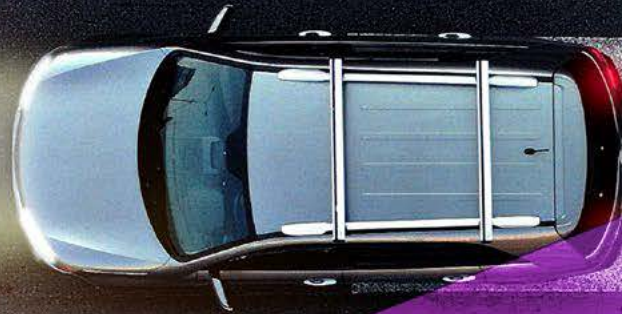




Eliminate Prototypes from Vehicle Testing.

Get certification right the first time with
only one regulatory physical release test
before market launch.



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Introduction.

Emerging technologies in future mobility are continuously triggering ever-fresh waves of regulations pertaining to active and passive safety. Automakers and suppliers must comply with these regulations to ensure overall safety through verification and validation across various environments and scenarios. Additionally, the success of new business models hinges on the ability of OEMs to **deliver on their Vision ZERO commitments promptly and convincingly.**

However, to do so, we need to relieve crash and safety engineers from some of the most difficult obstacles associated with the growing complexity of vehicle variants and systems: They need to be able to **efficiently test all of the widely expanding diversity of use cases.** Physical testing is not a favorable option due to its limitations when it comes to **making design changes in the early development stages,** which often leads to time-consuming modifications and delays in finalizing product design and launch.

This is why **virtual testing of vehicle performance has become crucial** for some of the world's most renowned automotive brands. Through **fully digital** means, they achieve **vehicle certification for crash, safety, and strength for the first time** without endangering humans or our planet.

This e-book offers valuable insights into the essential software capabilities required for reliable performance testing and provides guidance on setting up a digital crash and safety laboratory with the Keysight VPS simulation software.

According to McKinsey, amongst other top levers to improve battery-electric-vehicle profitability and reduce structural cost,

Virtual Prototyping can increase R&D efficiency
by 15-20%

Source: <https://www.mckinsey.de/industries/automotive-and-assembly/our-insights/improving-battery-electric-vehicle-profitability-through-reduced-structural-costs> as of July 13, 2023

Imagine the convenience of a full-time digital test facility.

At Keysight, we envision a future where a digital test track emerges as a viable alternative to extensive physical crash and safety testing for regulatory certification.

Take a moment and think about what the response of your existing engineering approach is to your daily work challenges:



When being tasked to test a greater range of crash scenarios, can you do this in the same timescale?



Is it possible to automatically assess the quality of simulation models before solving them?



In the early stages of development, do you have all the confidence you need in the safe crash performance of batteries and novel lightweight materials?



For safety certification, do you need to rely on scarce, expensive, and time-consuming test track studies with physical prototypes more than once?

If only one box is checked with no, it's really time to shift to a controlled VIRTUAL environment for evaluating vehicle performance, safety, and strength in real-world driving conditions!

Here are a few reasons why automakers should consider eliminating physical prototype builds from the test and certification of vehicle safety:

Reduced labor costs & freeing specialist resources	Faster simulation process with higher run-rate	Higher quality, lower recalls & warranty costs
Enhanced driving experience with optimized vehicle dynamics	Optimized use of materials & manufacturing processes to reduce cost	Higher result accuracy and predictability
Expedite certification processes	Data-driven, early decision making e.g. on new materials	Decreasing carbon emissions with minimal physical prototype builds
Overall increasing vehicle safety to meet, zero fatalities' goals	Better solve growing complexity	Pass safety certification right the first time

EV START UPS

SHOULD DEMOCRATIZE
VIRTUAL PROTOTYPING
FOR CRASH & SAFETY
ENGINEERING



TRIUMPH OVER SIGNIFICANT HURDLES...



Inability to meet production targets

...due to a highly unpredictable pioneering environment, and supply chain shortages.



Unhappy or unengaged staff

...due to a highly unpredictable pioneering environment, and supply chain shortages.



Competition with established OEMs

...due to their superior financial resources, manufacturing and R&D capabilities as well as existing trust & brand recognition, regulatory expertise, and distribution networks.



Financial targets are hard to achieve

...due to rising raw material prices, growing component costs, a tough Tesla-led price war, and a highly unpredictable pioneering environment.

...THROUGH A FULLY DIGITAL WORKFLOW.

Enhance productivity with a leaner team.

Virtual prototyping brings plenty of efficiencies by minimizing the requirement for physical prototype construction. Additionally, our shared model single core approach cuts down on model building efforts, resulting in a significant reduction of non-value-added work.

Reduce spiraling costs. Foster design experimentation.

Advanced model order reduction, intelligent machine learning technology, and unified core modeling bring rapid and precise digital test results.

Boosting innovation potential.

Concurrent engineering across multiple engineering domains together with a single core model approach facilitate fast, precise, and iterative design studies. Supplemented with machine learning technology, engineers can assess design alternatives in real-time.

ESTABLISHED AUTOMAKERS

SHOULD DEMOCRATIZE
VIRTUAL PROTOTYPING
FOR EV CRASH & SAFETY
ENGINEERING



OVERCOMING MAJOR CHALLENGES...



Occupant safety is a critical design factor

...due to the unique safety challenges posed by new powertrain technology.



Profit margins constantly under pressure

...due to high EV component costs leading to customer concerns regarding the expensive prices of electric vehicles.



Reduce vehicle weight

...with suitable lightweight and recyclable materials due to the need to satisfy sustainable mobility demands and address EV range concerns.



Navigating uncertainties in battery innovation

...due to unknown factors in terms of performance, capabilities, and potential drawbacks alongside yet to be explored safety risks when pushing range limits.

...THROUGH HOLISTIC **VIRTUAL ENGINEERING.**

Reduce development cost.

Accessible virtual prototypes equipped with advanced machine learning, model order-reduction, and multi-domain analysis replace physical tests and facilitate greater experimentation and design studies.

Innovate safety-compliant powertrain technologies.

Industry-compliant assessment of occupant safety when incorporating electric powertrains and batteries, covering simulation of battery crash, crush, and shock as well as analysis of water ingress, moisture exposure, and safety of high-priority areas like the vehicle's rear.

Effective material exploration for optimal weight-strength.

Fast, accurate solvers validate the structural integrity of multi-material parts and effectively analyze scenarios like water crossing and intrusion by assessing the interaction between structures and fluids. Fast design iterations and modular material simulation models optimize material selection for vehicle use in terms of strength, sustainability, and suitability.

Balance performance, range, and thermal safety.

Digital battery analysis and a multi-scale modeling approach facilitate a wide range of assessments including vibration, swelling, short circuit, and fire safety.



Virtual Prototyping is our gateway to meet SEAT's high-quality indices quickly and profitably.

Xavier Castillo

SEAT

[Read Full Story](#)





Harness the power of your very own digital test facility.

Going fully digital in vehicle crash & safety testing:

1

Airbag development Virtual performance simulation enables highly precise and fast prediction of airbag deployment, incorporating non-uniform and uniform pressure simulation, along with viscous flow capabilities, to accurately simulate even complex side curtain airbags.

2

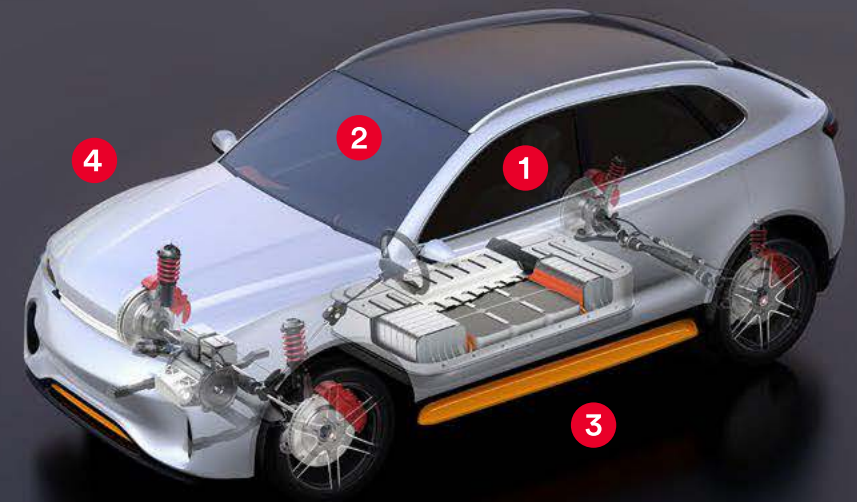
Crash testing Virtual performance simulation enables the examination of various crash scenarios, such as frontal impact, side pole impact, and far side impact. This is achieved by evaluating structural deformation and its impact on occupants and pedestrians. The capacity to extensively test a wider range of human occupant dummies utilizing intricately detailed human body models, including organs, skin, and muscles, surpasses that of physical testing. This leads to more precise simulation results in comparison to physical crash tests.

3

Battery safety Virtual performance simulation encompasses regulatory crush analysis, assessing cell short-circuits, and evaluating battery performance in terms of stiffness, shock, and swelling. This simulation even extends to full car crash scenarios, employing multi-scale and upscaling technology.

4

Strength and dynamics Virtual performance simulation is crucial for enhancing the robustness and reliability of new car designs while minimizing costs. It enables a vast number of virtual in-operation try-outs in diverse areas like stiffness, pothole impact, door & hood over-opening or fluttering, and waterflow, ensuring the safe validation of drivability under both anticipated and unforeseen circumstances.



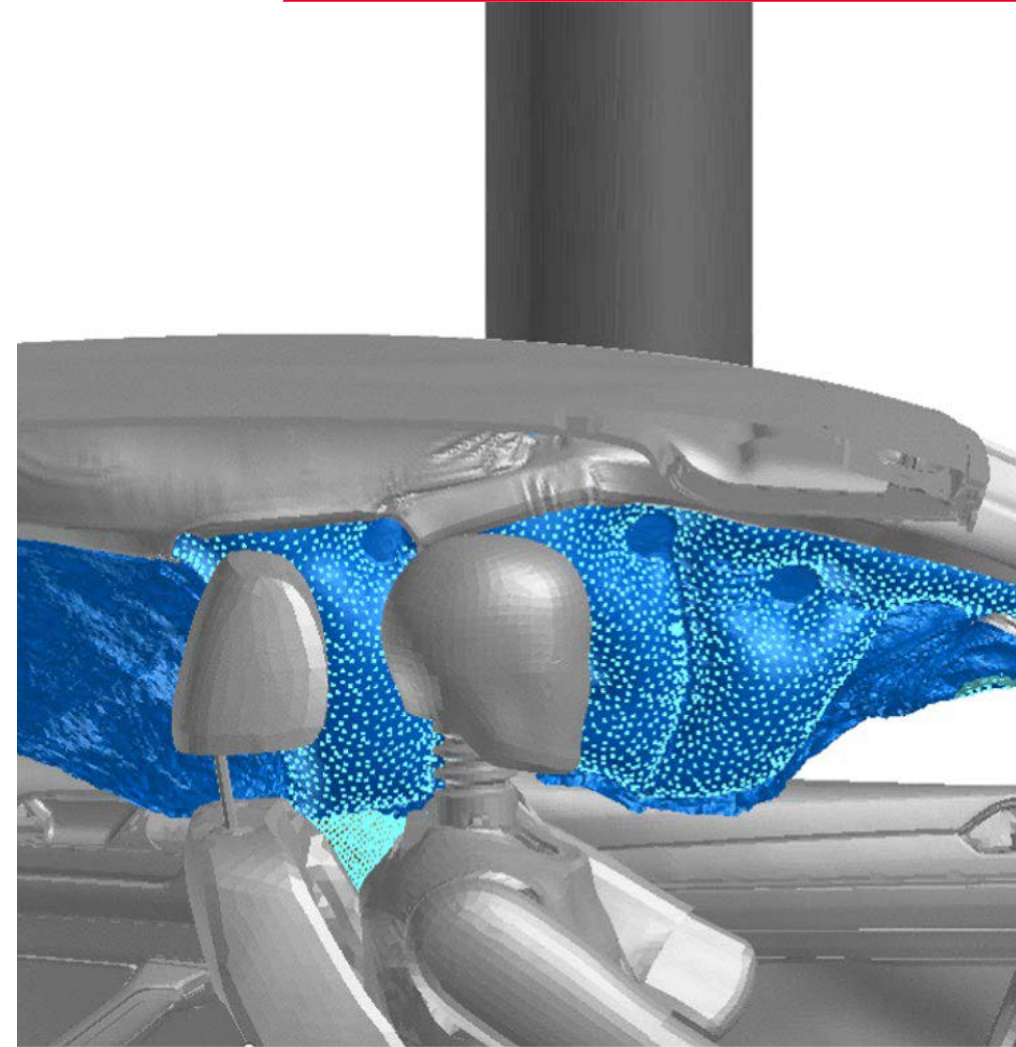


Unleash Unmatched Precision and Efficiency in Airbag Development.

Airbag development poses significant challenges in the field of vehicle safety engineering due to the intricate and non-linear nature of airbag folding and deployment across a wide range of crash scenarios. These challenges are further compounded by the ever-evolving and increasingly stringent safety certification requirements.

A robust and efficient simulation platform is one that allows for end-to-end airbag development, covering both folding and deployment aspects with a focus on accuracy, speed, and safety:

- **Streamlined and accurate simulation process** combining precise folding assessment and highly predictive deployment simulation in one complete solution, eliminating the need for separate analyses.
- **Accurate assessment of fluid/structure interaction**, enabling a thorough understanding of the relationship between airbag material, gas, and the impact during deployment.
- **High-fidelity and efficient results** through combined non-uniform and uniform pressure simulation, accurately predicting airbag deployment, even with out-of-position occupants.
- **Accurate dynamics simulation of airbag deployment**, including complex scenarios like side and side curtain airbags, through comprehensive capabilities and viscous flow.

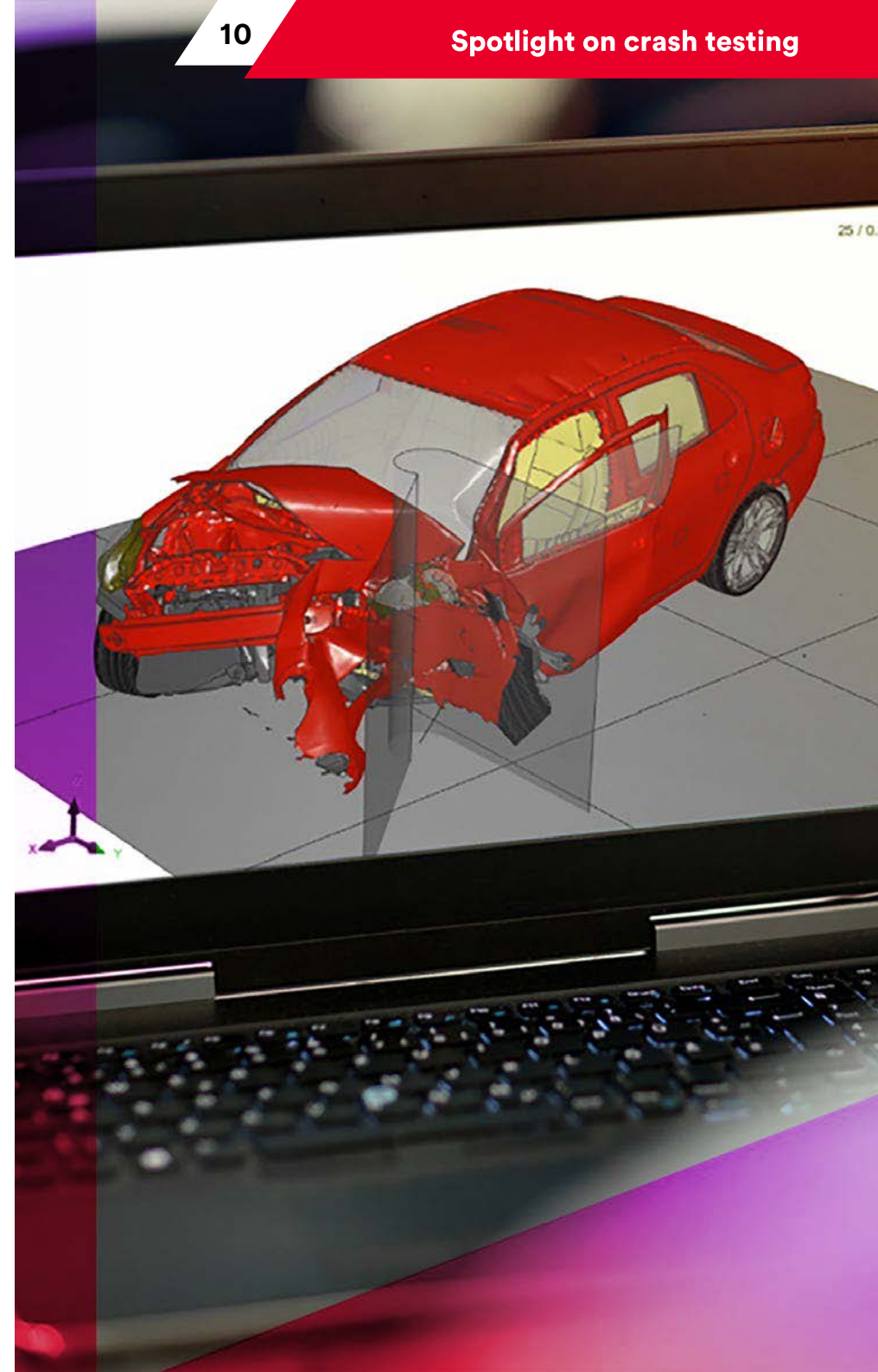


Elevate Crash Testing to New Heights With Unparalleled Speed & Precision.

Virtual crash simulation is becoming more prevalent in replacing physical crash testing for regulatory certification because of its enhanced accuracy, lifelike human body models, and the capability to digitally predict intricate scenarios. This shift reduces the need for hardware prototypes and testing in product development, fostering financial sustainability and minimizing carbon emissions in new business models.

Let's give crash engineers round-the-clock access to the complete virtual vehicle and their dedicated digital crash laboratory:

- **Virtually predict spot weld strength** the first time with unique rupture models for lightweight metals and multi-materials in a crash scenario.
- **Superior, customizable automation of key tasks** like the smooth integration of dummy model placement and positioning into customer workflows.
- **Co-simulation** with system simulation software to assess the influence of active safety systems on crash results by exploring multi-disciplinary system variations and the relation between active and passive safety systems.



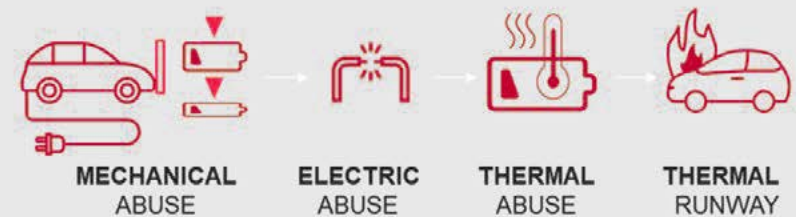
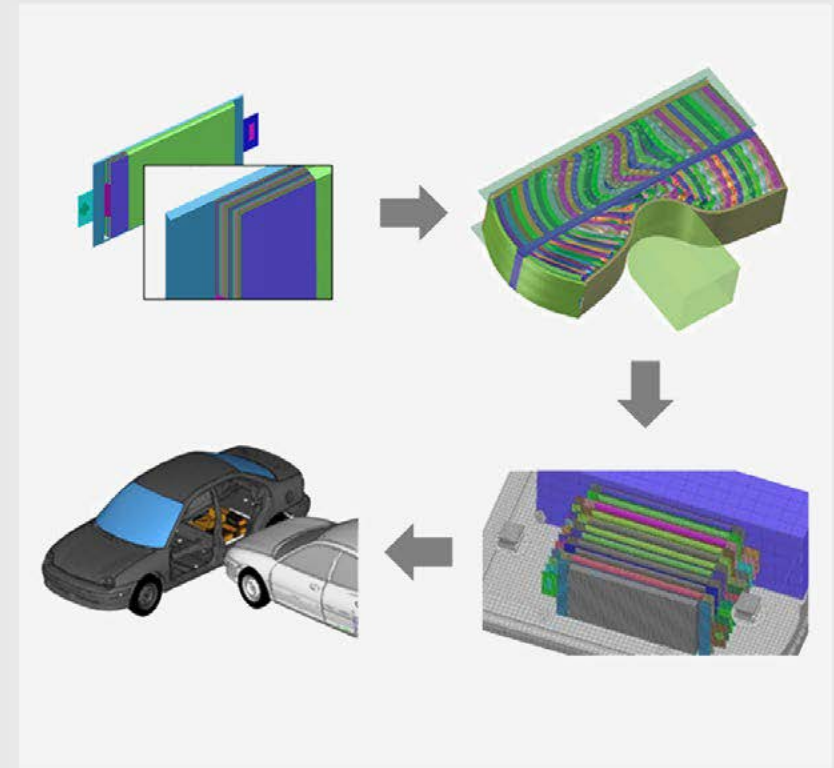


Ensure First-Time Battery Certification and Peak Performance for EVs.

As electric vehicles emerge in the market, battery safety has become a crucial certification requirement. Suppliers and OEMs must demonstrate compliance with ever-changing safety standards and ensure strong performance in terms of range. Yet, predicting and achieving these outcomes during the early stages of development, within tighter deadlines and the demand for environmentally friendly processes, significantly amplifies the complexity of this task.

Battery manufacturers and OEMs use virtual performance simulation to achieve regulatory certification, enhance battery safety, and reduce costs through comprehensive assessment, covering microscale cell analysis to macro-scale full car crash scenarios:

- **Comprehensive battery safety assessment** based on regulatory crush analysis, cell short-circuit assessment, stiffness, shock, and swelling simulation.
- **Full car simulations of complete crash scenarios** using multi-scale and upscaling technology.
- **Single-source battery model** allowing for the parallel assessment of multiple physical domains.
- Accurately assesses battery safety at micro and macro scales, including **cell short-circuit prediction and fire risk analysis** in full vehicle crash scenarios.

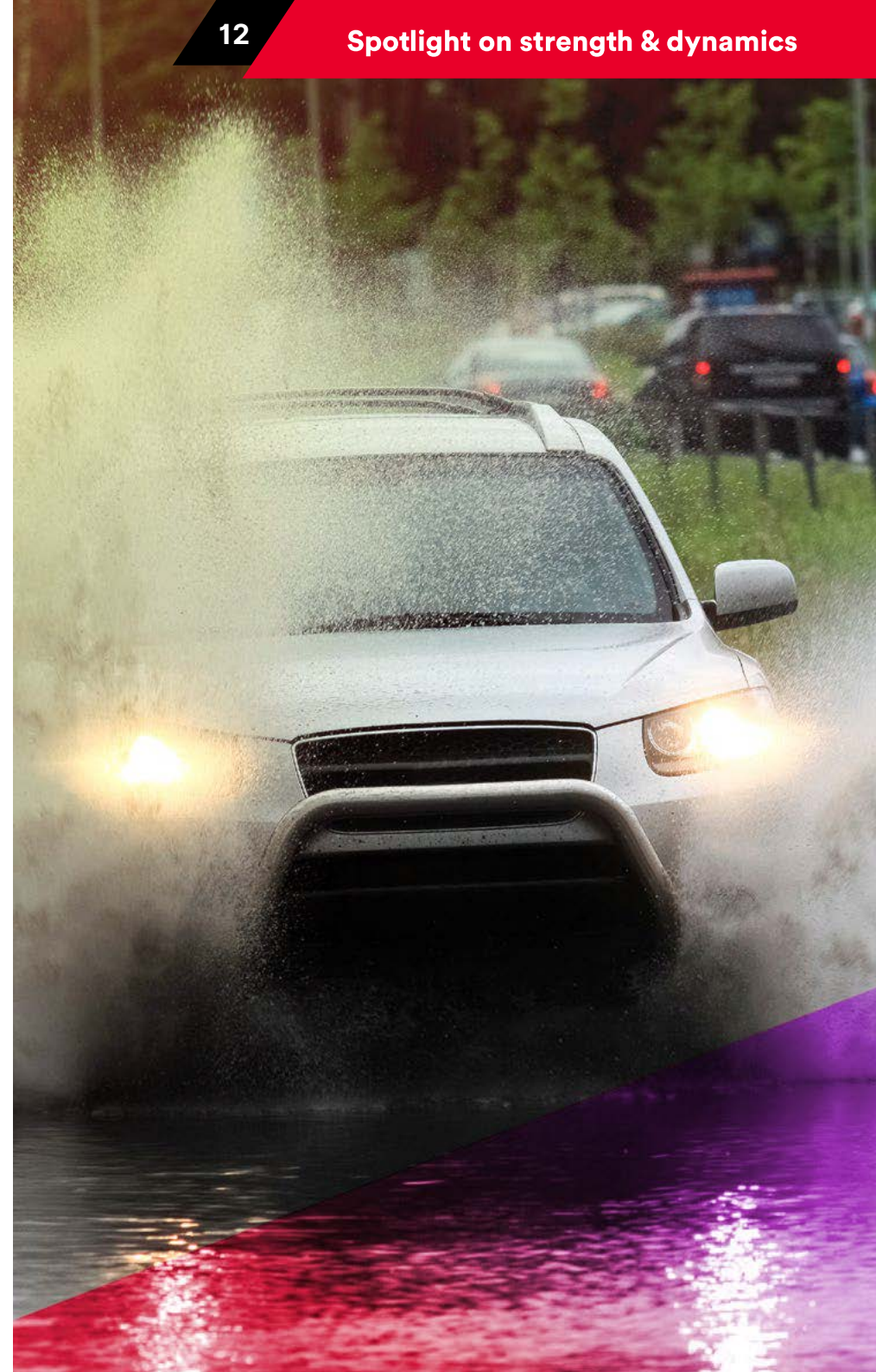


Discover Limitless Testing Capabilities for Vehicle Strength and Dynamics.

As lightweighting and new materials usage rise, assessing misuse damage, car strength, and reliability becomes crucial while maintaining cost effectiveness. Virtual in-operation try-outs enable unlimited simulated tests, identifying flaws early, saving time and resources, and achieving the optimal design quickly.

The following capabilities are essential for automotive engineers to enhance perceived quality, increase customer satisfaction, and prevent recalls:

- Assess a vehicle's stiffness overall to prevent excessive weight, inadequate vibration absorption, or compromised strength, and to achieve peak performance.
- Simulate torsional stresses on a vehicle's structure, or body-in-white (BIW) during realistic driving scenarios.
- Analyze the impact of road potholes on a vehicle, considering factors like tire physics and road speeds and eliminate the costly physical replication of this test.
- Identify potential damage from forcefully over-opening doors and hoods, along with assessing the vehicle hood's stiffness against aerodynamic loads.
- Evaluate water crossing, external water intrusion, and liquid sloshing in tanks, providing comprehensive predictive evaluations for vehicle structure deformation, barrier effectiveness, and tank integrity.

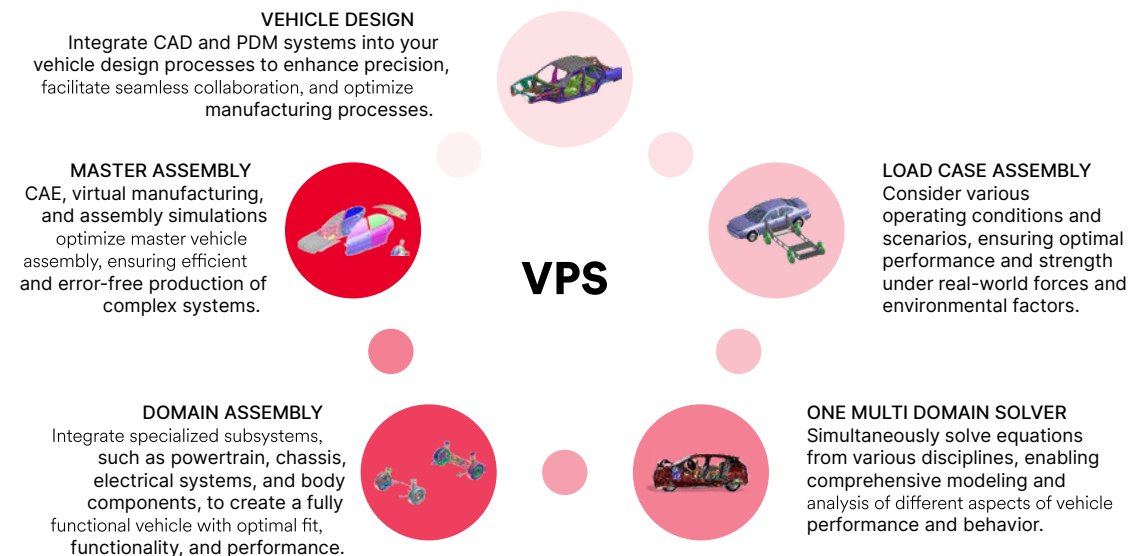




Pushing the Limits of Mobility Safety: Keysight VPS by the Pioneers in Automotive Crash Simulation.

At Keysight, we envision a future where a digital test track offers an alternative to extensive physical safety and crash testing. In the field of mobility safety engineering, automakers all over the world use our Virtual Performance Solution (Keysight VPS) to digitally pre-certify the safe performance of new vehicles upfront in the development cycle. Core software strengths are:

HARNESS THE SINGLE CORE MODEL Collaborate in an end-to-end fashion and make intelligent decisions with simple, precise visualizations to share between different teams.



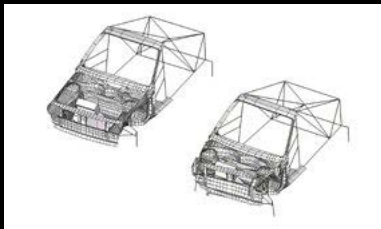
- **Fast solver** facilitates more simulation runs in the available time and delivers reliable simulation results quick and early.
- **Single core model** for concurrent engineering.
- **Built-in library of modular material models and physical properties** provides highly accurate performance predictions ensuring early confidence in compliance with safety standards.
- **Combining Finite Point Method (FPM) technology with the Keysight VPS structural dynamics solver** for a more precise prediction of liquid or gas flow effects on the vehicle structure.
- **Workflow automation & model quality check via Visual Environment** for greater efficiency in the simulation process and higher reliability of simulation results.
- **Multi-scale modeling** combines detailed micro-level assessment with a coarser macro-level model, achieving a balance between accuracy and time/cost efficiency.



Connecting Keysight's Legacy in Digital Crash Testing...

1985

Keysight conducts the first ever car crash simulation at a time, no one thought this was possible at all. This was the birth of the crash test software PAM-CRASH.



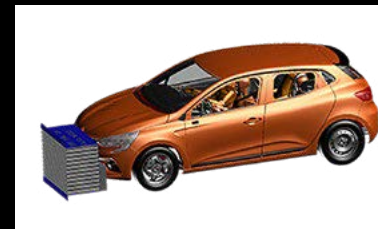
2010

The first 3D car crash simulation of the AUDI A8 with PAM-CRASH successor Keysight VPS for structural crash behavior testing under operating conditions throughout all phases of vehicle development.



2019

Renault achieves 5-star rating from the Euro NCAP and releases their new Clio on the market with only one regulatory physical crash test.



2021

SEAT S.A. Technical Center and Keysight Group set new car development standards towards 100% digital with the brand-new CUPRA Formentor.





With the Future of Smart Mobility Safety Testing.

The development of a product involves considering numerous variables that form the product's design space. Exploring and assessing all possible combinations of variables is impractical and costly with conventional methods, such as Design of Experiments (DoE) and traditional CAE optimization. These methods have limitations in scope, time consumption, and cost, requiring specialized skills.

Here at Keysight, we have been developing options to equip our vehicle models with cutting-edge model order reduction functionality, powered by smart machine learning technology to create a parametric model of the design space with fewer and more affordable simulation runs. We work towards **empowering both skilled and non-skilled engineers to swiftly grasp the variables' effects and pinpoint significant combinations that yield desired results, allowing them to prioritize load cases and design parameters for in-depth examination.**

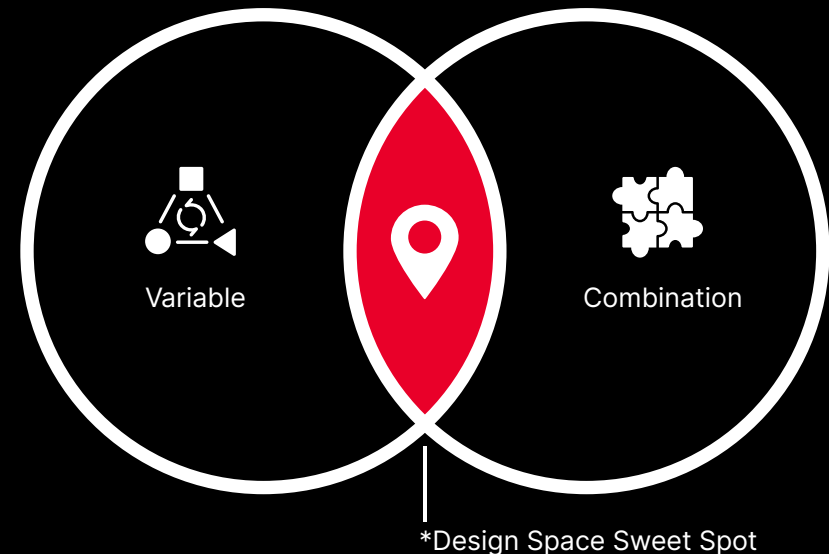
Fast parametric design space exploration could then be used for:

- Virtual crash test results, optimizing vehicle safety, weight, and cost in a limited timeframe
- Low-speed RCAR insurance assessment, optimizing crash reparability and safety ratings

There is a multitude of exciting applications awaiting, and we warmly invite you to join us on this incredible journey together!

The Future of Mobility Safety Testing...

...is 100% digital smart and artificially intelligent, driving engineers with speed, precision, and confidence to design space sweet spots. **Now, imagine the Power of Carrying out 1,000 Tests or More.**





Thanks to Keysight and their Virtual Performance Solution (Keysight VPS), we succeeded in developing one of our new vehicles, achieving good physical tests right the first time, allowing us to earn the whole five stars on the Euro NCAP safety test.

Olivier Colmard

Vice-President of Numerical Simulation and PLM, Renault



It's not about us being right – it's about our customers getting it right.

Compared to other simulation software on the market, Keysight VPS is seen as a more robust crash and safety simulation tool offering the most industrially ready crash simulation on the market – and it is developed by the pioneers of the first ever digital crash test back in 1985.

01

A Leading Battery Supplier Went From Zero to Won in Eight Months

In just 8 months, the battery supplier went from limited Virtual Prototyping capability to winning the bids from a German OEM. The head of the whole program conducting the bidding process went out of his way to tell us that the mechanical simulation was an instrumental part in helping to get the design approved.

02

Honda Motor Reduces Trial and Development Time

Additionally, and most importantly, they are now able to accurately investigate the three important factors with respect to water impact simulation: motion, deformation and fluid flow. Using Keysight VPS they plan to continue their research a variety of road conditions and environments.

03

Toyoda Gosei Europe Cuts Lead Times in Half Using Virtual Prototyping

By using Keysight Virtual Performance Solution's airbag module for airbag folding and sewing, the accuracy and lead time for developing complex Knee Airbag (KnAB) have improved drastically and allowed Toyoda Gosei Europe to improve their simulation-driven development process significantly.



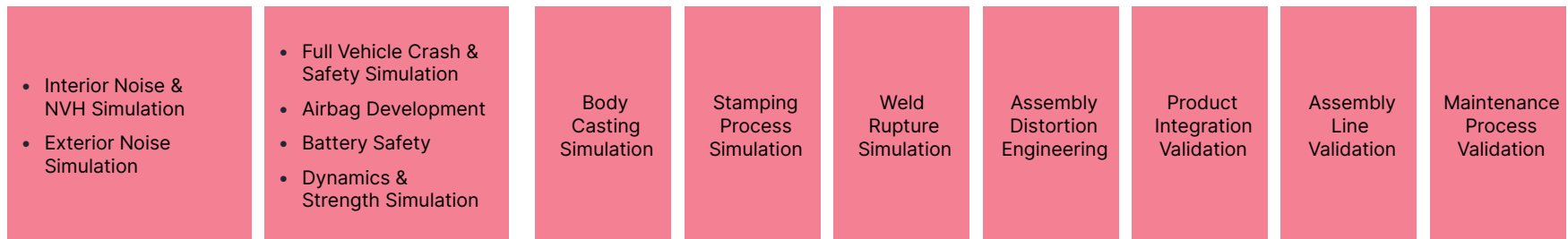
Get expert solutions across your critical priorities!

Our predictive, real-time, immersive physics-powered simulation solutions, combined with our extensive talent and intellectual property, help you solve complex simulation tasks at scale and save valuable time, resources, and money by avoiding costly and limited physical testing. Here's an overview about our simulation software that empower you to accelerate the development of clean, safe, productive EVs:

The power of our **proven simulation software..**



...enables you to effectively perform **key engineering tasks...**



...and facilitate end-to-end digital workflows when being combined into **virtual prototyping solutions.**



How ESI accompanies your digitalization journey.

Customer Training

- With close to 50 years of expertise in software application training, our training courses are taught by highly skilled engineers responsible for consulting and support activities and with years of practice and field experience.

Software Release Updates

- We release regular software updates to enhance the user experience, provide new features, address issues, and improve performance, security, and stability, reflecting our commitment to continuous improvement and customer satisfaction.

Access to Experts

- Customers have access to Keysight's experts in predictive numerical simulation and material science to receive personalized guidance, expert advice, and timely support, empowering them to make informed decisions, overcome challenges, and maximize the value they derive from our product or service.

Technical Concepts

- Joint service project as proof of concept.
- Collaborative workshops to outline a solution, create simulation models and configure the software.

Research & Innovation

- Automakers and research institutes regularly invite us to participate in industry research & innovation projects that address current challenges and future trends in vehicle engineering. By sharing this knowledge with our customers, we make sure they stay ahead of the curve, make strategic decisions, and drive innovation within their organization.



Guides & Toolkits



Expert Inquiry



Webinars & Online Events



Case Studies & Best Practices



Peer Connection



Live Conferences



User Training



Software Release Updates



Concepts & Benchmarks

Keysight. Innovation Without Compromise.

Over the last five decades, we have been pushing the limits of what's possible.

- We are **pioneers of a virtual-first approach** to solve the most complex and critical problems with simulation.
- Our **legacy of innovation** dates back to our first predictive simulated automotive crash test in 1985.
- We continue to **lead the way** with product assembly reviews in **the industrial metaverse**.

We believe that the diversity of people, perspectives, and experiences is our superpower.

When our **international teams** come together, we unleash our **creative potential** to protect what matters most – our people and our planet.

A passion for protecting our future.

We believe in **sustainable product innovation**, efficient **manufacturing** processes, and simulation-proven physical testing, to help create products that are clean throughout their lifetime with a smaller environmental footprint.

Unlocking true potential with human creativity.

Our **technology and expertise** are focused on helping companies work smarter, reducing costs, improving quality and productivity, accelerating time to market, and improving product lifetime and industrial performance.

Trusted to create a safer world.

We are **trusted** to create a safer world, and our work is critical to some of the **biggest brands on the planet** to ensure drivers, passengers, pedestrians, and workers' daily lives are ever safer.



With vision comes opportunity.

Our clients rely on us to assist them in building a safer, cleaner, and more productive world. We take that trust seriously, and it drives us to be the best we can be. By staying ahead of the curve, embracing innovation and sustainability without compromise. We are Keysight and together, we can shape the future of industry, and the world, for the better.

Engage with us!



Keysight enables innovators to push the boundaries of engineering by quickly solving design, emulation, and test challenges to create the best product experiences. Start your innovation journey at www.keysight.com.

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