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# Hold Onto Your Seat

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**PHYSICAL CONDITIONING AND TECHNOLOGY  
CAME TO THE AID OF SPECIAL OPERATORS TO  
MITIGATE SHOCK IN SMALL BOATS.**

The U.S. Navy has introduced a new way of looking at the health of its small boat operators to combat injuries sustained from the shock of riding through the water—which previously may have effectively cut their careers in half due to bone-jarring forces sustained as waves hit their boats.

Naval Special Warfare Group 4, which maintains the Navy fleet of 20 Mark V Special Operations Craft (SOC), applied changes in both training and technology to mitigate the shock experienced by SEALs and other special operators in their boats. Mike Strock, human performance manager for Naval Special Warfare Group 4, based in Little Creek, Va., told *Special Operations Technology* that a four-year old program has changed the way the group thinks about conditioning its warfighters.

“We started a human performance program,” Strock remarked. “We looked at the way that a lot of professional organizations were working with their elite athletes at high-end performance centers to see how they were training and compare to what traditionally the guys here at the command were performing in their physical training program.”

The Navy discovered that an emphasis on personal rather than group health revealed minor injuries

among individuals faster, thereby providing an opportunity to treat those injuries before they grew. In addition, Navy trainers and medical personnel took a more expansive look at the health of their special operators.

“We base what we do on what we call the professional sports model, which is really a fully integrated approach looking at different components like biomechanics, strength, conditioning and nutrition. It is really a multifaceted approach that we use with our tactically aware athletes,” Strock explained.

Special warfighters still undergo group training, but they also receive an individual full-body muscle and skeletal examination. Training personnel look at traditional orthopedic screening measurements as well as functional movement screening. Each operator receives an assessment of his quality of movement, broken down by different parts of the body and how well they move.

From that assessment, Naval Special Warfare Group assigns each operator a score that identifies where they could improve or rehabilitate a hip or an ankle or perhaps overall strength.

“We focus on a performance pyramid. We try to identify a foundation for fundamental mobility and stability issues. We attack that and set these guys up on a corrective strategy to regain those movement patterns and correct any imbalances they may have developed over the years,” Strock elaborated. “That gives us a roadmap on an individual basis to direct their physical training program with exercises and that sort of thing.”

The results speak for themselves, Strock declared. The Navy contracted a research group to examine the injury numbers within the group. In 2002, the researchers identified 60 separate operators that required rehabilitation, resulting in a time-loss injury. The Navy instituted the performance program in 2003, and the researchers took a look at injuries again in 2004. Only 21 separate operators experienced time-loss injuries the second time around. Time-loss injuries involved those that actually resulted in lost man-hours.

“There are some reasons for that,” Strock said. “One, we had a better way of training, better supervision and better guidance. The exercise patterns were implemented specifically to withstand some of the mechanical stress and whole body vibration on the boats. We did see a pretty significant reduction in some of those injury numbers.”

After special operators participate in a workout session, they also receive a recovery meal designed to provide key nutrients. The workout/recovery pattern is fully integrated with the medical examinations, as it would be in a training environment for professional athletes, Strock said.

“The success has been the fully integrated approach and the daily supervision and interaction with industry professionals,” he concluded. “Just like with the Pittsburgh Steelers or the Washington Redskins, you have the hired professionals within the units to provide the education and the oversight for what these guys are doing every day.”

## THE SEAT OF THE PROBLEM

Technological advancement also has played a significant role in reducing shock injuries among special operators in boats. Mitigating shock on the Mark V SOC became a first priority for Navy special forces partly because the boat was large enough to sustain some technological applications. For several years, researchers examined the concept of an active shock absorption system that would compensate for the forces generated by the boat's movement through water before they could strike. Finally, however, the Navy settled on a passive system that reacted to and absorbed forces through the seats of the Mark V SOC boat.

STIDD Systems Inc. of Greenport, N.Y., manufactures those seats. The company used existing technology to upgrade the seats and provide a highly capable shock mitigation system, STIDD Systems CEO Walter Gezari told *SOTECH*.

"This is a perfect example of what started out as quick-fix 70 percent solution, but turned out to be a very effective 99 percent solution," he declared. "It's an instance in which good engineering and existing technology that many people thought could only be solved by some long-term, state-of-the-art engineering program."

Teaming up with Taylor Devices Inc., STIDD Systems incorporated a shock mitigation device into the Mark V SOC seat, creating the model 800V53 seat.

"We were able to use a passive suspension that was finely adjusted and force functioned to the accelerometer outputs of the Mark V Special Operations Craft—data that was recorded underway on the Mark V with force function analysis of the suspension. That enabled Taylor to create a vessel-specific shock absorber system that would behave optimally on a Mark V in high sea-states, high-impact situation," Gezari explained.

STIDD Systems Vice President Dave Wilberding emphasized that getting the seats into the boats demonstrated how wonderfully effective congressional earmarks could be for solving a pressing problem such as shock mitigation. "The operators wanted it. We gave them a prototype, and when they liked it, we said we would go back to the factory and wait for the purchase order," Wilberding recalled. "They said, well, we don't have any funding."

Realizing the severity of the health problems suffered by special operators because they lacked the seat, Congress stepped in and provided the funding to outfit about half the Mark V SOC boats with the shock mitigating seats over two years. "Guys were suffering repetitive orthopedic stress injuries; it was damaging retention; guys who should have been able to drive a boat for 10 years could only drive it for five and then would retire on full disability," Wilberding said. By 2005, USSOCOM had fielded seats for all Mark V boats.

STIDD Systems then turned to applying the solution to other vehicles where shock mitigation caused operator injuries. The company developed a standup bolster to fit a variant of the seat into an 11-meter RIB boat.

"We took the same Taylor suspension from the Mark V seat, the 800V53, and we have embedded it in a RIB bolster, a standup bolster, for the 11-meter RIB or any other high-speed craft that don't have enough of an envelope or weight allowance for the big 800 seat," Wilberding said. Although the U.S. Navy has not



An interior look at a Mk V showing STIDD seats in place. (Photo courtesy of STIDD)

yet settled on the STIDD Systems solution for shock mitigation in the RIBs, the company has sold them to other RIB operators around the world.

The company also has been working with a large mining company to outfit its wheeled vehicles with shock-mitigating seats. That work could yield to breakthroughs that could provide shock-mitigating seats to U.S. Army wheeled vehicles as well.

## SHOCK ABSORBERS

Taylor Devices Inc., based in North Tonawanda, N.Y., has long manufactured shock-absorbing devices for the U.S. Navy. The company's expertise in the field inspired the collaboration between it and STIDD Systems to create the shock-mitigation seat.

"The key is that the shock absorber is optimized for various sea state conditions," Alan Klembczyk, Taylor Devices' chief engineer, told *SOTECH*. "The injury realized by operators would be minimized both in calm sea states to protect against the cumulative vibration through the spine and also to protect against large impacts realized during heavy sea states. The shock isolator was optimized for all conditions."

Taylor Devices analyzed the forces that acted on the Mark V SOC after the Navy awarded it with a contract to analyze, design, test and produce specialized shock isolators.

"We did the analysis and optimized the design based on injury criteria that was derived from research done years ago through Fort Rucker for aircraft ejection seats," Klembczyk revealed. "We took those injury criteria parameters and optimized them for the actual inputs that were measured for a Mark V at sea. Then we conducted an optimization study to derive our final shock absorber output characteristics."

The Mark V SOC, manufactured by VT Halter Marine of Gulfport, Miss., is made of aluminum and measures 81 feet

in length. The boat is powered by twin 2,285 horsepower diesel engines.

In 2000, the Naval Health Research Center in San Diego first took a serious look at injuries caused by shock in the boat in a study titled "A Survey of Self-Reported Injuries Among Special Boat Operators." In the survey, 64.9 percent of operators reported sustaining at least one injury, while some reported up to three. Injuries caused by shock included sprains, strains, disc problems, trauma, dislocations, chronic pain and stress, according to the report.

Taylor's shock-mitigation device, a part of the overall STIDD/Taylor shock-absorbing seat, has received a great deal of praise from special operators who use it.

"The response from the field was very positive and continues to be very positive with respect to our shock isolator in STIDD MkV seats, to the point where the use of that technology is continually expanding to other craft programs as well," Klembczyk noted.

### **OTHER SHOCK MITIGATORS**

While the STIDD/Taylor solution has been very successful, there are other factors to examine when mitigating shock on boat operators, revealed J.J. Marie, CEO of Zodiac Marine, headquartered in Paris, France.

When boat operators suffer up to 19 G's at even moderate speeds in a boat as large as the Mark V SOC, incorporating several shock mitigators may yield the best results, Marie noted. In addition to shock absorbers, hull design can play a role in mitigating shock.

"As we learned from off-shore racers, the deep V hull itself is a shock mitigator," Marie told *SOTECH*. RIB boats also mitigate shock, he added. "People think of RIB as cushioning for a side impact when coming alongside another boat. But a RIB with an air tube, as opposed to a foam tube, has enormous shock mitigation and acts like a shock absorber or acts like tires when you go from sea to sea."

So Zodiac developed a RIB with a deep V hull. The boat also has Almond seats, designed to help comfort crewmembers as well. Zodiac develops such specialized boats for special operations missions.

"It's not only the special operations community; the Coast Guard has the same problem," Marie explained. "Despite all of

the Coast Guard woes with Deepwater, one of the real success stories was the Coast Guard OTH [over the horizon] boats. OTH is very fast, over-the-horizon RIB that the Coast Guard uses that is deployed from a cutter to chase the go-fast boats. They work in conjunction with armed helicopters. They were having the same problem."

Zodiac developed the OTH boat to help the U.S. Coast Guard reduce the amount of shock its crewmembers suffered while on patrol. The Coast Guard has been taking delivery of the new boats and operator feedback has been extremely positive, Marie reported.

"In the small boat category, less than 25-foot boat or 7-meter RIB, the Coast Guard OTH boat is probably the best boat for shock mitigation on the market today," he declared.

Marie observed that training also plays a big role in mitigating shock, as USSOCOM operators well know. But it is important to fulfill mission requirements as well, so cutting down on speed to reduce shock does not produce a satisfactory result when speed is of the essence.

"It is clearly a problem and also a dilemma. If you make the seats and the environment so shock mitigated, you might at some point endanger the boat itself. The ideal solution keeps the operators of the boat in touch with the elements but keeps the passengers them as comfortable as possible," Marie stated.

One solution may sound humorous, but has proven effective in operator training with European special forces, he acknowledged.

"Some of the European commandos that we work with, who have some really fast boats and RIBs, they put the coxswain all the way forward. All the way forward is the most uncomfortable place. When he starts getting hurt, he slows down. It's a low-tech solution, but it really works," Marie noted.

Typically, the helmsman sits in the most comfortable position possible, somewhere after midship, leaving many of the passengers to suffer. Placing the driver elsewhere may produce a smoother ride.

"We don't believe there is a magic solution out there. It comes in like 15 percent increments. Between all of them is how you will eventually limit shock," Marie concluded.



The M 80 Stiletto's hull design recaptures the bow wave using its energy to create an air cushion for more efficient planing. (Photo courtesy of M Ship Co.)

## SPECIAL DESIGNS

The importance of hull design in particular as a means of mitigating shock should not be underrated. At least if the performance of the Stiletto and other boats manufactured by the M Ship Co. LLC of San Diego are any indication. USSOCOM has been examining the boat designs for special forces applications, Bill Burns, co-founder and executive director of M Ship Co., told *SOTECH*.

"Our philosophy is to address the issue of shock mitigation at the source, which is the hull," Burns commented. "We have developed a hull form, which is called the M Hull. It uses the air and water at the interface of the water to smooth out the ride and to make the craft more efficient."

The hull shape contains tunnels called planing tunnels for their ability to take in water, as well as a displacement section. The shape of the hull resembles the letter M from the front. The tunnels take on both air and water, providing greater stability to a boat as it passes through the water at both low and high speeds.

"On a conventional boat, it really is balancing or pivoting about one point underneath the boat," Burns explained. "We have been able to spread that over a

couple of different surfaces, so we almost get a tripod effect, which is more stable. That prevents the boat from pitching up and down where the bow is rising and falling with every wave. That is where a lot of the accelerations come from. The boat doesn't pitch like a conventional boat, so it's more stable to begin with and that helps alleviate the acceleration."

The capture of air and water in the tunnels create a cushion underneath the boat and the boat rides on top of the air/water combination, Burns continued.

"As you engage waves, the air and water automatically dampen out the slamming," he described. "So the wave slows the boat in a more gradual manner instead of just hitting it hard once. The bow wave travels up into the tunnel. The tunnel automatically dampens the deceleration. The air in the tunnel acts as a pneumatic cushion. As you go through the wave, you can actually see the air coming out from underneath the boat like a steam engine."

The M Hull design has been under development for about eight years, Burns estimated. His company sought to reduce the damage caused by waves on a conventional boat, but the founders soon realized they had made an efficient boat that provided a smooth ride. Those

qualities have enabled the company to create several variants of the original M Hull boat for commercial and recreational markets. USSOCOM expressed an interest in the 80-foot Stiletto, which has four planing tunnels for an even smoother ride, and how to adapt the Stiletto's design for smaller boats.

"When these operators are taking accelerations on the order of 10 or greater, it seriously degrades their ability to perform their mission and cuts their careers short," Burns observed. "The Navy and SOCOM are beginning to realize the cost of those accelerations and that shock. They invest a lot in these warfighters and if they can only work half of their career, that costs a lot of money. Then on top of that, they have to support them through disability for the balance of their lives. It's an expensive problem that is only getting worse as missions require boats to go faster and faster." \*

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