



Pioneering Heavy Machinery Innovation through Virtual Prototyping.

Introducing the Keysight Solutions that Power
the Design and Manufacture of Clean, Safe,
and Productive Heavy Machinery.



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Reduce vehicle development time by

1.5 Years

by using a virtual proving ground to
accelerate engineering iterations.

Introduction.

Amidst the unfolding transformation in heavy machinery and off-highway vehicles, a new era beckons—one electrified and charged with challenges. As industry pioneers, you stand at the crossroads of innovation and efficiency, charting a course that redefines the status quo. This journey mirrors the evolution witnessed in the automotive sector, urging us to uncover valuable insights about profitability and the indispensable role of Virtual Prototyping in achieving unrivaled R&D excellence.

As your horizons expand with electric variants, intricate engineering challenges arise. Seamlessly integrating next-gen technologies while meeting customer expectations for uptime and productivity adds layers of complexity.

If you want to **efficiently manage this complexity, boost agility, and push innovation without sacrificing safety and quality, turn to Virtual Prototyping.** This approach unites engineers across domains and distances on a single platform, allowing them to collectively test the future machine's performance in remarkable detail long before it's built.

As you embark on your journey, let Keysight help you understand how to harness the full potential of Virtual Prototyping.

Enjoy the read!

By reading this e-book, you will gain insights into the latest advancements in EV acoustics engineering and discover how Keysight Vibro-Acoustics (VA One) One can revolutionize your approach to testing and development.

Kearney expects that the consequent use of simulation for hardware prototype reduction can save up to

3 months
development time

10%
development costs

Source: <https://www.kearney.com/digital/article/-/insights/automotiveproduct-development-how-to-become-faster-and-cheaper-throughdigitalization> as of May 16, 2023



Make the Difference with Virtual Prototyping!

Pause for a moment and consider how soon in the development process you can instill confidence in all your stakeholders regarding the following questions:



How can we design the system for an “electric” future?



Will the “electrified” version deliver the same capabilities over the full range of probable use - or misuse?



During real service, can we anticipate when and where issues might arise?



Are the proposed materials and method the right ones to sustainably deliver parts?

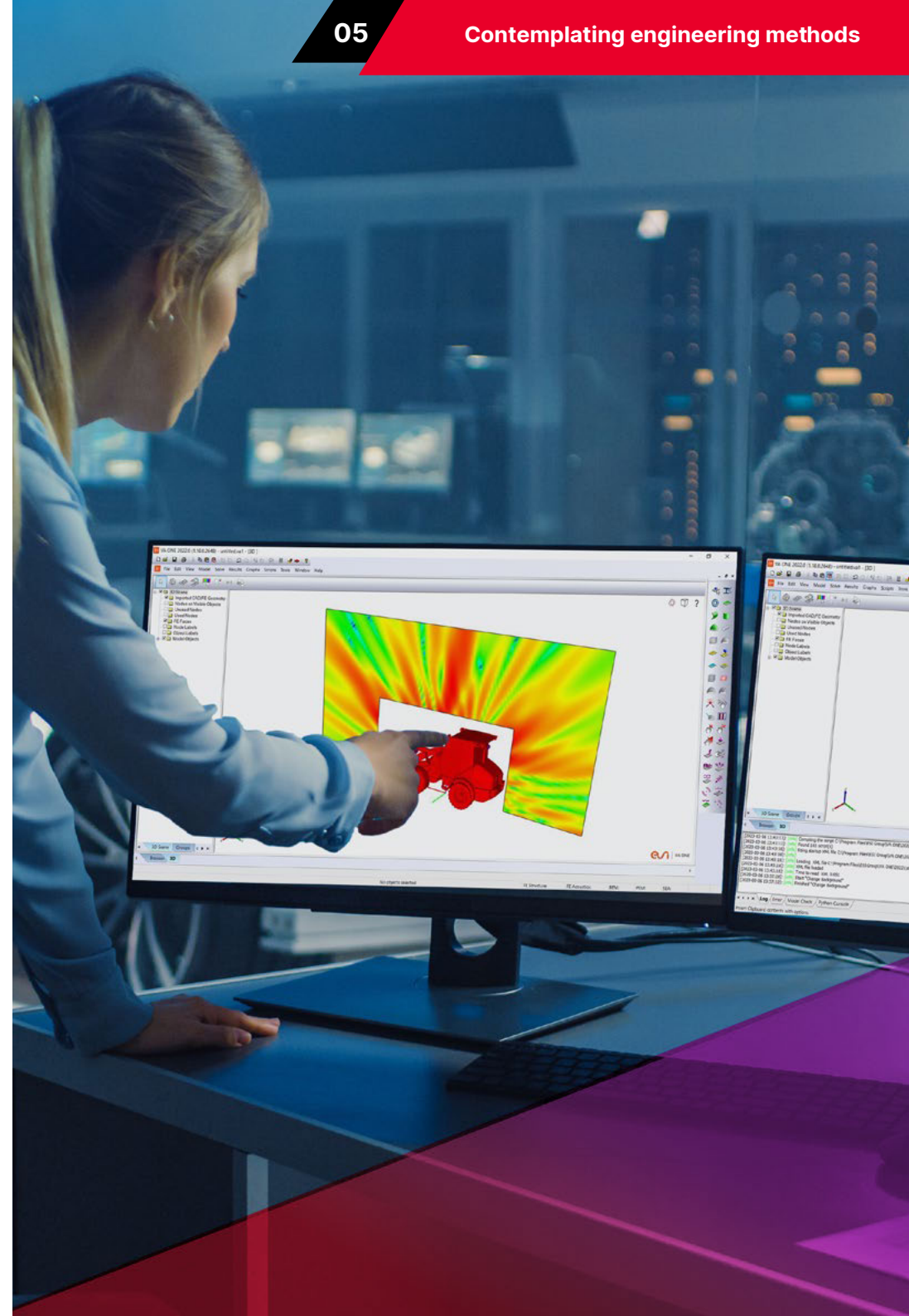


What challenges will the human assemblers face when producing?



Will people be able to safely and sustainably maintain this product?

If there's even one question that cannot be adequately addressed with confidence in the early stages of development, then NOW is the time to transition into a controlled virtual environment.





Keysight's predictive, real-time, immersive physics-powered simulation solutions, combined with extensive talent and intellectual property, help our clients save valuable time, resources, and money by avoiding costly and limited physical testing.





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 of our simulation software that empowers you to accelerate the development of clean, safe, productive machinery and equipment:

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

Keysight VA ONE
VIBRO-ACOUSTICS
SIMULATION
SOFTWARE

Keysight Simulation X
SYSTEM
SIMULATION
SOFTWARE

Keysight Pro CAST
CASTING SIMULATION
SOFTWARE

Keysight SYSWELD
WELDING SIMULATION
SOFTWARE

Keysight's Human Workflow (IC.IDO) Software
ADVANCED VIRTUAL REALITY
SOFTWARE

Keysight VPS VIRTUAL PERFORMANCE SOLUTION

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

- Interior Noise & NVH Simulation
- Exterior Noise Simulation

- Electrification & Energy Management
- Operator Safety & Comfort
- Reliability, Durability, Misuse

Sand Casting Simulation

Seam welding & Distortion Engineering

Product Integration Validation

Assembly Line Validation

Maintenance Process Validation

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

Build a Virtual Proving Ground for Machine Safety and Acoustic Performance

Create a Virtual Manufacturing Process Chain for Concurrent Engineering

Power Collaborative Virtual Workflows in the Industrial Metaverse

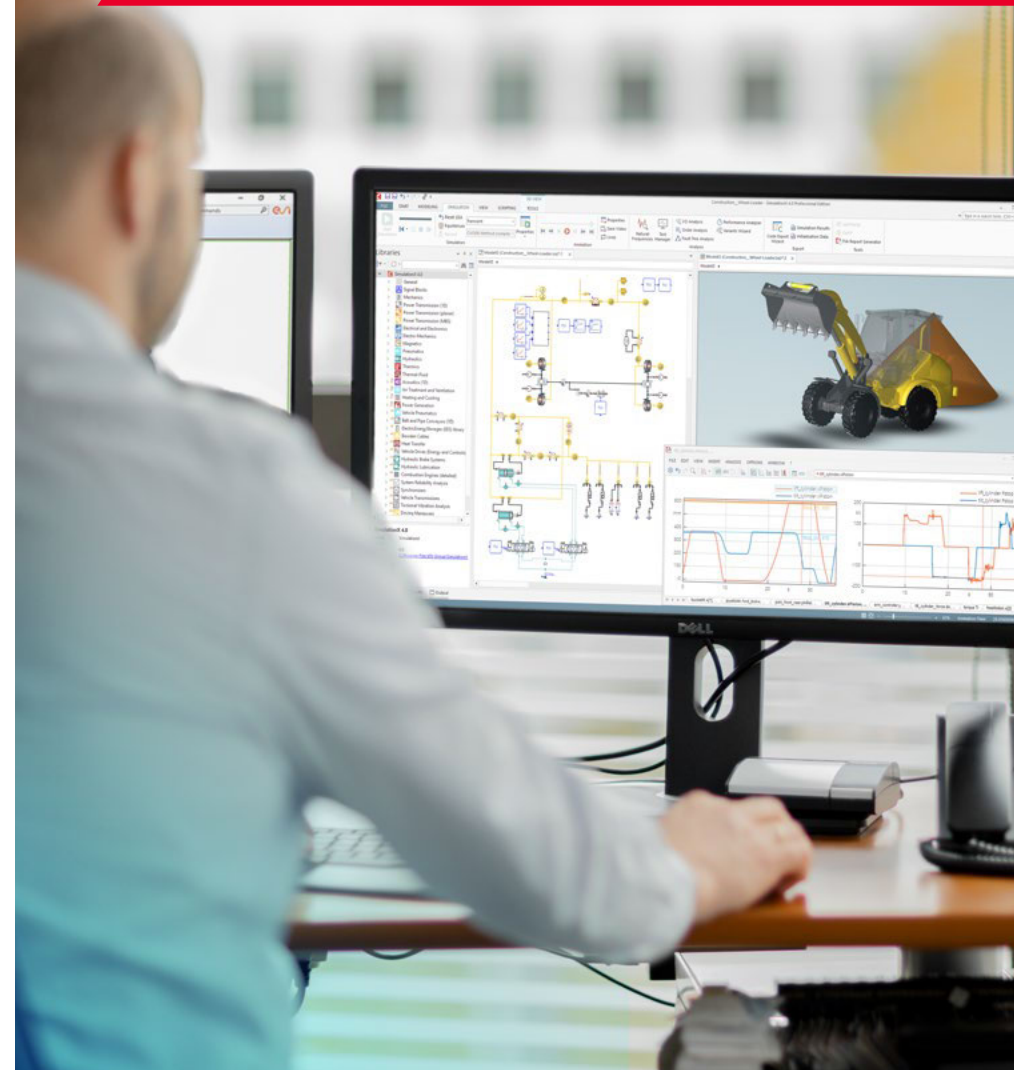


Create a Virtual Proving Ground for Sustainable Testing of Future Machines' Performance.

Earning certifications for new technologies introduced right the first time is one side of the story; ensuring the behavior of the future machine and establishing trust in its next generation prior to market launch and throughout the lifecycle is the other. This is what the virtual proving ground solution is here for.

To digitally assess the performance of the new machine in real-life operation by constructing fully operational digital prototypes and subjecting them to rigorous virtual testing on any virtual terrain. This environmentally friendly approach minimizes testing mileage and reduces lead time and costs associated with processes, tooling, and materials, all while facilitating market launch on time.

Leading enterprises in the heavy-machinery sector employ virtual prototyping software to get a realistic account of how multiple subsystems behave and interact in real-life under varying conditions.



Harness the virtual proving ground solution to get a realistic account of how multiple subsystems behave and interact in real life under varying conditions.



Virtually Test Comfort, Safety, Durability, and Acoustic Performance .

At Keysight, we envision a future where a digital proving ground provides an eco-friendly alternative to extensive physical testing. We achieve this by creating fully operational digital prototypes and subjecting them to rigorous virtual testing on a virtual proving ground, simulating the challenging conditions typically encountered on physical test tracks for new heavy machinery and equipment. The system simulation software Keysight SimulationX and the virtual performance simulation tool Keysight VPS provide insights into mechatronic system performance, energy efficiency, operational durability, and reliability. Supplemented by Keysight's Vibro-Acoustics (VA One), engineers can effectively manage interior and exterior noise.

01 Guarantee Operator Health, Safety, and Comfort

Maximize operator comfort, productivity, health, and safety by virtually optimizing energy efficiency and cabin climate for diverse weather conditions, precisely tracking vibration sources and paths in any terrain, and virtually predicting machine safety in extreme scenarios.

04 Manage Interior Noise, Vibration, and Harshness

Perfectly meet noise regulations and cabin comfort standards for heavy machines by leveraging advanced vibroacoustic simulation, providing operators with an optimized and tranquil experience.

02 Ensure Operational Reliability, Durability, and Misuse

Enhance overall reliability and durability of heavy machines by leveraging a virtual proving ground to simulate test runs on uneven terrains, gaining insights into the impact on component life and strength, particularly for tires and suspensions exposed to rough working conditions.

05 Pre-certify Compliance With Exterior Noise Regulations

Minimize noise pollution and ensure immediate compliance with exterior noise regulations by optimizing noise emissions in heavy machinery design fully virtually.

03 Effectively Design Electrified Machines

Develop high-performance and energy-efficient battery-electric machines through virtually optimizing battery size, thermic control, system layout, and subsystem integration within a comprehensive multidomain simulation model.



Virtual Manufacturing for Defect-Free Components.

Enhance your understanding of material physics through simulation-based testing and **unlimited virtual validations of individual components, subassemblies, and assemblies.** Make confident decisions in **selecting optimal production processes, ensuring manufacturability and dimensional quality** upfront in the development process.

Use the **casting simulation software Keysight ProCAST** to achieve right-weight sand casted parts and reduce material costs while ensuring structural integrity and performance. Mitigate weld distortion in seam welding processes with **the welding simulation software Keysight SYSWELD** to achieve precise weld quality, reduce rework, and ensure dimensional accuracy for flawless welded assemblies.





Deliver defect-free machine components and ensure consistent adherence to tolerances for reliable, high-quality products.

Harness virtual simulation to engineer and validate your in-house casting and welding processes, resulting in high-quality, reliable components and assemblies that adhere to the right dimensional tolerances.

01

Validate Sand Casting Processes Early - And Entirely Virtually

Harness simulation-based design to **proactively address castability issues** during initial development, **ensuring first-time-right production** of structurally integral and reliable sand-casted parts.

02

Effectively Simulate Seam Welding Processes

Harness digital simulation to **mitigate weld distortion and control dimensional tolerances** in seam welding processes, achieving superior welded structures with optimal material traits for exceptional performance throughout their service life and reduced material waste.



Using Keysight ProCAST software for sand casting simulation for a particularly complex part has helped Ironcastings solve metallurgical problems, and save around 0.3€ per kilo of the final net weight of the casting, translating to overall savings of over 400,000 Euros annually.



Step Into the Realm of the Industrial Metaverse.

A seamless digital thread empowers **effective virtual collaboration and informed, early decision-making**. Experience physical interactions with yet-to-be-realized machine designs without waiting for construction or required traveling to a common site. Immerse yourself in exploring new machine concepts from a worker and operator perspective, gaining **hands-on experience** in the processes required to make and maintain them. By doing so, you will **push engineering workflows months ahead of production** and revolutionize the way innovations come to life.

Leading enterprises in the heavy machinery sector leverage immersive virtual prototyping for design and manufacturing engineering. This enables them to capture process information in a timely manner, influencing decisions pertaining to both product design and process planning.



Validate tomorrow's products and processes through human experience... today.

Keysight's Human Workflow (IC.IDO) Software is used to immediately validate product integration strategies as well as assembly line and maintenance processes of yet-to-be-realized products. Evaluate all aspects of operator comfort, safety, and efficiency. Once a scene exists, it will take almost no time to put on your VR glasses to validate procedures and processes with physically realistic handling of collisions between parts and obstructed installation/removal paths.

01 Confirm Product Integration Plans

Validate product integration strategies efficiently, enabling informed design choices with minimal cost and time impact by **digitally evaluating packaging, mechanism design, and operational interaction** early in the development process.

Thanks to realistic physics, engineers **simulate the behavior of wiring, cabling, and hoses, on a real scale and in real-time**, empowering teams to discover issues with tangling, binding, or pinching of hoses and wires to avoid interference, collision, or abrasion in operation.

02 Validate Assembly Line & Assembly Cell Processes

Achieve operational excellence in heavy machinery assembly and accelerate production launch by immersively **exploring assembly and tooling for future machines** in the early stages of the development process.

Digital human models and immersive simulations allow engineers to efficiently plan, optimize, and validate assembly processes, **ensuring safety, ergonomics, and timely production** without the need for physical mock-ups.

03 Anticipate Maintenance and Service Processes Today

Unlock Maintenance Excellence: **Virtually perform future maintenance and servicing interventions**, ensuring safety, productivity, and ROI long before reaching the construction site.

Evaluate all aspects of operator comfort, safety, and also efficiency. Validate procedures and processes with physically **realistic handling of collisions between parts and obstructed installation/removal paths**.

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 - by staying ahead of the curve and 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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