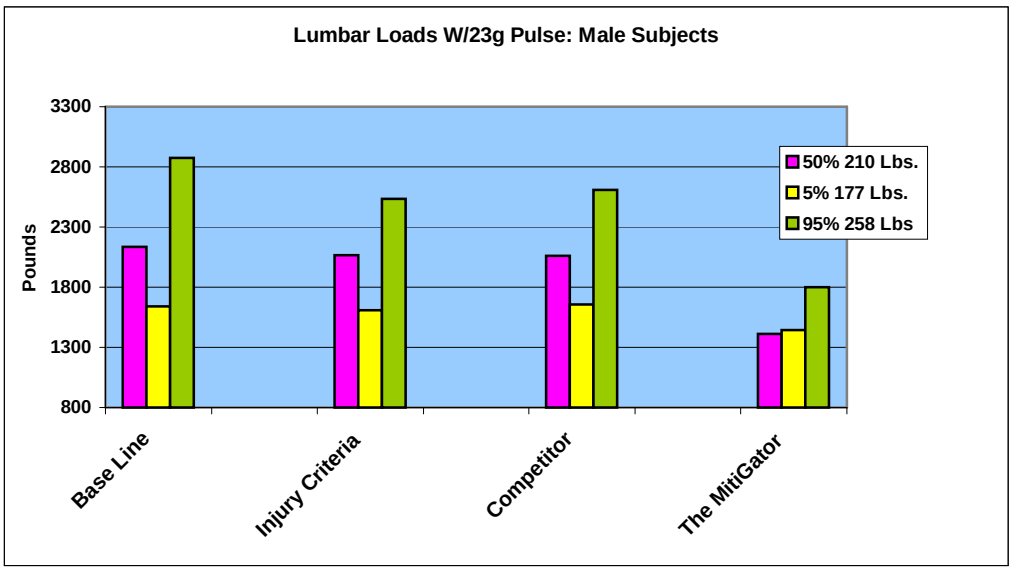
full-scale loads as high as 1,000 lbs. A triaxial accelerometer located centerline in the pelvis was used to measure impact loading. Figure 6 shows acceleration data for one MitiGator™ test in which the 3" cushion is seen to reduce the impact by 15g. Additional testing was also conducted using the Navy Crew System Horizontal Accelerator at Patuxent River Naval Air Station, Md. As shown in Figure 7, this facility uses a test sled that accelerates a reclining test mannequin with a 23g pulse.

Figure 7. MitiGator™ Seat Cushion System Test at Navy Air Crew Test Laboratory

Figure 8 compares the resulting lumbar loading for the base line, the injury criteria, the best performing competitor, and The MitiGator™ Technology using three mannequins: a 50% male weighing 210 lbs, a 5% male weighing 177 lbs, and a large 95% male weighing 258 lbs. The test results demonstrated that the The MitiGator™ Technology was less than both the injury criteria and the best seat cushion currently available. The test results demonstrated that a 3-inch thick The MitiGator™ was 40% more effective than any other aircraft seat cushion tested for reducing the lumbar load transmitted to

the crash test dummies of all sizes (5%, 50%, and 95% male) during the 23g impact tests.

Figure 8. Comparison of Lumbar Loading Criteria and Cushioning Systems



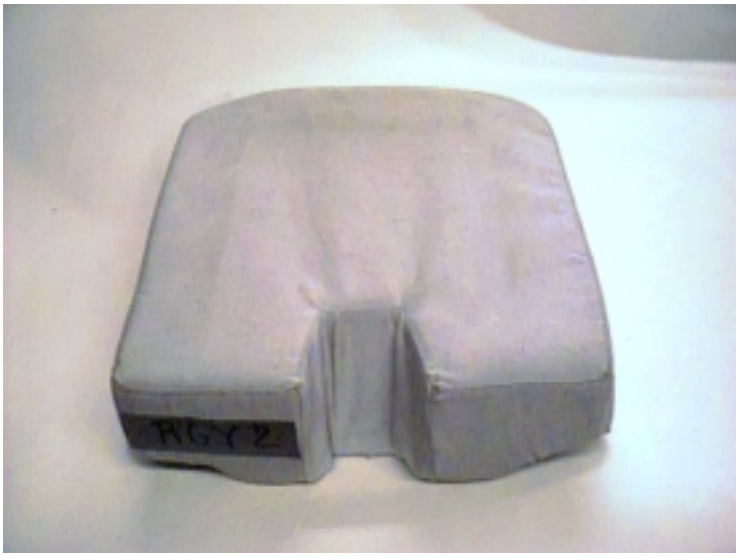


Figure 9. Super Cobra Cushioning System

The MitiGator™ Technology, as illustrated in Figure 9, is an engineered system. This novel and patented technology can maximize energy absorption while minimizing rebound. Optimal MitiGator™ configurations can be designed for other specific applications. Along with its good energy-attenuating characteristics, a MitiGator™ cushioning system has the added advantage of returning to its original configuration after impact, thus making it applicable to repetitive impacts or bounces, and completely reusable after high impact loadings. The superior performance of the new cushioning system is expected to reduce injuries to pilots, and become applicable to many other areas where single or repetitive impact loadings are a problem.

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