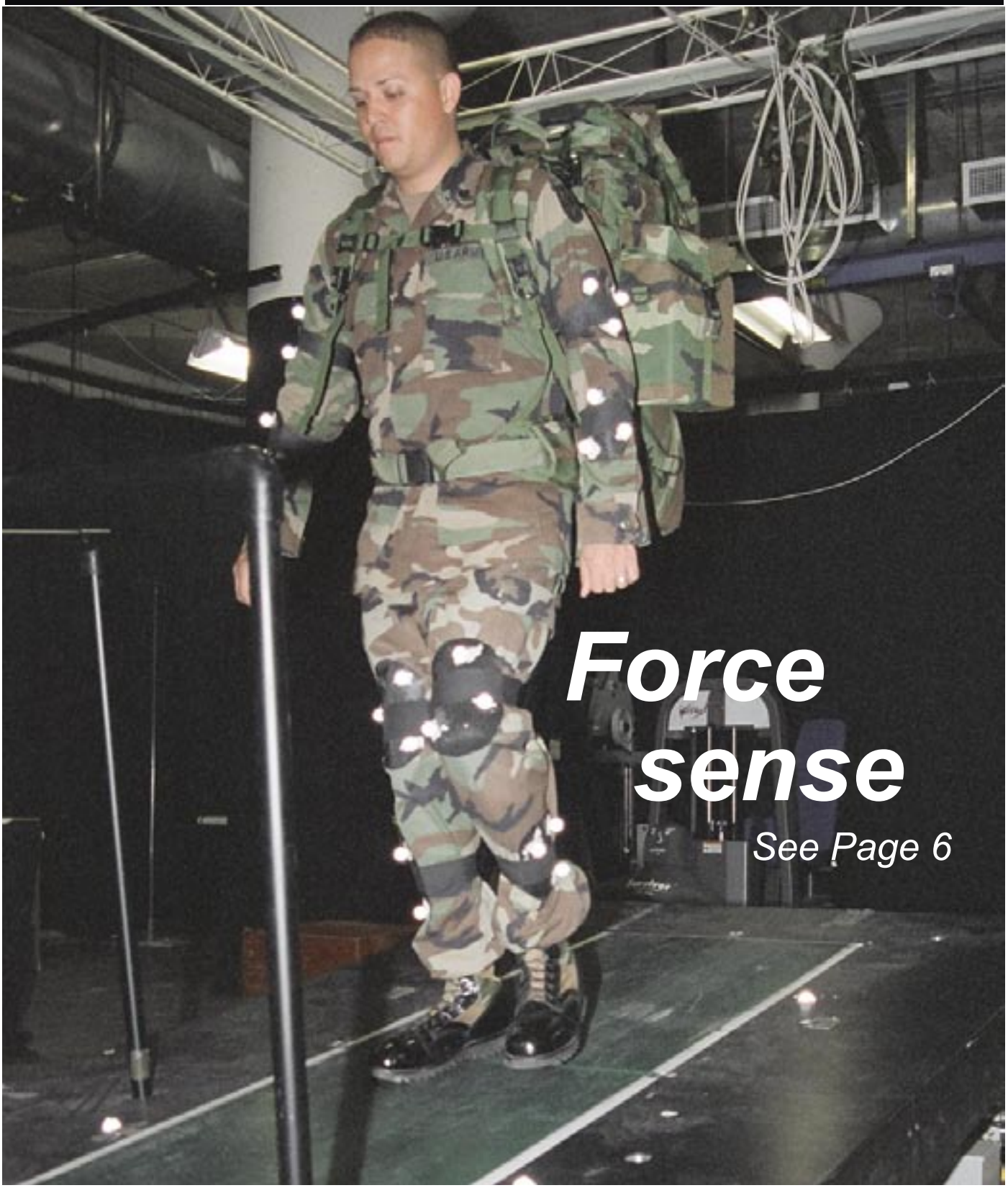
THE WARRIOR

Natick, Massachusetts

May-June 2005



Force sense

See Page 6

Dual belts on the Force Sensing Treadmill gather 3-D force data separately for each foot.

Force sense

Dual-belt force-platform treadmill advances gait studies

Story and photos by Curt Biberdorf

Each foot gets individual attention on the Force Sensing Treadmill, a newly-patented design invented by research physiologists at the U.S. Army Research Institute of Environmental Medicine (USARIEM).

Built by Advanced Mechanical Technology Inc. of Watertown, Mass., the treadmill features one rolling belt in front of another, each with its own independent force platform attached to a common chassis.

The treadmill gathers more and higher quality data during gait studies in much shorter time than traditional methods, said Peter Frykman, who along with Everett Harman and Michael LaFiandra invented the treadmill as an upgrade to the existing force platform used in the Center for Military Biomechanics Research, a facility shared by USARIEM and the Natick Soldier Center at the U.S. Army Soldier Systems Center in Natick, Mass.

"The new force-platform treadmill is a unique tool that addresses the gait biomechanics of marching Soldiers," Frykman said. "During previous gait studies, the test subjects had to step on the force plate just right. That made it very hard to walk naturally. In addition, you had to assume that what was happening on the right foot was happening to the left foot as well."

The idea of joining two separate rolling belts on a treadmill has been attempted, but they were positioned laterally to each other rather than fore-aft, said Harman.

Because the left and right foot tends to cross over or overlap the body's midline as each lands, he said that design makes it impossible to walk naturally while keeping each foot on a separate belt.

By positioning the two rolling belts front and back moving at the same speed, separate information on the 3-D forces and torques on each foot can be collected during walking or running the entire time either foot is in contact with the belt.

"If you stand on a scale to measure your weight, you can't determine what pressure each foot is exerting," Frykman said, illustrating how a single-belt force-platform treadmill can't do the job. "(With this treadmill), you're never situated where both feet are on the same belt at the same time. To get a good analysis, you need to know the force on each foot separately."

Frykman said data collection from each foot is especially important while walking because during part of the stride, both feet are touching the ground at the same time. That is when a single force platform under a treadmill belt cannot tell how much of the total force is on each foot.

Computer post-processing produces independent time records of the forces on each foot with the new treadmill. The computerized system records thousands of data points per second captured by the force-platform treadmill and video cameras for later analysis, assisted by reflective

markers worn by test subjects.

In five minutes of testing, researchers can now collect more information than when conducting many trials over several hours using a conventional force platform.

Knowing the magnitude and direction of forces on the feet as well as body motion information recorded with high-speed video cameras allows researchers to use computerized mathematical models to calculate the forces and torques at the ankles, knees, hips and the other major body joints, said Harman.

How rucksacks, boots, or clothing affect posture and gait are examples of the types of studies conducted in the biomechanics laboratory for the military.

Large universities conducting biomechanics studies and hospitals with gait analysis labs for medical diagnosis and physical rehabilitation are potential customers for the new treadmill, which the Army hopes to license to Advanced Mechanical Technology Inc., Frykman said.

The treadmill bed looks and feels like a conventional treadmill except for a sliver of space between the front and rear belts, which doesn't disrupt normal walking. Maximum speed is 11 mph, and hydraulic lifts adjust the platform up to a 25 percent uphill or downhill grade without stopping the belt or test subject. Bed capacity is 400 pounds to accommodate larger test subjects and their cargo load, and a removable handrail clears the view of the lab's cameras.

Several heavy cables connect the force-platform treadmill to the control panel, which is necessary to operate its high-precision motors, according to Frykman. The whole gait analysis system can be moved to another location if necessary. "We couldn't get the same data or the tremendous time savings without the new force-platform treadmill. Those are the factors that make it the great scientific tool it is," Harman said.

A control panel adjusts the treadmill's speed and grade.

Spc. Hipolito Ramos walks on the Force Sensing Treadmill in the biomechanics lab. Hydraulic lifts adjust the platform up to a 25 percent uphill or downhill grade without stopping the belt or test subject.