A leading-edge look at Impact Sensors

Technological Solutions for Evaluating Occupant Safety

XSENSOR | Intelligent Dynamic Sensing

Shifting focus back to the goal of actively bettering vehicle safety design may help highlight and zero-in on missed opportunities in assessing current and informing future design.

Access to complementary and far higher-resolution data is NOW a reality with leading-edge Intelligent Sensing Technology, which, augmented with currently captured data, WILL provide a more complete picture of what happens in crash scenarios, creating the opportunity to significantly enhance the performance of future safety design.

ATD Impact Sensors — Evaluating Occupant Safety

SECTION

01

The challenge faced by current Crash Safety Testing

Understanding design performance problems due to insufficient impact data

The goal of the Test Environment — Assess current design performance and improve on safety in future designs

The key pursuit of Crash Safety Tests has not changed.

The world saw its first crash test dummy back in 1949 when the instant classic, Sierra Sam, was created by Alderson Research Labs and Sierra Engineering to track what happened during aircraft ejection, specifically noting the performance of pilot helmets and restraints. Sierra Sam continues to proudly serve as the foundation of the industry and although anthropomorphic test devices (ATDs) have improved considerably with the addition of sensors, timers, photonics and fibre optic technology to improve capture and transmission of data, the striving of the data and test engineers hasn't changed: understanding what happens to a body in an emergency scenario, in as much detail as possible.

Though advanced the technology is not being leveraged to its broader potential as we currently only 'see' certain areas — either on the dummy or discrete measurements on the surface — and miss the opportunity to gain the most detailed picture, critical to improving systems, minimizing injury and saving lives.

Additionally, the high cost of recalls is a challenge which — albeit, not all associated with impact testing, compels to design more effectively, and to make products that go through the design cycle with more information on the consumer side.

Research shows about half of car buyers look at safety reviews before seriously considering a specific vehicle. Impact testing data and ratings play a significant role into their decision (and subsequently a car manufacturers bottom line).

In other words, consumers are looking for this information as much as car manufacturers are.

One of the best ways to encourage potential customers to purchase a specific car (and build customer loyalty) is to prove it's safe for them. We achieve this by:

1. Testing for safety using highly granular data and look for weak points

2. Addressing and fixing those weak points, leading to a substantially safer vehicle overall

There is a compelling case to run simulations where granular detail of data over a larger surface area (on ATDs, and active and passive restraints) is captured, leading to the design of safer vehicles. So, why are we currently not 'seeing' enough detail?

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Why today's Vehicle Test Impact Data may not be sufficient

Why today's Vehicle Test Impact Data may not be sufficient

High-speed, hyper-spatial resolution sensors — a reality in bespoke industries like Medical Imaging and Sports Performance — provide a significant improvement in test coverage by supplying accurate, actionable complementary data and insights but are not currently being leveraged by testing environments.

Current impact measurement equipment provides data using discrete sensors, such as accelerometers, load cells, strain gauges, anthropomorphic test devices, and high-speed cameras to determine what occurs during vehicle crash simulations. While together these sources provide good information on the anatomical hotspots of impact injury they do not capture data with the level of resolution and surface coverage that is now possible with the addition of high-speed granular sensors.

The pursuit to enhance the safety of future design would benefit greatly from augmenting current discreet data capture with the additional insights offered by much higher resolution data, over the entire area of interest.

Like never before the automotive industry has now the ability to measure and characterize impact data and pressure profiles at a very high spatial and measurement resolution. This will augment the currently captured data with a newly accessible level of information, providing a more complete picture of what happens in impact scenarios.

A not-so-average Test Dummy

Today's ATDs don't reflect the average passenger well enough; as a result, injury dynamics and insights for a broader demographic are being missed.

As impact tests rely heavily on ATDs for data-gathering the dummy not being representative of a broad enough sample leads to a skewed or at the very least a limited picture, and may lead automotive companies to make safety design decisions that serve only a portion of their customers.

Current ATDs and sensors they are fitted with do not leverage the best the technology has to offer. We need complementary systems that will aid in:

- Capturing more data and detail that reflects a broader and more realistic demographic
- Cross-referencing this data to validate the expected effects on passenger safety due to different body types

If we can address the aforementioned issues and overcome the challenges they bring, we can advance Impact Testing in a real sense, significantly enhancing future safety design and ultimately reducing crash injuries.

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How Product Designers and Safety Engineers can address missing Test Information

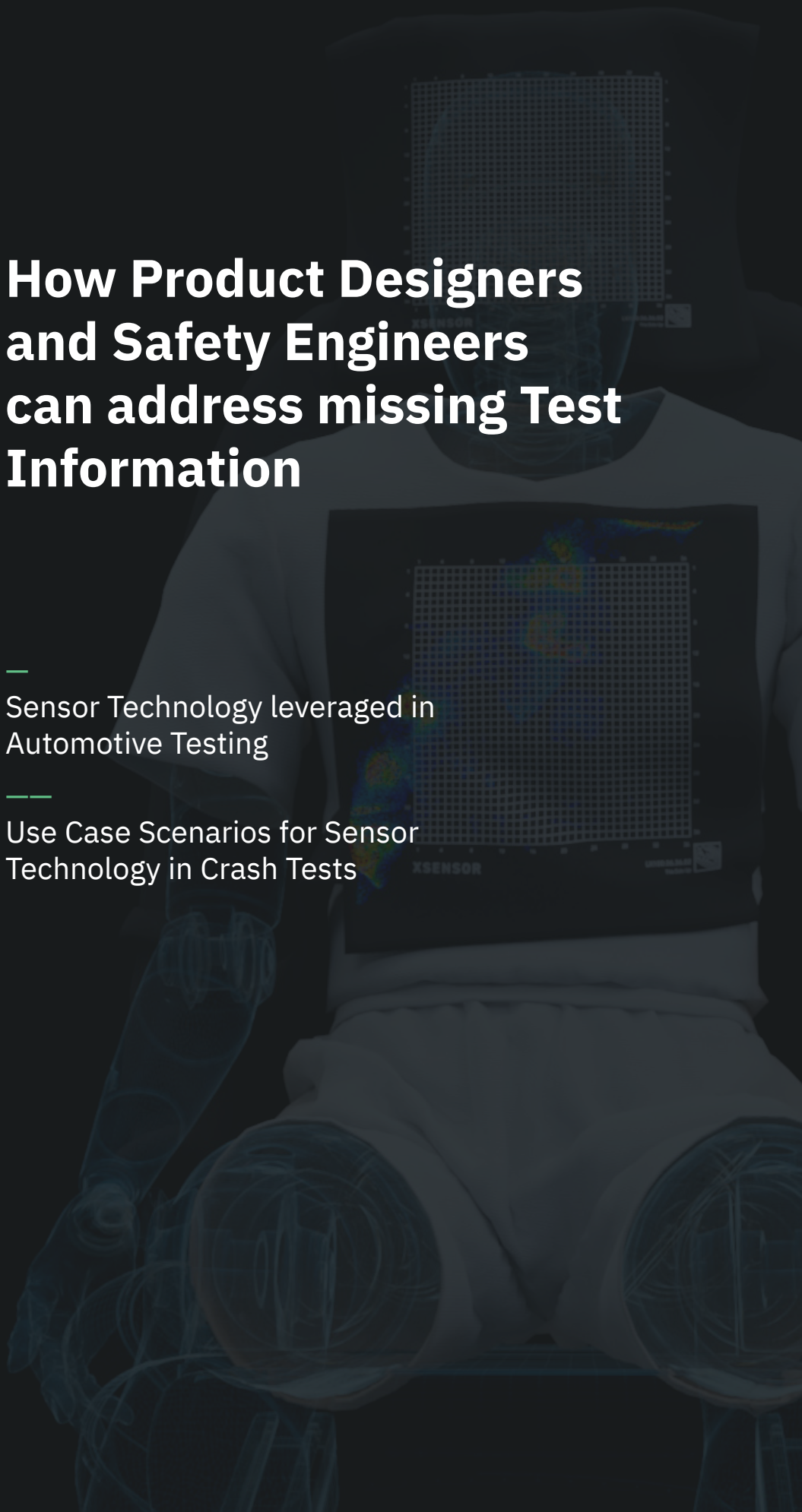
SECTION

02

How Product Designers and Safety Engineers can address missing Test Information

Sensor Technology leveraged in Automotive Testing

Use Case Scenarios for Sensor Technology in Crash Tests



Sensor Technology leveraged in Automotive Testing

Informing vehicle comfort & safety design performance for over 25 years, Sensor Technology has been an integral part of the automotive sector, particularly the testing environment.

Intelligent sensing is used in assessing the performance of seating design, to track comfort and seat durability for ingress or egress – getting in or out of the car. On the design side, being able to capture and visualize pressure data and profiles of the driver or passenger on the seat, and combine it with qualitative questions in regards to comfort and functionality, enables design engineers to create a better experience.

Moreover, the technology capacitates engineers and designers to see and understand what's happening in a car seat when different layers of mechanization are placed inside it, and predict its performance with any related add-ons or upgrades. Whether it's heating/ cooling systems or motors for adjusting the support area (i.e. lumbar) support, they are all visualized with sensor technology software by automotive companies worldwide.

As an analogy, high-resolution sensor technology is a key technical enabler in Automotive Tire Testing and leveraged by the majority of the world's top manufacturers. A high-resolution visualization provides a detailed pressure profile of the tire print, as well as important information related to contact patch ratios and calculations off the center.

In general, anything that involves qualitative processes for touch or driving experience can be accurately measured by sensors.

With key technical enablers, the same high-quality data is made available by sensor technology in the crash safety testing environment. Within a crash test setting, we might use sensors to accurately measure:

- Whiplash movement in medium- to high-severity situations
- What happens on the seat surface when the dummy comes into contact with passive restraint systems
- How the seat belt contours or conforms upon impact, and whether there are strains in the belt
- The deployment shape of airbags, and whether they make uniform contact with the dummy
- What happens when a projectile enters the cab

In all of these scenarios, not only are we enabled to capture and measure what happens, but more importantly to use the high-resolution data and acquired insights to assess design performance guided by impressive detail. Thus, allowing for redesign or retrofitting that leads to a better driving experience and greater occupant safety.

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Use Case Scenarios for Sensor Technology in Crash Tests

Use Case Scenarios for Sensor Technology in Crash Tests

Three examples help highlight well the capacity of advanced sensor technology for measuring and characterizing impact data and pressure profiles at a very high resolution, and opportunity it lends to augment with presently captured data in crash tests.

Let's look at some specific use case scenarios.

First up, Airbags.

To collect data related to this scenario, we can place sensors in one of four main places:

- A dummy
- A seating surface
- A dashboard
- A windscreen

Upon deployment of an airbag, the captured data will provide novel information on the airbag deploying or not and will show in high resolution the distribution of impact pressures. It will also show if those estimated loads are within range or not. This is especially advantageous as, in certain instances, the high-speed camera gets obscured by the deployment of the airbag. We lose a source for precious data when that happens, so sensors can ensure it is captured in every run test.

Next, Seats.

Sensors also allow us to visualize what's happening with the seat back and head restraint, either being utilized independently or as one shared sensor. We can visualize seat location and magnitude, and determine consistencies and inconsistencies of design, ultimately having the opportunity to assess the seat's overall performance in a crash scenario.

In turn, we can use this data to understand how the head makes contact, and how we can modify airbag and head rest design with the goal of offloading peak pressures in impact scenarios.

In our last example,

we can employ sensors to track whether lumbar adjustments come through into the dummy upon impact and how the dummy moves relative to the seat, allowing us access to a new level of information to assess how seating surfaces perform under different impact speeds.

All of these examples show clearly how sensors can provide high-detail, new and complementary information to enhance design and improve occupant safety, providing the opportunity for a more effective design cycle overall.

Now, let's turn our attention to exactly how, the right technologies – like those championed by XSENSOR – provide crucial additional insight in assessing design performance and significantly enhance occupant safety in crash scenarios.

XSENSOR Technology is helping make vehicles safer for all occupants

In a milestone for improved vehicle safety for those that ride in the front AND rear seats (often children and elderly adults) IIHS longest-running crashtest protocol was recently updated.

The update includes belt position, captured using XSENSOR's High-Speed Impact system.

Learn more about the release of this new safety protocol

The Insurance Institute for Highway Safety (IIHS), an independent, non-profit American scientific and educational organization dedicated to reducing deaths, injuries, and property damage from motor vehicle crashes, recently updated its longest-running crash test protocol, the Moderate Overlap Frontal Crashworthiness Evaluation, to address a growing gap in the protection provided for front and rear occupants of motor vehicles.

XSENSOR Technology's High-Speed (HS) Impact system is now part of this protocol update to record dynamic belt position changes on anthropomorphic test devices (ATDs) during crash simulations. Safety engineers and vehicle designers can use the HS Impact system to evaluate the movement of a seatbelt during an impact test scenario.

During vehicle crash tests, the HS Impact system provides users with hardware and software to visualize impact pressures from seatbelts, airbag deployments, and other vehicle surfaces.

With thousands of sensing points capturing pressure distribution, designers and engineers can isolate issues, implement effective changes, and improve designs as their injury prediction simulations are enhanced.

SECTION

03

Intelligent Sensing Technology

The case for incorporating high-resolution sensors in Crash Testing

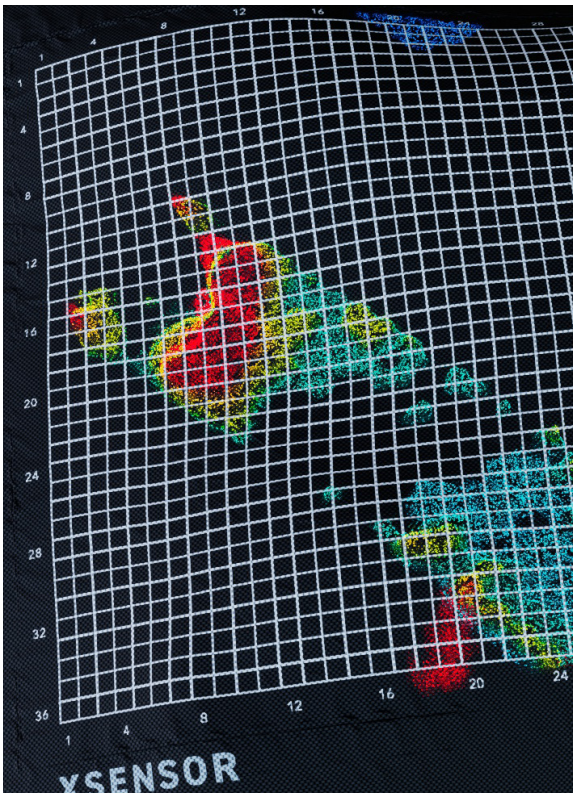
Adding a new level of information and insight to Impact Testing

XSENSOR Technology in the Testing Scenario

The Benefits XSENSOR Intelligent Dynamic Sensing Technology brings to Crash Testing

Adding a new level of information and insight to Impact Testing

Intelligent Sensing Technology offers a huge array of benefits. From leveraging thousands of data points, high-speed capture and a range of analysis and detailed imaging options, sensors like those championed by XSENSOR add tremendous capacity for Impact data and insights.



XSENSOR's proven high speed sensors, adopted globally in the crash testing space, have shown to correlate well with traditional data-capturing devices already in use. In-line with the opportunity to significantly improve on test coverage and accuracy, the technology allows for visualizing pressure distributions, on the passenger, the seat, the airbag, and safety restraints in an impact scenario. Providing additional insights that add clarity to the picture being assessed and helping isolate where problems may occur.

We provide a validated impact sensing system with a range of benefits, including:

- Thin, conformable sensors that allow for fast, easy set-up
- A data acquisition system that runs at up to 9,000 Hz
- A scan rate of more than 8 million sensels per second, with a 16-bit resolution
- Small electronics, easy enough to be installed in-car or onto the sled
- A complete system that can get up to (even in excess of!) 65,000 sensing points
- Hardware Field tested ssuccessfully at up to 50 g's with Tier 1 automotive manufacturers
- Sensors that maintain calibration over extended periods of time and test cycles

Additionally, the data visualizing and analyzing software that our sensors come equipped with, provides pre-recording triggers which can be set up to engage with the other devices included in the sled. You are able to set recording speeds and time frames that match your testing needs. The software gathers information for multiple sensing points, providing a very high spatial resolution image of any of the points of contact.

Lastly, captured data can be viewed in either a 2D or 3D array, with detailed pressure-over-time graphs that will convey a very clear representation of the impulse, where high pressure areas of contact occur and what is happening within them.

So what is additionally discerned in a test scenario when using XSENSOR technology?

XSENSOR Technology in the Testing Scenario

How Intelligent Dynamic Sensing complements existing crash test software systems and captured data.

In a whiplash test scenario, for instance, an ATD is placed on a car seat equipped with its own sensor. Upon impact, with the sensor running fast enough and the response rate of that sensor picking up impact, we can see with clarity where pressure is distributed on the surface, measurements which in turn are recorded and downloaded to the software for processing.

Once in the system, the data takes the form of a high-resolution image, behind which are individual cells providing pressure measurements on each of the points. The sensor used in this particular test scenario has more than 2,800 sensing points from which the image is modelled.

Now, one of the questions we frequently get at XSENSOR is how well our data matches up with information measured by existing sensors on the ATD or other test devices. The question always relates to force — more precisely, the forces showing from our sensors in comparison with the force indicators from the dummy and other test devices.

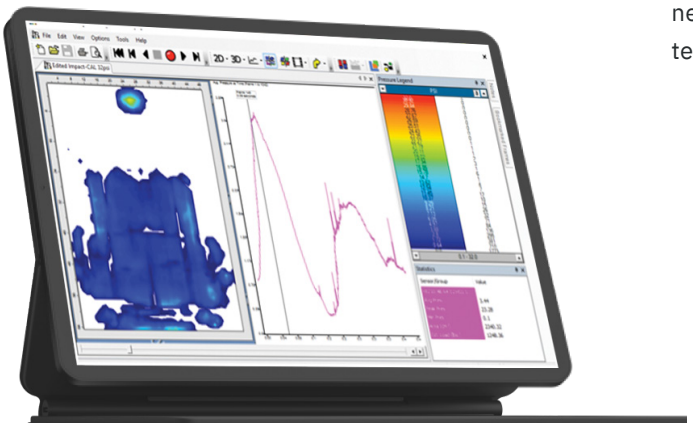
Encouragingly, we've seen that data captured by our sensors correlates closesly with that captured from existing sensor systems. This has shown to be particularly true for head restraint, pelvic acceleration and other similar data, proving the wide-ranging situations and related challenges XSENSOR's Intelligent Sensing Technology can help, respectively, see clearly and overcome. Our sensor technology can help assess with more data:

- Low- to high-severity impacts
- What happens on the front and the back of a seat
- Data changes in response to varying seat belt placement
- Interactions between different safety systems i.e. between airbags and seatbelts
- What happens when the dummy comes into contact with non-safety systems i.e. the trim or other areas of the dashboard

This last scenario is an especially good example of the potential our sensor technology offers. The sensors will allow for detailed imaging of the head form upon impact, providing visualizations of important injury-prone areas like the forehead, eye socket, nose, lips, and chin.

By migrating the data from the software into a CAD model, we can then better understand why certain tests are failing, if there are changes that could be made to parts of the trim to minimize potential injury, as well as alterations to be made in order to meet specifications, ultimately makes strides towards greater vehicle occupant safety.

There are legitimate questions regarding the possibility of our sensors having a negative impact on accelerometer data in the test environment. To address these concerns and with the intent on being open to improve on our sensor design, we've conducted tests excluding the sensors and comparing the data. What we see is consistent accelerometer data in all test scenarios, disproving a negative impact of pressure imaging when added to impact testing.



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The Benefits XSENSOR Intelligent Dynamic Sensing Technology brings to Crash Testing

The Benefits XSENSOR Intelligent Dynamic Sensing Technology brings to Crash Testing

Our High-Speed (HS) Impact System:

- Is a commercially available system, already in use today in 20+ facilities worldwide
- Works in more than 35 different types of testing scenarios, including whiplash, medium- to high-severity situations, seat belt and airbag testing, and many more
- Is a productive addition to testing in any safety system permutations, from individual to combined (i.e. seat belts and airbags together)
- Has been validated with other devices, such as accelerometers and load cells

We are confident when we claim that XSENSOR technology used in conjunction with existing devices helps significantly enhance safety design, minimizing vehicle occupant injury and saving lives.

XSENSOR Intelligent Sensing Technology provides the ability to clearly see what happens on any tested surface at impact, and is ultimately a long-term investment in greater safety, appeal to buyers and market share.

Book a demo with us today at xsensor.com