Embedded data acquisition

Integrated DAQ and sensors in the new advanced Pedestrian Legform Impactor help improve safety and survivability of pedestrians involved in accidents worldwide

Pedestrian accidents still result in a large number of fatalities globally, each year. According to the World Health Organization, more than 5,000 pedestrians are killed each week worldwide. The Governors Highway Safety Association reported that pedestrian fatalities in the USA have risen by 41% since 2008 – the highest in 30 years. Pedestrian deaths now account for nearly 16% of deaths related to vehicles in the USA. There are many contributing factors worldwide, including population density, socioeconomic status (in particular poverty) and visibility, with the majority of fatalities occuring at night. In addition, alcohol impairment (of either the pedestrian or driver) was reported in about half of crashes that resulted in pedestrian fatalities in the USA. Add in drug use and smartphone distractions and the case becomes even more concerning.

As part of the global NCAP, all new vehicles now receive a pedestrian protection score. These assessments are based on a series of testing involving an instrumented legform being launched at the bumper and a headform at the hood and windshield.

Lower limb injuries account for approximately 40% of the serious injuries sustained in car-to-pedestrian

accidents, according to data available in the USA, Germany and Japan. Studies show that impact angle and bumper height are highly correlated with the pedestrian in-crash kinematics and injury probabilities, which also commonly include head injuries. In addition, incidents involving SUVs are twice as likely to result in a fatality. SUVs tend to be heavier and have a more blunt front-end

styling that is less aerodynamic, which directly correlates with the lower limb injuries.

Since it was introduced in 2000, the Flexible Pedestrian Legform Impactor (Flex PLI) has been the standard test article for measuring pedestrian leg injuries. Earlier this year, Euro NCAP announced that it will adopt the new advanced Pedestrian Legform Impactor (aPLI) in its testing from 2022.
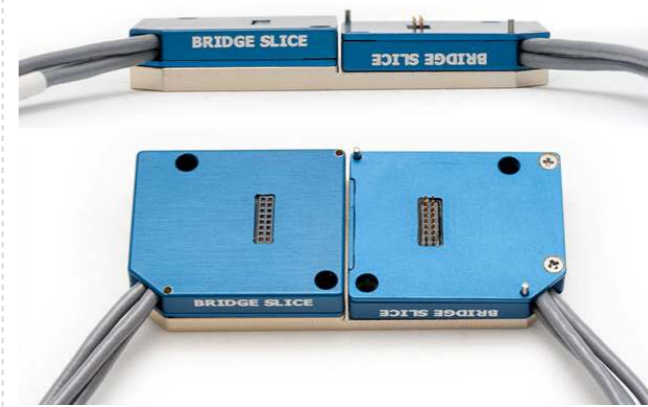
Manufactured by Cellbond, a company in the UK, the aPLI is the result of extensive FE modeling and PMHS testing. The initial prototype has already undergone a round-robin of testing worldwide. Most notably, the new aPLI includes an upper body mass (UBM), which represents the torso to enhance kinematics. The aPLI weighs 24.9kg (55lb), compared with the 13.2kg (29lb) Flex PLI, and the mass

ABOVE AND LEFT: The standard configuration for the new aPLI includes 18 channels of DTS Slice Nano DAQ and a 6DX Pro sensor package (triaxial angular rate and triaxial accelerometer) in the upper-body mass, along with a single-axis ARS Pro angular rate sensor in the knee

distribution has been refined to be more biofidelic, top to bottom. The structural design has also been simplified to improve repeatability and reproducibility of results.

The aPLI follows the industry trend of integrating both the sensor channels and the data acquisition system (DAS) in the test article, as also seen in ATDs, including THOR, WorldSID and WIAMan. Like its Flex PLI predecessor, the aPLI supports integrated Slice Nano DAS from DTS. Embedding the data acquisition into the test article minimizes exposed cables throughout the leg and eliminates any trailing cables that could affect the launch. The new integrated legform is supplied as a complete turnkey solution engineered to maintain proper mass, center of gravity and moments.

Using the Slice Nano stack extender, a special DTS mounting hardware solution designed for applications with limited height restrictions, the modular sensor layers can be split into two stacks, but still require only one BASE+. The BASE+ layer features the microprocessor, 16GB flash memory and supports up to 24 channels. As part of the biofidelic mass redistribution, the DAQ is now mounted in the torso area, compared with the Flex PLI, which has the DAQ in the knee area. The result is a more humanlike, lightweight knee that can more accurately measure ligament elongation and corresponding injuries.

The standard aPLI configuration includes 18 sensor channels focused on three primary types of measurements: injury assessment, flight dynamics and vehicle impact. Strain gauges and string pots in the femur, tibia and knee measure

ABOVE: To fit the low-profile integration requirements, a Slice Nano stack extender is used to mount the DAQ sensor interface layers side-by-side, along with the BASE+ layer, which includes the microprocessor, full signal conditioning and memory

injury probability. While angular rate sensors (ARS) in both the torso and knee measure free-flight dynamics and the impact angle of the legform, plus accelerometers mounted in the same locations as the ARS quantify the impact timing of the legform into the vehicle.

To keep mass and cabling to a minimum, an ultra-small DTS 6DX-Pro sensor package with three accelerometers and three angular rate sensors can be mounted in the upper body mass. Measuring 19 x 19 x 14.5mm, the six-channel sensor weighs only 12g and

terminates into two cables. There is also a uniaxial DTS Pro ARS angular rate sensor for the knee. Other sensors can be added to the aPLI, along with more Slice Nano, which can be added in three-channel increments, up to a maximum of 36 DAQ channels per leg. The system can be triggered with a level trigger or contact closure and data writes directly to flash memory. A quick-charging supercapacitor ensures reliable data capture and storage during launch.

"Current users who have a Flex PLI with Slice Nano can swap systems between an aPLI and Flex PLI," explains James French, project engineer at Cellbond. "This not only offers the advantage of having spares in stock, it also allows the extra data acquisition channels, connectors and
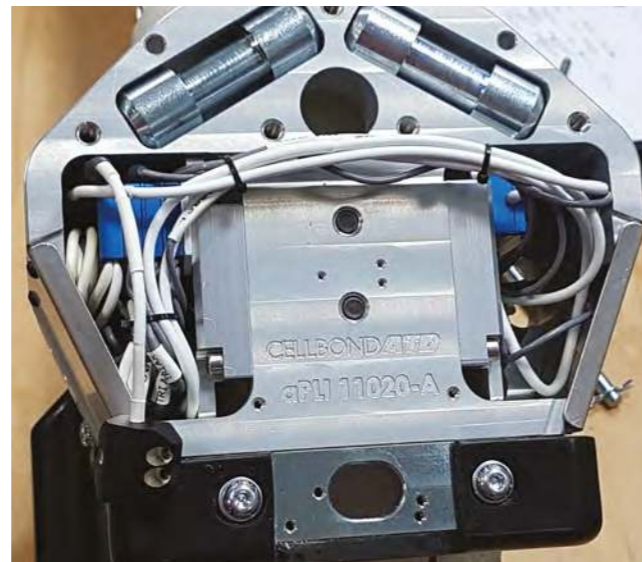

ABOVE: The integrated Slice Nano DAQ includes a quick-charging supercapcitor to ensure data capture

interface hardware to be added or swapped as needed."

Another big advantage for Slice Nano users is reduced setup time and improved testing productivity. Especially for Slice Flex customers, using the same setup, control and data viewing software offers continuity for both the engineers and the data. Beyond the legform hardware, the launcher interface hardware, including distributors and other ancillary devices, can also be used seamlessly with either the Flex PLI or aPLI.

Keeping test schedules on track and offering staff continuity of hardware and software is significant in many ways. "DTS understands that testing is not only about the data," says Steve Pruitt, DTS co-founder and CEO. "Test engineers are looking for solutions they can rely on, and that make their work easier and more productive. DTS DAS and sensors do that for NCAP, in-dummy solutions, pedestrian safety, bench testing, and more." ❮