BRINGING SIMULATION TO LIFE WITH IMMERSIVE VIRTUALITY

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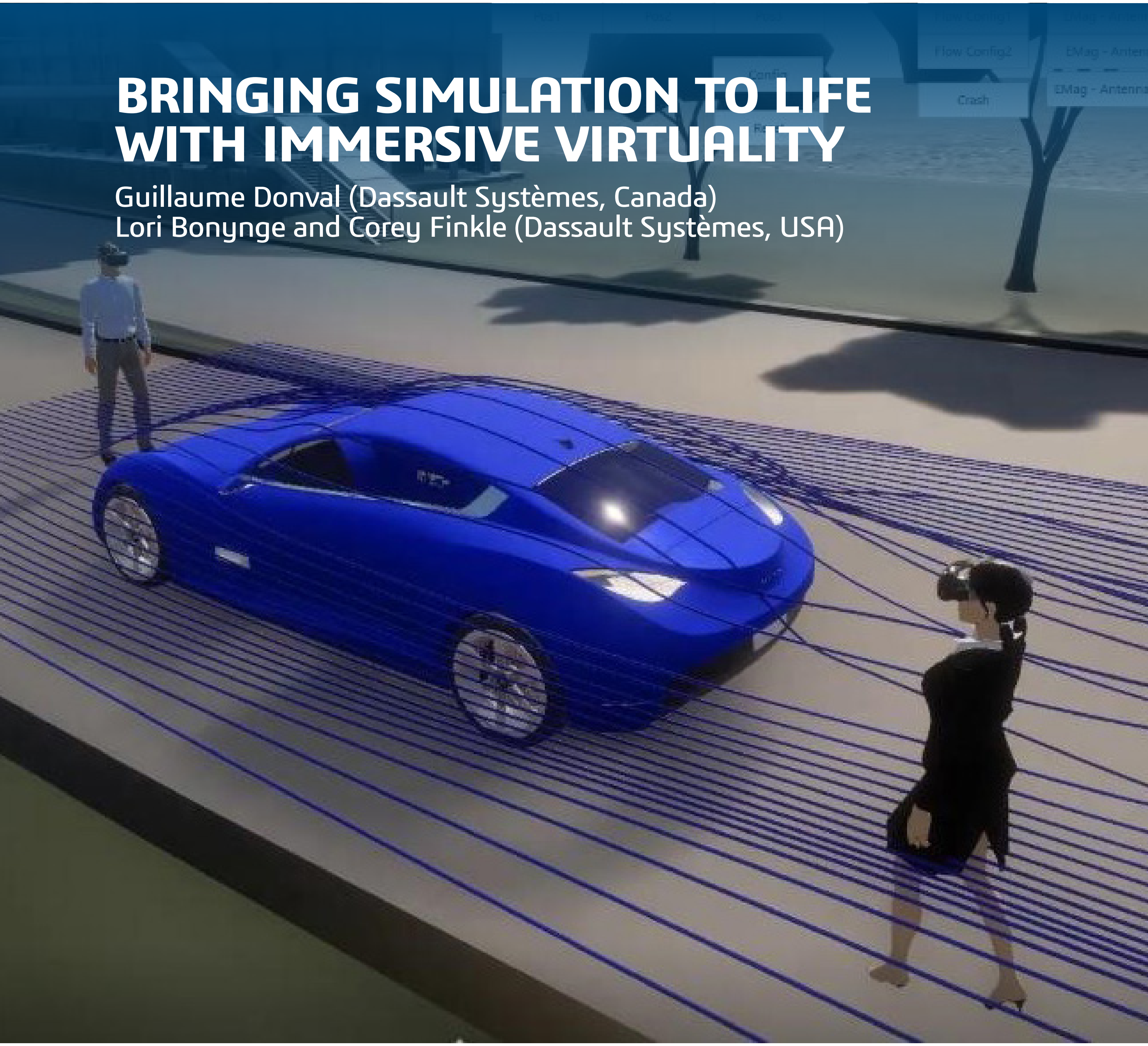


ABSTRACT

As simulation has become an integral part of the development process throughout all industries, it has brought with it a demand for increased digitization, and expanded use cases. By encompassing more and more complex and multi-scale phenomena such as structural, fluid, thermal, and electromagnetic forces, modern simulation allows companies to more accurately visualize their goals, and share their results with a wider audience.

In other words, simulation is no longer simply about generating data; it now involves interacting with it as well. Fortunately, by marrying this technology with the continual advances of Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), this goal is well within our grasp through a process we call Immersive Virtuality.

Immersive Virtuality allows us to observe things that simply cannot be seen in the real world, such as the cooling patterns of an additive manufacturing process, the under-the-hood deformation that occurs during a vehicle crash test, air flow around a jet engine, or even the blood flow through a beating human heart. By facsimileing these processes in an observable and measurable way, we can gain valuable insights for improvement, and share these findings in engaging and memorable ways. As a result, innovators can expect improved decision making, and findings, at each stage of the development process.

Keywords: Advanced Visualization, Augmented Reality, AR, Virtual Reality, VR, Mixed Reality, MR, Simulation Democratization, Immersive Virtuality, iV, Virtual Twin, Digital Twin

1. INTRODUCTION

In today's world, virtual simulation has become an integral part of development throughout all industries, and it's easy to see why. It accelerates the timetable for evaluating the performance, reliability, and safety of both raw materials and finished products, before committing to physical prototypes, saving effort and expense.

This could not be happening at a better time. As our world is inexorably shifting its focus to electrification, sustainability, connectivity, and liveable cities, the products that are being imagined and created are becoming ever more complex. By adopting simulation-based innovation, design, and manufacturing, companies can now take a holistic approach and include considerations such as electromagnetics, fluids, structures, and other technologies to their production process.

Somewhat paradoxically, as simulation becomes more and more sophisticated and complex, it also becomes increasingly important to share the results with a wider and more varied audience, as they can drive not only design, but also innovation and education.

In both cases, the key to making the most out of every simulation is visualization. Luckily, the advancements in Immersive Virtuality (iV) technologies have kept up with the pace. Immersive Virtuality encompasses Virtual reality (VR) which immerses users in a fully artificial digital environment, Augmented reality (AR) which overlays virtual objects on the real-world environment, and Mixed reality (MR) which overlays and anchors virtual objects to the real world and can allow the user to interact with the virtual objects. It is the merging of real and virtual worlds to produce new environments and visualizations where physical and digital objects co-exist and interact in real time.

Today's visualization technology has become much more accessible for businesses and consumers. The variety and maturity of Immersive Virtuality devices on the market is steadily increasing, setting it on a path that will eventual make the technology mainstream.

When Immersive Virtuality is combined with simulation, there is nearly limitless potential for where it can lead.

Simulation of a shampoo bottle drop with deformation and flow visualized through the Microsoft Hololens device.

2. VIRTUAL TWINNING

The main reason why Immersive Visualization is so important to modern simulation can be summed up in one word: twinning. Virtual Twinning is the process through which complex real-world objects get recreated in a virtual 3D environment. It has applications at every stage of design, from prototype to final production, by bridging the disconnect between the physical and digital worlds.

However, the real potential of twinning becomes apparent as it goes beyond concept and production. When incorporated as part of a platform environment, Virtual Twins enable companies to create a comprehensive and consistent experience for all stakeholders, from design and manufacturing all the way through marketing, sales, delivery, and servicing.

More advanced platforms create assets that can be used outside the context of any single organization. For example, if a Virtual Twin can be exported from the prototype stage into a form that marketers can use, it can be built into VR experiences that customers can explore before they commit to purchasing the real thing.

When AR is added to the equation, the possibilities become even more intriguing. AR will transform how we learn, make decisions, and interact with the physical world. It will change how we train people, design and manufacture products, communicate with internal and external customers. In other words, AR brings 3D to the people, and makes it a universal language.

3. IMMERSIVE VIRTUALITY IN THE CONTEXT OF SIMULATION

When simulation is combined with the power of Immersive Virtuality, improvements can be seen throughout the product development process. Here are a few examples:

Improved Evaluation—By simulating a Virtual Twinned product or component, engineers put the user's perspective at the center of the development process from an earlier stage. For example, by simulating the hood vibrations on a car, you can induce reflections visible by the driver, revealing the negative impact and discomfort that might result.

Simulation Preparation—With the ability to make use of natural interactions for loadcase and constraints definition, space reservation can make this stage of the simulation setup's learning curve shorter, enabling a more casual usage. It has to be emphasized that this will completely redefine the whole user experience and interface for existing applications, by allowing them to adapt to the new kind of interactions and capabilities enabled by VR.

Real-Time Context—Closed loop simulations can be created to represent a full dynamic system, yielding results that can be integrated in a real-time context.

Experience can cover use cases like Driving Experience, which involves Co-simulation (motion, noise...), with a human in the loop. This requires VR in a dynamic environment, and requires the ability to add CAE simulation results in VR.

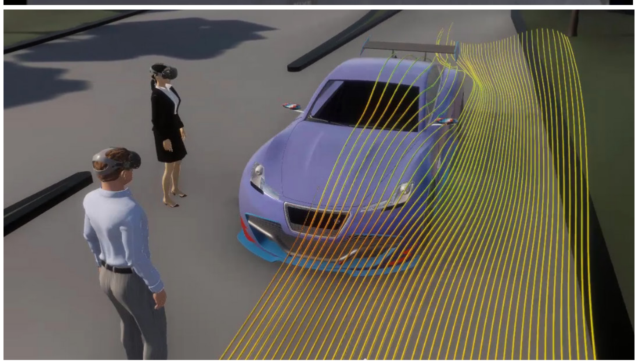
The Simpack Realtime driving simulator leverages motion, coupling forces and stresses in real time, whether experienced via monitor, or in VR with a HTC Vive headset.

Simpack Realtime driving simulator

4. THE POWER OF COMMUNICATION

As we have just shown, Immersive Virtuality is a transformative way to leverage simulation throughout the business. And this universality creates the opportunity to make the results available to a wider audience, in a context everyone can understand. When done correctly, a robust immersive simulation can be understood by specialists and non-specialists alike, in a wide variety of situations, including:

Design and Development—A clear simulation can facilitate cooperation between teams and departments on design iterations. This process can be made even stronger by interactive capabilities that work locally and across multiple sites. As an example, consider automotive manufacturing. The early, collaborative evaluation of a vehicle's complete digital design— including essential areas of performance of the vehicle structure as key design targets—is best performed early as part of a systems-level approach. A physical test with known accuracy limitations cannot provide insight into the invisible forces that work together to impact performances. Only simulation can do that. To meet multiple, sometimes competing, targets for vehicle performance—including crash, durability, noise vibration and harshness, aerodynamic lift and drag, chassis and vehicle dynamics performance, among many others—evaluating the complete 3D geometry as it evolves concurrently allows engineers to see the effects of their design choices across all of these targets simultaneously. This is especially important as they seek a final design that maximizes performance without sacrificing other critical attributes like vehicle weight and fuel economy. An early, detailed, highly visual representation of these critical interactions—supported by high-fidelity physics that enables the visualization and measurement of temperature, airflow, and thermal transients—can help multiple engineering teams compare the differences between design choices and justify the changes needed across so many interrelated vehicle systems.

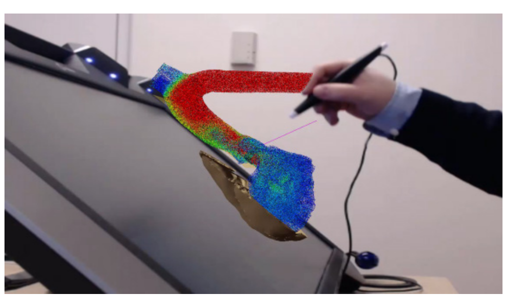


Crashworthiness immersive review during the early conceptual design phase of vehicle structural architecture.

Communication—Immersive Virtuality is a very efficient and effective way to communicate internally to management / executives. It is both pleasing to simulation-oriented people, and educational to non-simulation people. 3D is a common language that speaks to everyone, is useful for getting or justifying budgets, and an effective way to communicate results.

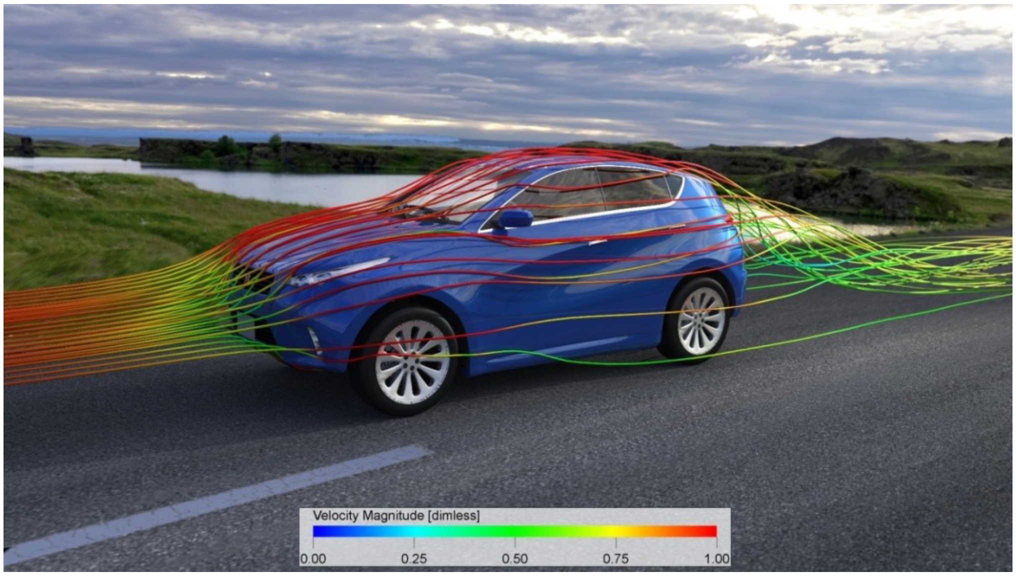
A recent customer case saw a controlled environment room's air conditioning system tested with a smoke test. The company switched to simulation and used AR (Microsoft HoloLens) to visualize the flowlines, both on a 3D mockup and onsite. The visualization was successfully used to convince its executive team of the validity of simulation.

Doctors often use plastic models in discussions with patients. These can be better than a picture, but they are static: But what if doctors could leverage the simulation of heart in their treatment planning and communication with patients? Real-time moving images can facilitate the conversation between doctors and patients, and greatly improve patient and family understanding and engagement. Immersive or holographic 3D speaks to everybody.



Blood flow visualized using a holographic screen

Marketing—Unlike traditional forms of communication, immersive virtuality is processed in the part of the brain that deals with emotion and memory. In other words, companies can use immersive virtuality to create experiences that connect with their customers at the emotional level and create meaningful connections. This can happen in several ways. If a Virtual Twin can be built into a VR experience, customers can explore the product before committing to purchasing the real thing.



External flow around a vehicle. Streamlines colors represent air velocities

Sales—An immersive simulation visualization can go a long way in helping convince customers of the usefulness and validity of the product or process you're trying to sell. By providing a "taste" of what advanced options could provide (AC flows for a car, for example), it could make features more attractive to a customer and go a long way toward "upselling" all by itself.

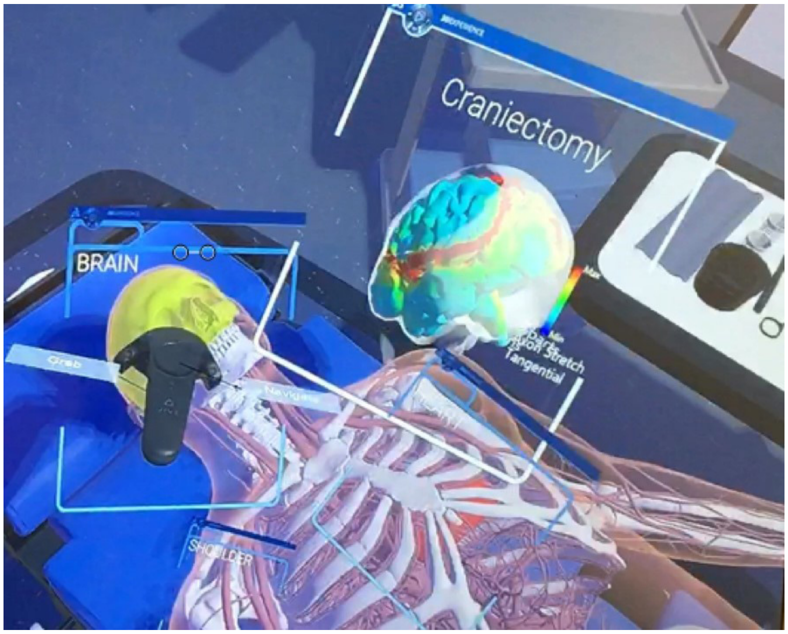
Airflow visualization inside a vehicle. When visualized immersively, the airflow surrounds the user.

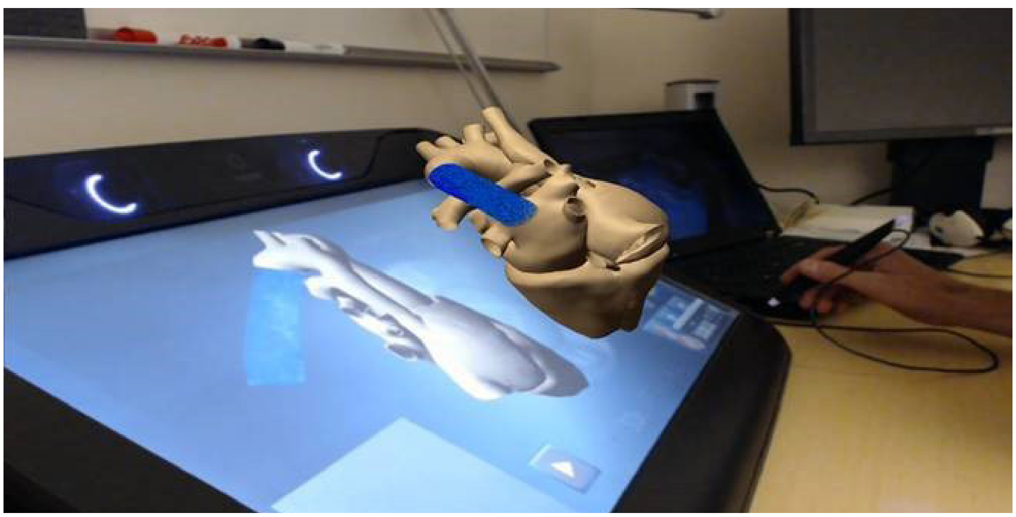
Education—Immersive Virtuality has the potential to become a standard tool in education and could change the way in which students are taught for both K-12 and beyond. As Benjamin Franklin once famously said, "Tell me and I forget. Teach me and I remember. Involve me and I learn."

Allow students to become immersed in the discovery process involved in any good learning experience, by revealing features difficult or impossible to see with the human eye or physical testing.

Medical schools are already using "cyber anatomy" to teach student about the human body, including flows and electrical behaviours.

SIMULIA created a 3D model of a beating human heart that people can virtually "walk through" and explore. It helps to understand the complexity involved in the heart and all its components: tissue, electric physiology.





Brain and Heart simulations visualization. Users can access, view and interact with all the simulations from a Virtual Human Model.

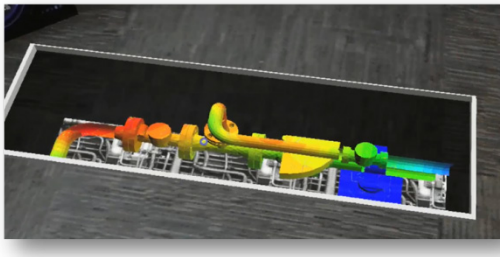
Training—Simulation can be used to recreate complete environments and settings that might be otherwise difficult or impossible to replicate physically. This could mean anything from creating a virtual operating room to prepare practitioners for complex surgery, to facility inspection scenarios that help prepare people for different extreme conditions like fire or earthquake.

Real-Time Guidance—With the ability to overlay virtual simulation over a real-world environment, Immersive Virtuality offers a great opportunity to provide intelligent guidance for specific tasks in an unobtrusive way. Recently, we have seen cardiologists and orthopedic surgeons using this technology to get a better representation of their patients' individual anatomy during particular procedures. In the past, a major challenge for this type of work is controlling the location and content of visual displays in the room. However, a modern Microsoft HoloLens device has the ability to completely eliminate this process, allowing you to create a custom layout of patient-related information, where and how the doctor wants it.

Field Services—By allowing input from all parties on a Virtual Twin, Immersive Virtuality can be leveraged in the field in a variety of extremely valuable ways. Facility inspections could be run based on running simulation predictions on the Virtual Twin. Or, Immersive Virtuality could be used to compare a real bridge (from a LIDAR scan captured onsite) to a Virtual Twin to assess performance in its structures, serving as a foundation for engineers to suggest further tests and recommend repairs.

5. CONCLUSION

At Dassault Systèmes, we believe that the future is bright and exciting for simulation and Immersive Virtuality. When the two technologies are brought together, the combined result has the potential to change the business landscape permanently.



Pipe inspection using the Microsoft HoloLens device. Geometries and simulations (here temperature) can be visualized on-site, and can even be viewed underneath the floor or inside walls during facilities inspection.

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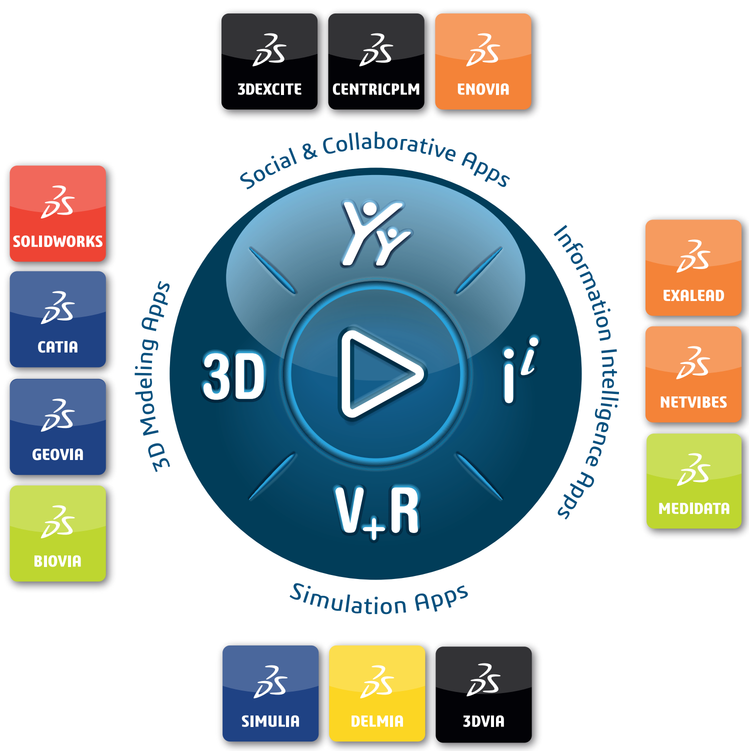

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