After years of studying the biomechanics of physical performance in athletes, Pitt's Scott Lephart in the School of Health and Rehabilitation Sciences is now leading an unprecedented initiative to benefit the nation's elite warriors.

PERFECT FIT

WRITTEN BY CARA MASSET ■ PHOTOGRAPH BY GETTY IMAGES (THIS PAGE)
OTHER PHOTOGRAPHS BY JOHN SCORZA AT THE NAVAL SPECIAL WARFARE COMMAND

A Navy sailor, with muscles primed, leans over a stationary bike and pedals at medium speed. He maintains his pace as two observers watch his energy output ticker up and down on a nearby screen in the exercise laboratory.

Steady, they say. Stay steady.

Then: **"GO, GO, GO, GO, GO,"** they bellow.

The sailor pedals as fast as he can, thighs pumping with enough force to lift a ship's anchor. There's a sweat stain on the back of his brown T-shirt, issued to him recently during training. He is among a small percentage of his recruiting class to join one of the U.S. military's most elite teams of special operators, Navy SEALs.

To earn his brown T-shirt, he survived days of sleep deprivation during "Hell Week" and ran for miles in soft sand while carrying a boat over his head, never once ringing the surrender bell that most of his classmates rang to get the hell out of SEAL (Sea Air & Land) training and back into the regular Navy. He passed a physics course on the science of underwater diving, a manageable task for this university-educated Texan with caramel-colored hair. He also met dozens of other challenges of his mental toughness alongside men from the Ivy League and military academies.

On the stationary bike, the SEAL-in-training is completing another challenge, a 30-second sprint in the University of Pittsburgh's Human Performance Research Laboratory on the Naval Amphibious Base in greater San Diego. The clean-shaven sailor with a missing front tooth, perhaps a token of his college rugby days, is pedaling with so much force that the two observers—a Pitt nutritionist and a Pitt physical therapist—have to clench the ends of the handlebars to prevent the bike from tipping over, yet they encourage him to pedal even more vigorously.

"KEEP PUSHING! HARD AS YOU CAN! KEEP GOING!" the nutritionist yells so loudly that he'll be hoarse the next day.

"YOU GOT IT! YOU GOT IT!" the physical therapist adds as the sailor goes all out, working to get his training class into the Top 5 on a nearby record board decorated with a Pittsburgh Panther mascot. He pushes harder and harder to see whether he can beat the records of NHL hockey players on this test. He exerts himself at 100 percent simply because he's that kind of man—a competitor ready to overcome challenges, whether they are gym exercises or formidable national security matters.

After all, 30 seconds of effort could determine success or failure in a SEAL military operation, such as a reconnaissance mission to track terrorists. The bicycle sprint is testing the Navy sailor's anaerobic power to see how responsive his muscles would be, perhaps to bolt out of a sinking vehicle or haul an injured teammate out of harm's way. By comparison, he has already galloped on a treadmill in the lab to test his muscle endurance, an important capability during tactical pursuits like long-distance underwater swims in enemy waters.

When the sprint is over, the sailor breathes heavily while pedaling at a leisurely pace to cool down his muscles. "Wow, man, you guys want to come to the gym with me sometime?" he half jokes as he thanks the nutritionist and physical therapist for their motivational yelling.

A breeze from the San Diego Bay spins into the room with the assistance of a window fan, freshening the air around the stationary bike, also known as the Velotron Electromagnetic Cycle Ergometer. Before the sprint, the sailor tested his muscular strength on the neighboring Biodex System 3 lifting apparatus—one of only a handful in the world—while fellow Navy sailors squeezed into the lab's egg-shaped BOD POD to have their percentage of body fat measured or hopped over hurdles while wearing reflective sensors for a three-dimensional motion-analysis test using the same technology that sports-video games have used to create lifelike football players.

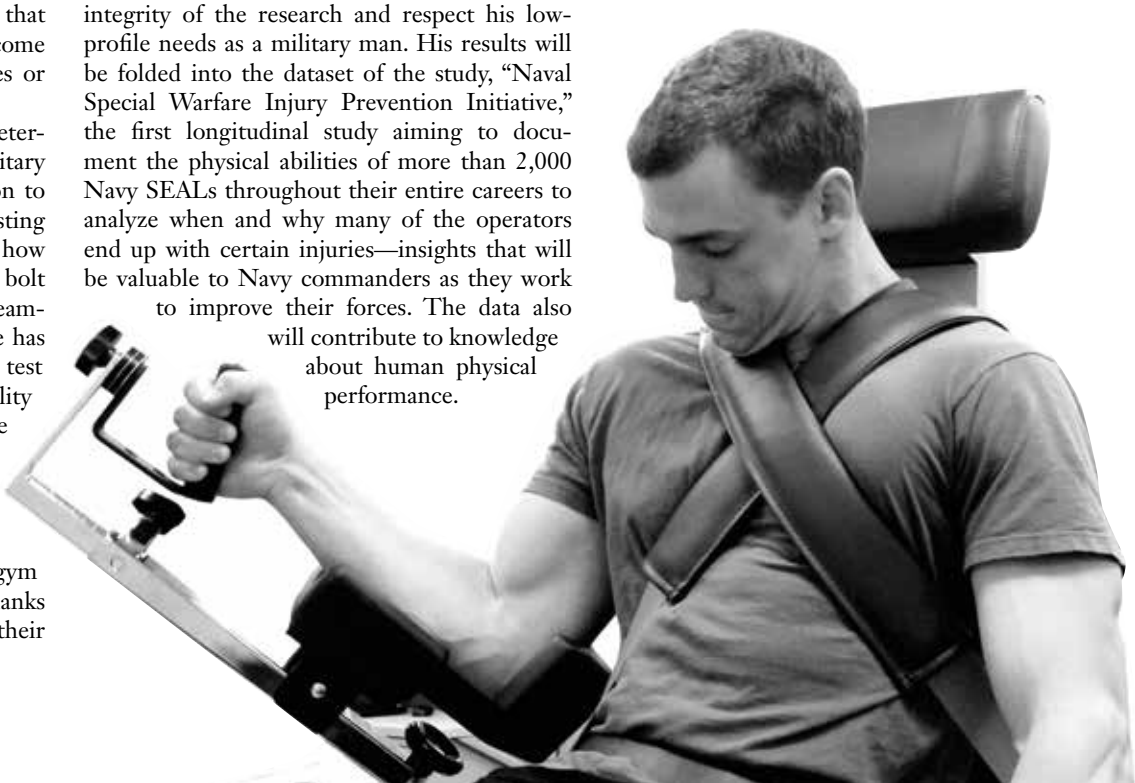
When the sailor dismounts from the state-of-the-art bike after four hours of intensive testing in the lab, the nutritionist tells him that he'll soon receive a performance report that will compare his strength, flexibility, endurance, and other physical characteristics with fellow SEALs-in-training, experienced SEALs, and elite athletes who have also been tested in Pitt human performance labs. Red markers in the report will indicate physical imbalances—say, a left shoulder that's stronger than the right, which could increase his risk of injury. If he wishes, he can share the detailed information with conditioning coaches and medical professionals so he can better chisel his physique to meet the demands of future missions.

Otherwise, the sailor's individual stats will be kept private and anonymous to ensure the integrity of the research and respect his low-profile needs as a military man. His results will be folded into the dataset of the study, "Naval Special Warfare Injury Prevention Initiative," the first longitudinal study aiming to document the physical abilities of more than 2,000 Navy SEALs throughout their entire careers to analyze when and why many of the operators end up with certain injuries—insights that will be valuable to Navy commanders as they work to improve their forces. The data also will contribute to knowledge about human physical performance.

Lephart, realizing that soldiers' movements could be analyzed just like those of professional athletes, offered the services of Pitt's Neuromuscular Research Laboratory. In 2005, he began the groundwork for research with the Army's 101st Airborne Division at Fort Campbell in Kentucky.

The study, one of six such military-related studies on human performance that Pitt researchers are conducting with grants from the U.S. Department of Defense, is being led by Scott M. Lephart, professor and chair in the Department of Sports Medicine and Nutrition in the University of Pittsburgh's School of Health and Rehabilitation Sciences. Lephart and his colleagues have established an unprecedented research enterprise with the U.S. Navy, as well as the Army, Air Force, and Marines. The mission: evaluate the physical capabilities and job requirements of thousands of troops, then use the data to develop better training methods that will reduce injuries and propel the nation's already-primed warriors to the peak of what's possible for human bodies to accomplish.

Back in 1990, when the United States began sending soldiers into the Gulf War in Iraq, Lephart was in the process of founding the Neuromuscular Research Laboratory at Pitt, which today operates the human performance centers on military bases nationwide. At the time, Lephart had recently added "Dr." to his name with a PhD in sports medicine and was serving as coordinator of sports medicine services in the University's athletics department. He became director of the new laboratory and initially geared research toward traditional athletes.



Pitt staffers encourage a Navy sailor to test his anaerobic power on a stationary bike.

Lephart and his team studied the shoulders of baseball players to identify characteristics that could lead to injuries and developed "pre-habilitation" programs to strengthen at-risk shoulders. They studied female athletes with torn knee ligaments to figure out why they are eight times more likely than men to have such injuries. They examined the swings of professional golfers and created the "Par Without Pain" injury-prevention program now used by the Professional Golfers' Association. They invited Steelers, Penguins, and other local pro athletes into the lab for comprehensive fitness examinations. Essentially, Lephart and his team perfected the art of scientifically evaluating body movements and figuring out how to remedy imbalances that can lead to disabling injuries.

After a decade of testing athletes, Lephart read a military report, "Injuries in the Military: A Hidden Epidemic," that had been reprinted in the *American Journal of Preventive Medicine*. Too many soldiers were getting injured during routine training, the report stated, even before

While Lephart and his team of researchers were working with the Army's 101st Airborne, word got around that the research was top-notch and pragmatic. The Navy became interested in partnering with Pitt's Neuromuscular Research Laboratory, primarily to find ways to keep SEAL operators in peak physical condition.

trooping off to battlefields. Musculoskeletal injuries like ankle sprains were keeping many soldiers from performing at their best.

Lephart, realizing that soldiers' movements could be analyzed just like those of professional athletes, offered the services of Pitt's Neuromuscular Research Laboratory. In 2005, he began the groundwork for research with the Army's 101st Airborne Division at Fort Campbell in Kentucky. First, Lephart and his colleagues visited the base to observe how the 101st Airborne soldiers were training, watching as they leapt out of tanks, traversed ditches, and climbed over obstacles, landing on their feet multiple times a day—and night. Then they used these empirical data to design laboratory tests to evaluate the soldiers' tactical movements.

In one such test, Pitt researchers asked soldiers to drop off a 50-centimeter platform and land properly, while six cameras captured their leg mechanics and generated three-dimensional analyses. The soldiers landed both with their eyes open and while wearing blindfolds, replicating the covert night conditions in which they often work. The results, published in *Military Medicine*, showed that soldiers are at much greater risk for injuries when landing with decreased visual input.

While Lephart and his team of researchers were working with the Army's 101st Airborne, word got around that the research was top-notch and pragmatic. The Navy became interested in partnering with Pitt's Neuromuscular Research Laboratory, primarily to find ways to keep SEAL operators in peak physical condition. At the request of the Department of Defense, Lephart opened laboratories filled with the same leading-edge exercise testing equipment that exists in his Pitt lab at naval bases in Virginia, Mis-

Scott Lephart

sissippi, and most recently in California where SEAL recruits, like the stalwart sailor who completed the 30-second bicycle sprint earlier this summer, are tested and trained.

In the meantime, the U.S. Special Operations Command, which oversees special operators from all branches of the military, requested Pitt's expertise, too. Now the Army's Fort Bragg in North Carolina has a Pitt Human Performance Research Laboratory for special operators, and additional labs are under development at the Air Force's Hurlburt Field in Florida and the Marines' Camp Lejeune in North Carolina.

The laboratories—run by Lephart and five fellow faculty in Pitt's Department of Sports Medicine and Nutrition, 20 off-site faculty at the military bases, and 16 graduate students, all with varying backgrounds in nutrition or physical therapy or athletic training—use the same research model and follow the same protocols. "We deploy our methodologies to the various locations," says Lephart, who now has a habit of sprinkling his vocabulary with military terms.

Troops are observed in training, then individually tested in the lab for about four hours. The averages of their results are assessed to highlight problems within the populations and entered into the University of Pittsburgh Military Epidemiological Database. The findings are shared with military commanders, who use the data to develop exercise programs designed to overcome the troubles, and Pitt researchers assess the effectiveness of the regimens.

The expansion of Pitt's human performance laboratories reflects the way in which the U.S. military is changing some of its tactics, according to Glenn Mercer, a 26-year SEAL operator with the rank of master chief who is serving as a human performance program manager with the U.S. Special Operations Command.

"Leadership has recognized that after almost a decade of combat zone employment, a different system of physical and mental preparation is going to be required to meet growing global demand for Special Operations Forces," he says. That means using all tools available, like the Velotron Electromagnetic Cycle Ergometer stationary bike and the brain power of Pitt researchers, to evaluate today's elite warriors and help them to reach—and maintain—their physical pinnacles throughout their careers.

Sensors are used to collect physical performance data.

"The stakes for all soldiers, particularly special operators, are so high that they are seeking any advantage they can possibly obtain to effectively conduct their missions," says Lephart. "Their enthusiasm and commitment to testing and determining what areas can be improved upon to meet these goals and objectives are truly remarkable."

"Leadership has recognized that after almost a decade of combat zone employment, a different system of physical and mental preparation is going to be required to meet growing global demand for Special Operations Forces."

—Glenn Mercer, U.S. Special Operations Command

The results being produced by Lephart's team are remarkable as well. "The Pitt protocol is by far the most expansive and occupationally relevant testing model I have seen or been involved with," says Mercer, who has collaborated with Lephart's Neuromuscular Research Laboratory since 2004. "There are many outcomes that we can refer to as having significant value. However, providing an objective measure of our rate of injury, per man and per year, is a statistic that the organization had spent years trying to quantify. This singular conclusion is an unusually compelling factor."

Other compelling findings of Pitt's human performance research are: the possibility that soldiers might not need to run so much during boot camp because over-running, especially with a rucksack, often causes stress fractures, and soldiers don't generally run 10 or 20 miles in war zones but in short sprints; the conclusion that Navy SEALs with greater than 15 percent body fat, regardless of whether they have the physiques of lumberjacks or martial artists, are more likely to get injured than SEALs with lower body-fat percentages, underscoring the importance of good nutrition even among super-fit warriors; and the discovery that many military men aren't incorporating enough balance exercises into their workout routines, which may increase their risk for injury when they're on bumpy rides in swift-moving river boats or armored tanks.

Lephart's team has begun working with military leaders as they develop supplementary training programs to try and solve some of the issues raised by the Pitt data. They've established, with the Army's 101st Airborne Division, the Eagle Tactical Athlete Program, which includes new training activities like jumping with closed eyes to better prepare soldiers to land properly in the dark. They've introduced a similar exercise program for Navy SEALs, and the Pitt researchers are currently determining whether or not the programs are reducing injuries.

The Pitt researchers are improving not only physical capabilities but equipment, too. Timothy Sell, associate director of the Neuromuscular Research Laboratory and Pitt assistant professor of sports medicine and nutrition, attended a meeting at West Point earlier this year as part of his role as a primary investigator of the Defense Advanced Research Projects Agency's prototype of the Warrior Web, a skin suit designed to fit under a military uniform and sense when joints are in vulnerable positions; the suit then responds by providing additional support to those joints.

The value of Pitt's research is also generating buzz abroad among U.S. allies. Last year, Lephart gave presentations across Europe, including one in Brussels, Belgium, during a meeting of the North Atlantic Treaty Organization (NATO). Afterward, the commander of NATO Special Operations shook Lephart's hand and slipped him a coin with his symbol. It's a way that high-ranking military officers recognize excellence and signal appreciation. The commander was surprised when Lephart slipped him a coin, too—with an emblem representing Pitt's human performance partnership with elite warriors. ■