

SIMULIA

COMMUNITY NEWS

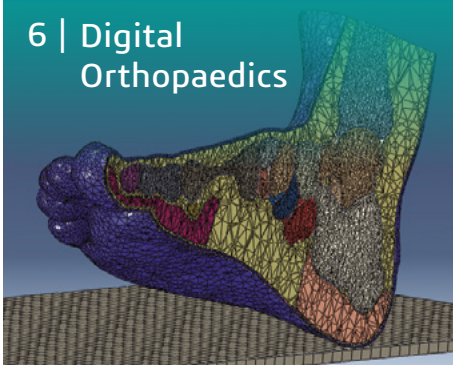
#18 December 2017

EMPOWERED BY THE CLOUD

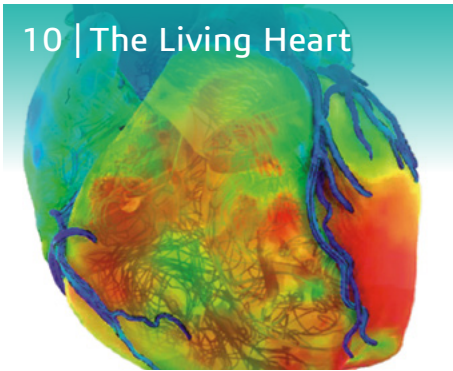


**COVER
STORY**
DIGITAL ORTHOPAEDICS

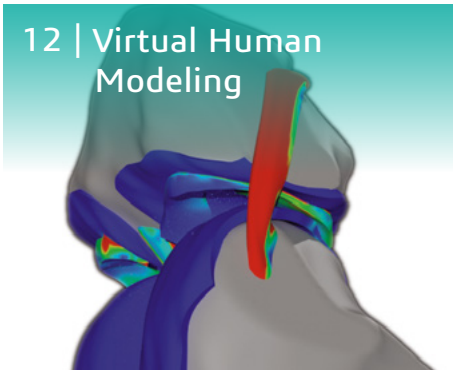
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Bringing Innovation and Industry into the Classroom

Contributors: Parker Group & Digital Orthopaedics

On the Cover: Mr. Eric Halioua, Dr. Thibaut Leemrijse, Dr. Bruno Ferré, Digital Orthopaedics

Photo by: Couloir 3, Paris, France

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 **SIMULIA**



CLOUD TAKES CENTER STAGE

There's a new phrase going around that you may be hearing more of these days: "the democratization of simulation." But what exactly does that mean to you? Read on to learn more in this issue of SCN.

Several important trends are shaping the way you're already accessing simulation now—and will be even more in the future. You, as a SIMULIA user, are seeing that the tools are getting increasingly powerful even as run times are speeding up exponentially. Concurrently, these capabilities are becoming accessible to a wider swath of experts and non-experts alike who can interface with the most advanced software at whatever level best suits their needs. With so many simulation tools becoming available on the cloud, collaboration—so critical to innovation—is truly achievable among teams across every industry.

For examples of how this democratization of simulation is being realized, see the Future Outlook article on page 4 to learn how the cloud might help your own business/industry, small or large. Then hear from actual customers (Digital Orthopaedics, page 6) who are setting up an innovative life-sciences startup based on the understanding that it *has to be on the cloud* so their healthcare customers can access services easily and quickly to serve patients better.

Of course, the ultimate example of cloud-based simulation that could help everyone on the planet who has a heartbeat is the Living Heart project. See page 10 for an update on how far advanced these capabilities have become in just a few short years. The addition of BIOVIA to the Dassault Systèmes family is already starting to deliver on its promise—imagine being able to virtually test drugs on a beating heart model in order to determine whether they are a good candidate to advance to the clinical-trial stage. Researchers at Stanford University are working to achieve just that—and the U.S. Federal Drug Administration (FDA) is paying close attention.

No matter what industry you work in, we at SIMULIA are dedicated to continuously developing new and better software tools that provide everyone with more power to innovate, collaborate and achieve your own particular vision. And we never forget how important it is to get input from our customers to guide the development of new capabilities and deliver them to you in accessible ways. As an example, see page 9 to learn more about the new multiscale-multiphysics co-simulation tool in our Multiscale Systems Specialist Role. And take a look at the door-sag workflow available in the Structural Analysis Engineer Role in the Tech Tip article on page 17, another example of how you can explore and understand real-world product behavior and performance without extensive knowledge of FEA.

Being able to run roles such as this on the cloud is an added benefit. But not everyone needs the power of the cloud all the time. So, to help you manage unpredictable surges in simulation needs, the Tech Tip article also introduces our on-demand licensing for Abaqus, POWER'BY **3DEXPERIENCE** on the cloud. It's all about access—for all—to the best-in-class simulation technology that you've come to expect from SIMULIA and the DS ecosystem. Happy reading!

BRUCE ENGELMANN,
SIMULIA R&D VP & CTO

ACCESSING THE LATEST SIMULATION TECHNOLOGIES FROM SIMULIA ON THE CLOUD

You may not have noticed it, but the cloud has been quietly rolling in to many aspects of your personal and professional life. If you've used social media or streamed a video over the Internet, you've been accessing the cloud. In fact the cloud has become so reliable and so accessible that it is only natural that the most demanding of applications, realistic simulation, has begun leveraging the virtually limitless resources available on the cloud. These massive capabilities are provided to you on demand and can make it much easier for you to answer the difficult design challenges you face today and the more rigorous challenges you'll face in the future.

According to the article, "Predicts 2016: Cloud Computing to Drive Digital Business", published by Gartner, a leading research and advisory company, "By 2020, a corporate 'no-cloud' policy will be as rare as a 'no-Internet' policy is today". At SIMULIA we've seen acceptance of the cloud concept accelerate over the past couple of years, as our customers have increasingly asked for on-demand access to software and hardware.

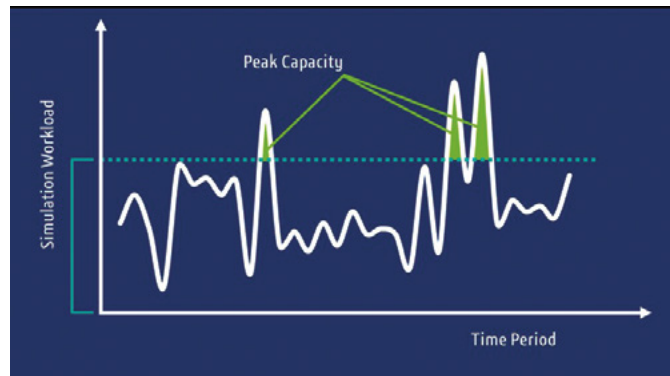
In response to customer demand, Dassault Systèmes has created the **3DEXPERIENCE** platform on the cloud, which combines robust software and elastic hardware infrastructure to provide an easy to deploy software-as-a-service (SaaS) solution with access to HPC compute power for simulation. Available via data centers located throughout the world, **3DEXPERIENCE** platform on the cloud is easily configured to suit the size of your business, fluctuations in your workload, and different levels of expertise within your teams. SIMULIA users will find the advantages of this offering particularly compelling, as it provides reliability, scalability, cost-savings, ease-of-use, and secure global collaboration.

A SOLUTION FOR SIMULATION USERS OF EVERY TYPE

Users of all types must have access to the tools they need to quickly test and evaluate ideas when innovation strikes. The designer may have a clever idea to fit a component into a reduced design space but must check that the new concept supports the product's life requirement, or a team of analysis specialists may need to check for an acoustic response in a complex assembly caused by lightweighting a component. You are likely experiencing situations like this yourself brought on by the ongoing competitive pressure to shorten the product design timelines while delivering products to meet an evermore difficult set of requirements. These demands have heightened the need for, and application of, the most advanced tools available for realistic simulation (FEA, CFD and coupled multiphysics, topology optimization and so on).

This more extensive use of sophisticated design and simulation software in turn requires more high-performance computing

(HPC) power. Yet there can still be a dramatic variation between the peak and lull of simulation demand. Consider the graph of simulation workload vs. time in the image below, which illustrates the rise and fall in demand that a typical SIMULIA customer experiences. Normally the level of token use doesn't exceed the dotted line of licensed coverage. But note the three peaks during which the average is significantly exceeded:



The spikes in simulation demand that typically occur near project deadlines are sometimes dealt with by adding new analysis tokens and adding compute hardware, but this approach is often cost- and time-prohibitive for the occasional peak. In other cases programs are simply delayed until the simulation data is available to make informed design decisions. In still other cases, critical design decisions are made without having the supporting data, often resulting in subpar product performance, or worse, product field failures.

The cloud now provides for another alternative to manage these occasional peaks in simulation demand by cost effectively accessing "burst compute" resources to secure the software and compute power only as they are needed.

Let's take a look at how the cloud can help different kinds of users overcome a variety of challenges:

Experts at large OEMs may already have a license that covers hundreds of thousands of simulations throughout the year. But suppose a new product is about to be launched, more validation tests need to be done quickly, and the existing token pool is being fully utilized by another internal team. Rather than raise the company's entire annual subscription, the additional software and compute capacity can be leased as a service from the cloud, for just a single business quarter (three months), in order to finalize the new product design.

Another benefit of the cloud for large OEMs is global reach. A company may have offices spread across the planet—say, Detroit, India, China and Brazil. But their data hub is located in Detroit, so any simulation-file traffic between offices involves copying and sending files over the

network, requiring huge amounts of time for downloads. Instead, by centralizing everything on the **3DEXPERIENCE** platform on the cloud infrastructure, users can log into the platform and view all their data on a secure web browser for instant access, easier sharing with colleagues, and enhanced collaboration throughout the enterprise.

Experts at small- and medium-sized companies (SMBs) can have very different needs from larger companies, which is where the cloud can provide real value in terms of competitive advantage. If they are a Tier 1 or 2 supplier to a large OEM, the SMB may be required to use the same FEA software tools as their clients. But if that work typically only comes in a few times a year, the cost of an annual Abaqus software license can be prohibitive. Instead, through the **3DEXPERIENCE** platform on the cloud, the supplier can subscribe to an Abaqus license for only a three-month period, doesn't need to hold onto a license that's not being used in the interim, and can re-subscribe when the next project comes in. Expertise, and the ability to compete at the highest levels, can be established and maintained by a smaller company without a huge advance investment.

Designers, design engineers, and other non-expert users will find that the advent of the **3DEXPERIENCE** platform on the cloud dramatically changes the landscape for them in other powerful ways. Those who are using our sister brand CAD tools like CATIA and SOLIDWORKS may not have been able to afford, or had the expertise to run, realistic simulations in the past. But now the user roles on the cloud come with what we call "embedded compute," so you can virtually test your product designs without having to purchase any additional coupons. And the best part is that, underneath the ease-of-use design tools created specifically for your non-expert role, runs

the very same 40-year-proven Abaqus solver technology that the experts use. So the floodgates are opening for the design-engineering community to access the resources they need to fully engage the power of simulation for product development.

SECURITY IS PARAMOUNT

Your data on the **3DEXPERIENCE** platform on the cloud is more secure than what most customers have access to on premise. That's due to data centralization, stringent procedures enforcing regulatory standards and best practices, and proven technologies from experienced cloud providers at both infrastructure and application levels. For more information see our whitepaper on Security in Depth.

THE DEMOCRATIZATION OF SIMULATION

Cloud computing on the **3DEXPERIENCE** platform is available to every kind of simulation user, regardless of the size of your team and company or your personal level of design engineering sophistication. By providing unprecedented access to industry-leading tools and hardware capabilities, as well as ease-of-use that enables everyone to collaborate from their own level of expertise, the cloud has truly democratized the use of simulation so that everyone can take advantage of its benefits. Many of our customers have already adopted cloud computing to help them achieve sustainable innovation. Let us know how we can help you begin your own cloud journey!

For More Information

<https://3dexperience.3ds.com/cloud/>

Whitepaper: Security in Depth—<http://bit.ly/2FfNQg8>



FEET IN THE CLOUD

Digital Orthopaedics is developing cloud-enabled modeling and simulation tools for foot surgeons and their patients

The résumés of surgeons Bruno Ferré and Thibaut Leemrijse demonstrate an impressive mastery of orthopedic surgery focused on the highly complex foot and ankle. Their extensive research and academic credentials, in their native France and Belgium as well as internationally, clearly identify them as leaders in their field. Both of them remain full-time orthopedic surgeons (Dr Ferré in a private hospital in Monaco, Dr. Leemrijse at the Foot and Ankle Institute he co-founded in Brussels). Yet not content to rest on their laurels, the two joined forces in 2016 to create a startup company called Digital Orthopaedics. Their CEO is Eric Halioua, a serial entrepreneur in the Life Sciences industry who holds Masters Degrees in pharmacology, biology and business administration. The young company's goal is to develop a cloud-based, comprehensive Clinical Decision Support System that will enable orthopedic surgeons to personalize the planning and execution of orthopedic surgeries for patients anywhere in the world.

When the Digital Orthopaedics team reached out to SIMULIA for an Abaqus license, they learned about the 3DEXPERIENCE Lab, applied, and were accepted into the Dassault Systèmes' accelerator program. Their company is currently developing models of healthy and diseased feet using CATIA, Simpack, and Abaqus and building the algorithms that will power their proprietary decision-support system through the 3DEXPERIENCE platform on the cloud.

SCN interviewed Dr. Ferré and Mr. Halioua separately; the following Q&A brings together some of their comments about their exiting new venture.

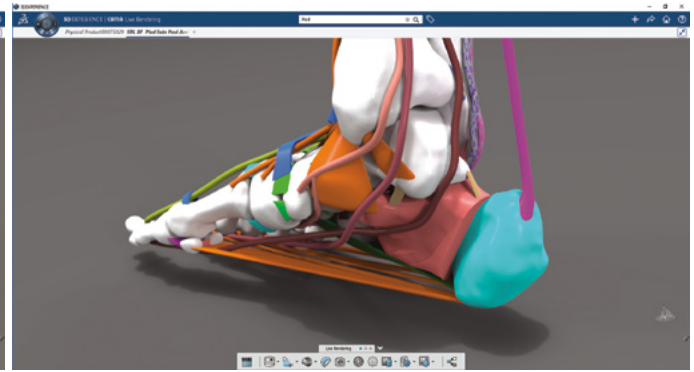
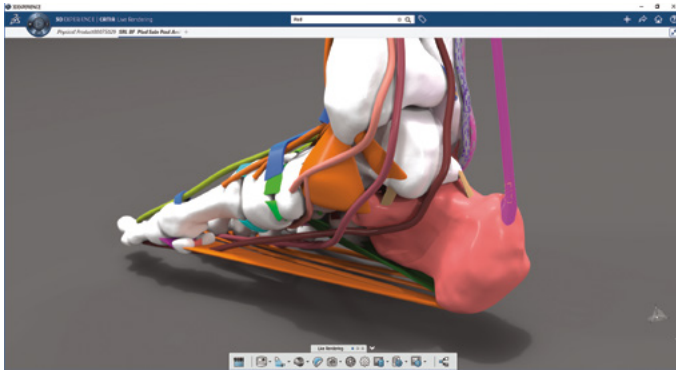
Why the focus on the foot?

Ferré: About ten years ago I switched to feet—after decades of performing lower-limb surgery and implanting thousands of hip and knee prostheses—because I saw the foot as an exciting intellectual challenge. It's a highly complex structure, both anatomically and functionally. Anatomically there are 28 bones interfacing with cartilages around 40 joints defined by more than 100 ligaments and driven by more than 30 tendons. Functionally, foot movement varies a lot depending on the muscular activation of each patient for every gait scenario—walking, running, jumping and so on. I'd been studying

digital modeling for a number of years and I realized that the complexity of the foot could be best interpreted using realistic simulation.

What made you and Dr. Leemrijse decide to create your company?

Ferré: Dr. Leemrijse and I have known each other for a long time. He's an extremely brilliant spirit who shares the same curiosity as I do and an understanding of the critical importance of shared knowledge. Together we realized that imaging, modeling and simulation presented an opportunity to truly advance diagnosis and treatment for foot surgeons and their patients. It just seemed natural to join together to form a company to achieve this!



What is the long-term goal of Digital Orthopaedics?

Halioua: We are on a journey to transform the planning and execution of orthopedic surgeries and treatment by personalizing Precision Medicine. This disruptive technology will change current one-type-treatment-suits-all thinking to a personalized therapeutic approach that takes into account the patient's unique anatomy and functional entities. We are creating the framework necessary for developing CT- and MRI-scan based, patient-specific, 3D digital models to be used to diagnose injuries and abnormalities, identify optimum treatments for every patient, and simulate surgery in silico in each patient's virtual 3D twin. We'll provide this framework in the form of a three-part platform offering of Knowledge Base and Diagnosis Support, Personalized 3D Surgical Simulation, and Machine Learning and Clinical Cases.

We are in the middle stages of development, not commercialized yet, but we have already received ISO 13485 certification for quality assurance of our services, which are considered a medical device. We've filed for a patent, will apply for European CE certification, and are in the process of preparing an FDA application as well.

So how does the 3DEXPERIENCE on the cloud help your company achieve its objectives?

Halioua: Our vision is to offer all our services completely on the cloud—which is really mandatory in order to be fully functional, and cost-effective, with the amount of HPC capacity required. Close collaboration between engineers and medical teams in an interdisciplinary group is key to success in this area. In order to share tools and techniques among surgeons and hospitals worldwide, we have to be on the cloud.

We are in the process of adapting our services to the **3DEXPERIENCE** platform on the cloud, which will be a key enabler to our success because it offers:

- The framework necessary to capture and automate the “medical image to 3D model to realistic simulation” workflow
- The potential to connect to hospital imaging systems and enable a clinical decision-making service to orthopedic surgeons worldwide
- Efficient development, testing and deployment of custom solutions for clinical services
- Collaboration and sharing of ideas and feedback within our user community of physicians and engineers

For us, being on the cloud is the only way to reach the surgeons, who don't want to invest in a machine or device—they just want quick access to solutions via a web interface that is easy to use and very ergonomic.

Talk about what Dassault Systèmes tools you're using to develop your own offerings and how these capabilities can help advance medicine in general.

Ferré: The existing medical treatises on physiology and biomechanics of the foot are not sufficient to capture the dynamic phenomena of everything the foot of a living human being can do. Dassault Systèmes helps us organize our accumulated knowledge with algorithms that work inside that knowledge.

In the capabilities of Dassault Systèmes are all the processes of physics needed to simulate the actions of cars, aircraft, and other products. This accumulated intelligence now provides my team with many tools that we can apply to simulations that can help with planning and performing orthopedic surgery.

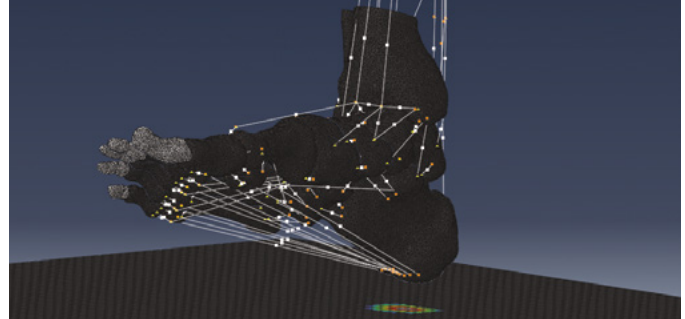
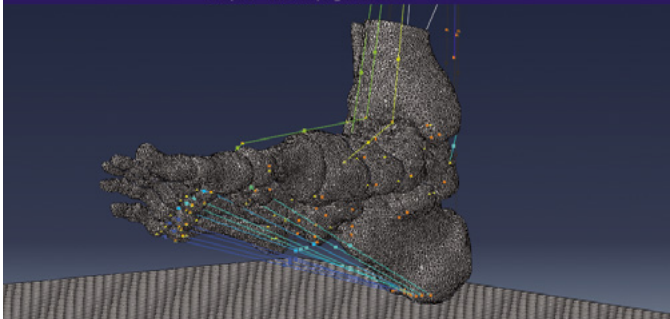
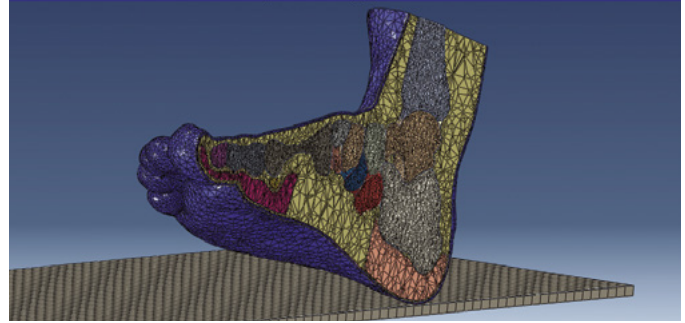
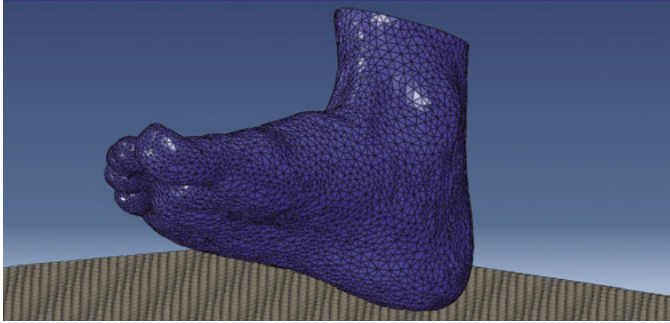
I've just recently started working with CATIA and it is really magic for creating geometries! Simpack allows us to model entire multibody systems, which helps us understand the kinematics and global displacement of the foot. That reaction force and joint kinematics data can then be used as input for FE modeling with Abaqus of the complex contact behavior between the foot and the ground, and the simulation of internal foot quantities such as joint cartilage contact pressures and tissue stress levels. For full comprehension of the entire foot, you need patient data.

Halioua: Dassault Systèmes and SIMULIA offer the entire breadth and width of solutions we need.

Ferré: Looking at the big picture, we are a simple actor within the profound change that is taking place in medicine. We're only at the beginning of this digital era of serving patients. We must continue to develop our techniques but also ensure the transmission of our knowledge and enthusiasm to the generations that follow.

We've found a similar state of mind at Dassault Systèmes and we believe they will be one of the great players of this medicine of tomorrow, just as they have been in the automotive and aviation industries.

Cover Story



What do doctors think of your vision?

Ferré: A lot of surgeons still don't fully understand the power of simulation and part of my role is to convince them of how essential it is to the advancement of medicine overall. As a surgeon myself I can explain to them how predictive simulation can help them identify the correct diagnosis for each patient, and then custom-design the best treatment for the problem.

For 2,000 years medicine has been more of an art, with doctors almost in the role of sorcerers. The influence of hard science has been accelerating in recent decades and we are now at a point where the power of data can be focused onto evidence-based medicine. While being careful to protect the proprietary biology of each patient, you can use digital data to reach a much more precise analysis of that patient's particular problem in order to come up with the appropriate solution.

Halioua: Yes, this represents a major change for many doctors, using simulation within a clinical decision support system. But these surgeons are first of all scientists, so we need to convince them that the model we're developing provides value—meaning, for example, that you will identify exactly how many millimeters of tendon you need to cut in order to remove specific constraints on the motion of the foot. Once they grasp that, they become more open to the idea. And then you need to discuss training, the right economics, user-friendliness, and speed, in order for them to reach a decision. At the end of the day in the operating room, the decision is still in the hands of the surgeons; we can help them consider surgical options, but they make the final choice.

Ferré: One thing we are seeing is that those surgeons who are already performing advanced surgeries and methodologies—piloting surgical robots, helping develop devices, and so on—are very interested in what we are doing. They already

understand that you can prepare and rehearse surgery ahead of time through simulation.

And how do patients feel about this?

Halioua: In the future healthcare system the role of the patient will be more and more important. The level of education of patients, thanks largely to the Internet, can be extremely high these days. Using simulation, the surgeon can show the patients specifically what is wrong and how they will fix it.

Ferré: When you explain this predictive medicine concept to patients, they really want this, they understand the value of treatment that is specific to their own body, and it gives them confidence in their surgeons. Everyone wants to be able to predict the good or bad consequences of a medical intervention. Modeling and simulation are essential for achieving this and are the foundation of the medicine of tomorrow.

For More Information

<http://www.digital-orthopaedics.com/>

The **3DEXPERIENCE** Lab from Dassault Systèmes is a new open innovation laboratory that merges collective intelligence with a cross-collaborative approach to foster entrepreneurship and innovation. Entrepreneurs, makers, and innovators everywhere are invited to join the **3DEXPERIENCE** Lab, a community of intelligent, creative and passionate people, focused on positively impacting society, through the creation of disruptive, groundbreaking projects. Dassault Systèmes is committed to helping them bring those projects to life, with the hopes of unleashing further progress and growth for tomorrow's world.

For More Information

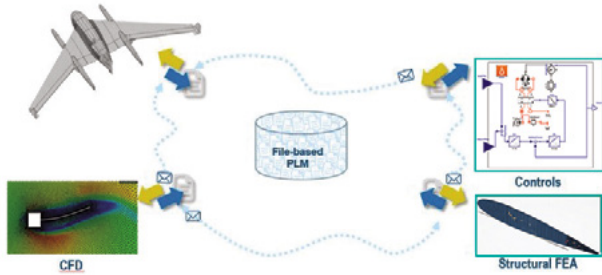
<https://3dexperiencelab.3ds.com/en/homepage>

A TOOL TO CONNECT MULTIPLE DOMAINS ON THE 3DEXPERIENCE PLATFORM

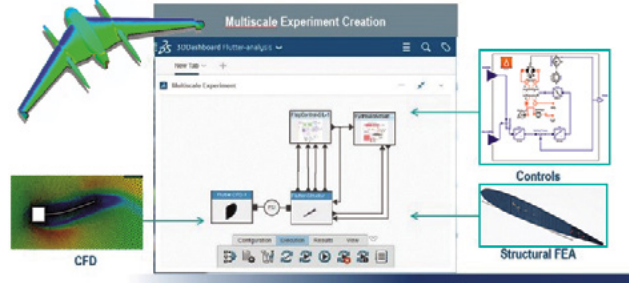
Multiscale Systems Specialist is a Role for specialists who collaboratively create, execute, explore & manage co-simulation experiments and associated artifacts involving multiple physics over multiple scales across a wide range of experimental intent.

Multiscale Experiment Creation application (packaged in the Multiscale Systems Specialist Role) provides a collaborative multi-disciplinary environment and connects digitally all the stakeholders of a complex workflow.

Manual Co-simulation

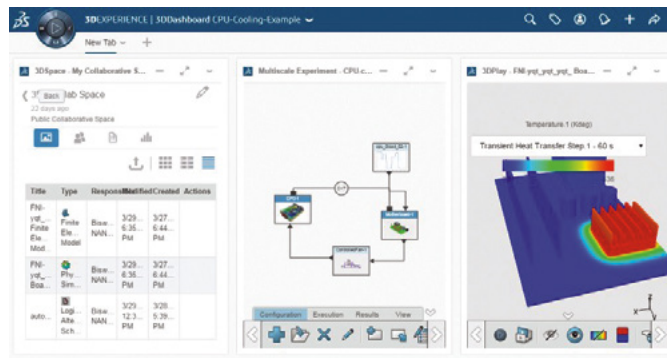


Digitally Connected Co-simulation



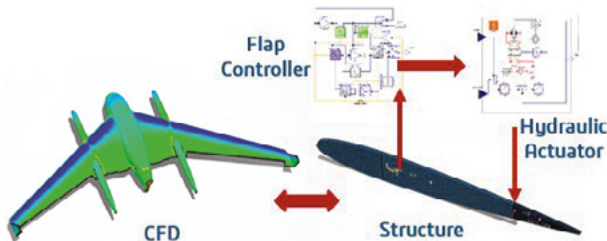
HIGHLIGHTS

- Easy-to-use user experience with drag-and-drop options
- Best-in-Class Multiphysics, Multiscale technology leveraging the Dassault Systèmes ecosystem
- Open environment for system/subsystem/multiscale simulations
- Review unified experiment results to make innovative design decisions
- Enhanced co-simulation execution experience
- Multidisciplinary and collaborative environment

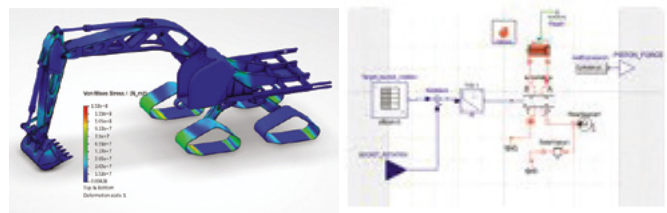


TYPES OF APPLICATIONS

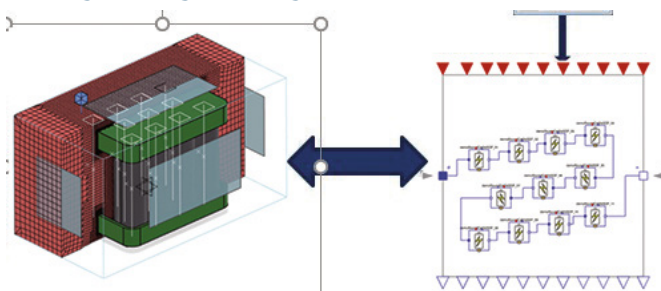
Flutter: FSI and Multiple Logical Models



Logical-Physical



Battery Cooling: CHT/Dymola



For More Information

<https://www.3ds.com/products-services/3dexperience/whats-new>

ACCOLADES FOR LIVING HEART ON-CLOUD UNDERSCORE GROWING AWARENESS OF PROJECT COMMUNITY AND VALUE OF MODELING AND SIMULATION FOR LIFE SCIENCES

Moves from FDA highlight importance of virtualization for innovation, quality, and cost control in healthcare

Three years ago, the Huffington Post wrote this about the Living Heart Project: “This is thought leadership at the leading edge of innovation in medical research and innovative in several ways. First, in the application of advanced simulation and 3D visualization technology in the biomedical arena, and second in its crowdsourcing approach.”¹ At that time, the vision may have been profound but the technology was nascent. Fast forward to today and we find the Dassault Systèmes’ Living Heart—the flexible and robust 3D multiphysics model of a lifelike, beating, human organ—available to all on the cloud as a commercial-grade business tool. More importantly, leaders across the medical device industry are now embracing the project vision and putting plans in place to act on it.

Yet the project team is not standing still. The first-of-a-kind applications of disease modeling, personalization and device design optimization emerging from the community are receiving increasing attention these days from private industry, medical professionals and regulators. When this new capability is combined with the power and universal access provided by the cloud, the broader benefits of simulation for the future of healthcare are becoming ever more apparent.

To explore this potential, the Dassault Systèmes team worked with members of the Living Matter Lab at Stanford University led by Professor Ellen Kuhl (and supported by Hewlett Packard Enterprise (HPE), Advania and Uber Cloud) to create a highly detailed version of the Living Heart FEA model that could exploit this power. The model contained sufficient detail as to predict the electrical conductivity through the ion channels in each of the cells of the heart. These cells were assembled into the Living Heart electrical model and began to communicate and function as a real heart would, confirmed by placing the heart model into a human torso and computing the ECG trace. The model was then subject to the molecular level interactions of drugs known to have varying side effects. The model correctly predicted the electrical signal of a healthy heart and also the known disruptions to the natural rhythm when exposed to a drug,

¹Simon, Phil. "Crowdsourcing Healthcare" Huffington Post, 12 November 2014, https://www.huffingtonpost.com/phil-simon/crowdsourcing-healthcare_b_6149028.html

even spontaneously inducing a life-threatening arrhythmia. With over 250 million independent variables to be solved, it is a truly multiscale and multiphysics breakthrough to predict from cell-to-organ, enabled by the power of the cloud and ushering in a new horizon for biomedical simulation.

SIGNIFICANCE NOTED

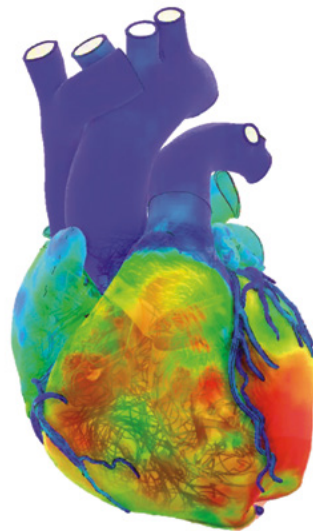
The significance of this work was not ignored. At the recent 2017 Supercomputing conference in Denver, Colorado, the team received three separate awards: the Editor’s Choice Award for “Best Use of HPC on the Cloud” from HPC Magazine; the “Best Paper Award” from Intel (at their developer co-event); and the “Innovation Excellence Award” from Hyperion/IDC.

The judging panels represented a broad range of HPC and other subject-matter experts—who overwhelmingly voted for the Living Heart from among more than 110 submissions, in the case of the Hyperion/IDC award.

As important as these technical breakthroughs are, the Living Heart Project is unique in its emphasis on rapidly translating technology into practical, real-world applications. For healthcare, this means bridging the cultural and technical boundaries between researchers and medical professionals. We are now seeing signs that this is happening. As evidence, this fall, in honor of the 6th International World Heart Day, Dr. Nikki

Stamp, an Australian cardiologist, featured the Living Heart in a network TV special on the future of cardiovascular medicine. In Germany, Dr. Christian Schlensak, a cardiothoracic surgeon from University Hospital Tübingen, gave a public-television demonstration of how the Living Heart could improve pre-surgical planning of a complex congenital heart-defect repair.

Such validation from both IT and medical sources reflects the important advancements the project members have made and reveals the potential of simulation to address some of the toughest technical and business challenges in healthcare. The continued growth worldwide of the project also reflects the second point from the Huffington Post, the significant input—in the form of innovation, sharing of real-world data and clinical experience—from a vast team of academic researchers, physicians, industry and regulatory agencies committed to



a better future and the principle that a rising tide lifts all boats. Together this collaboration is advancing heart modeling to become more powerful, flexible and accurate over time and showing no signs of slowing down.

Of course, in between the innovations of the researchers and practice of the clinicians lie the regulatory bodies. The U.S. Food and Drug Administration (FDA) clearly sees the bigger-picture message behind the success of the LHP: validated virtual human and animal models will deliver huge time and cost savings while enabling innovation throughout the healthcare industry to the benefit of all patients. In line with their mission to protect health and safety, and promote public health awareness, the agency has been a supporter of the LHP from its earliest days, advising the expanding LHP community on their growing interest in simulation for regulatory purposes for years.

Dassault Systèmes has reciprocated by sharing its expertise and experience in related industries with the agency. Dassault Systèmes is a founding member of the Medical Device Innovation Consortium and serves on the FDA’s policy committee to establish verification and validation standards for drug and device modeling (V&V 40). For its part, the FDA has already begun exploring virtual clinical trials and accepting simulation data to support regulatory submissions to the Center for Devices and Radiological Health (CDRH).

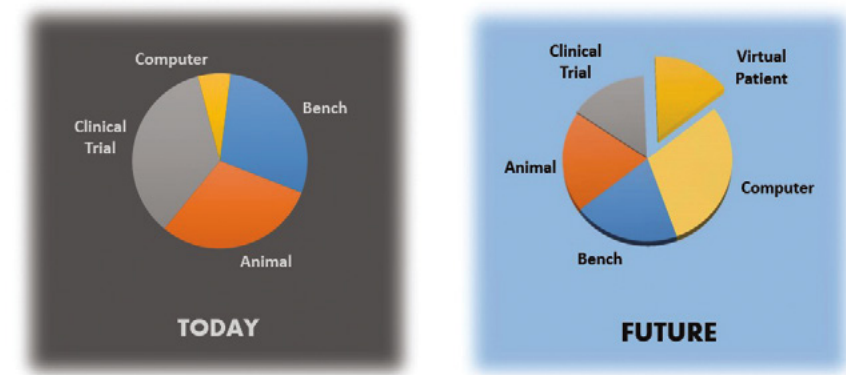
When FDA Commissioner Scott Gottlieb announced the agency’s new Innovation Institute this year, he made a point of saying that “in silico” tools will improve drug development and make device regulation more efficient. The director of the CDRH, Jeffrey Shuren, publicly cited simulation as a possible source for regulatory approval in a recent article in the *New England Journal of Medicine*.

NEW WAY TO CONDUCT RESEARCH

With the release of the Living Heart on the cloud, the industry has a new way to conduct medical research—virtual organs-on-the-cloud. Just three years ago, simulation of a clinical use of a medical device for improved design, selection or training was out of reach for all but the most advanced organizations. Today, companies of all sizes can immediately access a complete, on-demand HPC environment in which they can scale up virtual testing securely and collaboratively without having to build and manage an in-house, physical infrastructure of computing resources.

Most importantly, the underlying technology, methods and platform that power the Living Heart are also immediately available for companies outside of the cardiovascular arena.

State of *Digital Evidence* in Medical Devices



www.fda.gov

Source: Dr. Tina Morrison, U.S. Food and Drug Administration - Access 17 Nov 1, 2017

For example, the Abaqus Knee Simulator, a highly advanced application that offers virtual knee-implant wear testing to replace lengthy bench tests, is being refined in the latter stages of the FDA’s Medical Device Diagnostic Tool (MDDT) program. Other virtual organs—such as brain, spine, foot, colon and eye—are being used to design and test implants and replacements, surgical tools, syringes, catheters and more.

Is this evolution or revolution? Real-world testing in living humans remains the endpoint for FDA approval, but with the barriers to innovation and the skyrocketing costs of the current systems, it is simply not sustainable. With the ability to incorporate real-world evidence, optimize designs faster, and get advance notice when proposed drugs or devices will have unexpected side effects, in-silico methods on the cloud are poised to take their rightful place in medical research and practice.

Once in place, customized devices and treatments become a logical and practical reality. For their part, the FDA projects that evidence sources could move to almost 50% digital and virtual patients. The industry is already gathering valuable insights from simulation that help to produce more effective and reliable devices. Yet those insights are lost and rarely applied to directly lower the costs or increase the speed of regulatory approval. The FDA seeks to change that and the members of the Living Heart Project have doubled down on their effort to help them with the goal that no device will ever be put into a real patient before first being tested in a virtual one. We all will benefit if they are successful.

And so the beat goes on! Medicine today is in many ways a less predictable industry than others, and the digital age is bringing with it a huge transformation in healthcare practices. The power of simulation, in combination with high-performance computing on the cloud, is key for this transformation to be fully realized, and to add predictability for the benefit of patients and innovators everywhere.

For More Information
www.3ds.com/heart

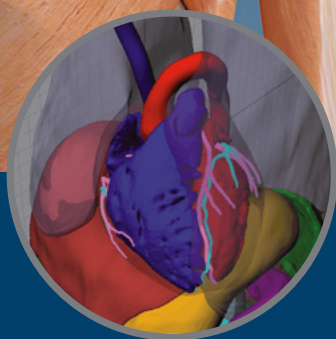
VIRTUAL HUMAN MODELING ON THE CLOUD



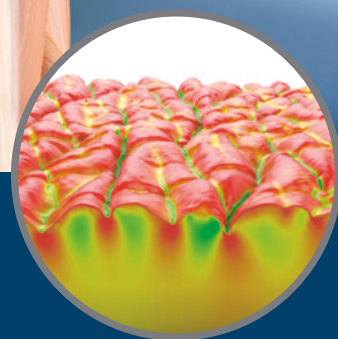
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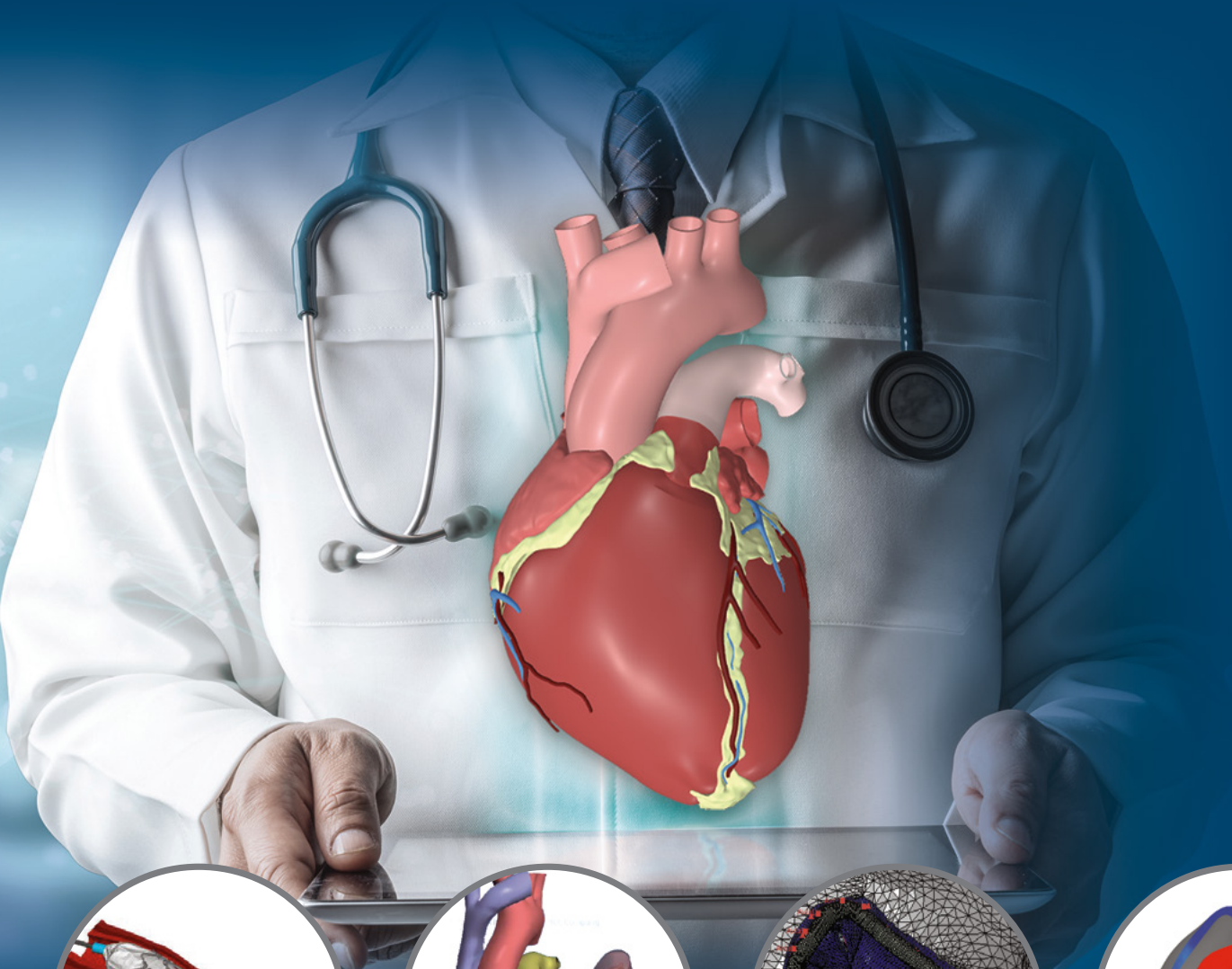
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VIRTUAL HUMAN MODELING

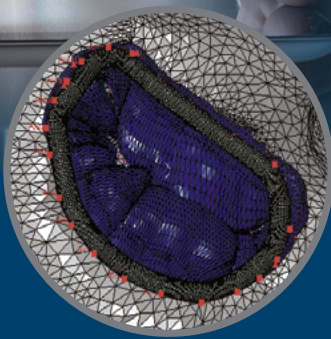
ADVANCING BIOMEDICAL ENGINEERING
THROUGH REALISTIC SIMULATION



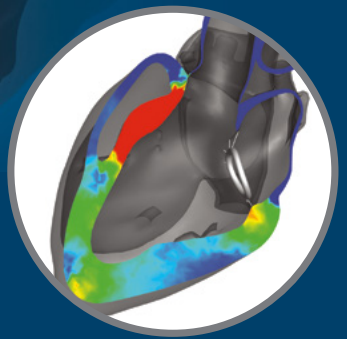
INTEGRITY ↗



SENSITIVITY ↗



EFFICACY ↗



**ORGAN
RESPONSE** ↗

RUNNING AN ABAQUS JOB ON THE CLOUD

Realistic Simulation is becoming an increasingly integral part of the product development process and companies are realizing the advantages of performing simulation throughout the development process as opposed to simply validating their final design with simulation.

As the need for realistic simulation continues to increase, companies often find themselves with insufficient software licenses when there is an unpredictable surge in simulation requirements. In order to address this need, we have introduced on-demand licensing for Abaqus POWER'BY 3DEXPERIENCE on the cloud. On-demand licensing allows companies to cost-effectively meet their peak needs for both software and hardware.

Convenient access to the on-demand license model is provided through the web-based Abaqus Study application. Getting started is as simple as logging on to 3DEXPERIENCE from a browser, then clicking the Abaqus Study icon. Everything is web-based so no installation is required.

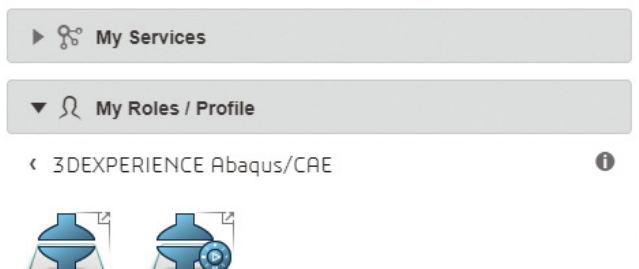


Figure 1: Select V+R quadrant in the compass to access Abaqus Study application

The rest of the workflow can be broken down into 4 simple steps.

Step 1: Upload an Abaqus input file to a secure project space on the DASSAULT SYSTEMES Cloud. The input file can be generated using Abaqus/CAE or any other pre-processor preferred by the user.

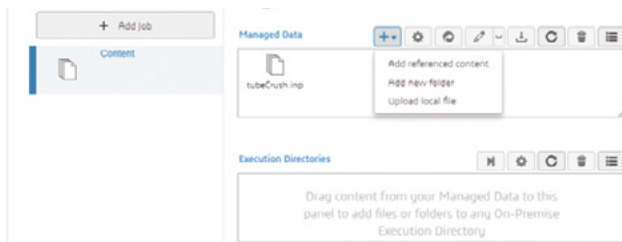


Figure 2: Content tab to upload the Abaqus input file

Step 2: Configure the simulation from the Run Options tab in Abaqus Study.

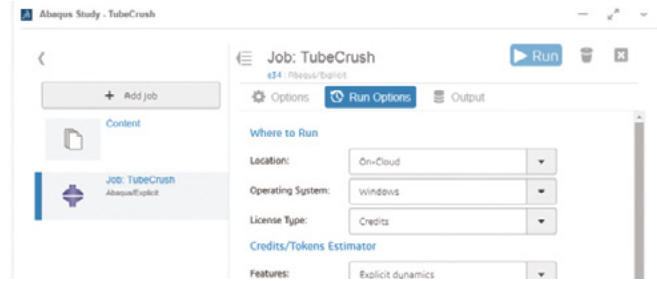


Figure 3: Define Run Options

Available options include where the simulation will run, the type of license to use, and how much hardware should be used. Abaqus Study allows users to run simulations on the Dassault Systèmes cloud or their own local hardware. Available license types include the on-demand credit model and the traditional token model. The Run Options tab also provides a tool to estimate license usage.

Step 3: Run the simulation. Simulation progress (e.g. sta/msg/dat files) can be monitored within Abaqus Study as the simulation executes.

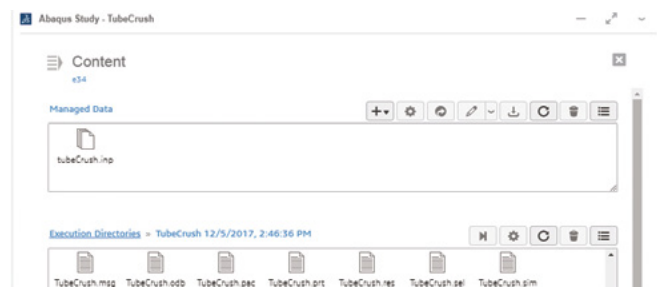


Figure 4: Monitor simulation job progress

Step 4: Analyze results after the simulation has completed. One option is to download the Abaqus results file (odb) and use Abaqus/Viewer for local post-processing. Another option is to perform lightweight visualization using the browser-based 3DPlay application (Figure 5). A final option is purchasing Simulation Results Analyst, which is a Role that provides remote high performance visualization from the cloud.

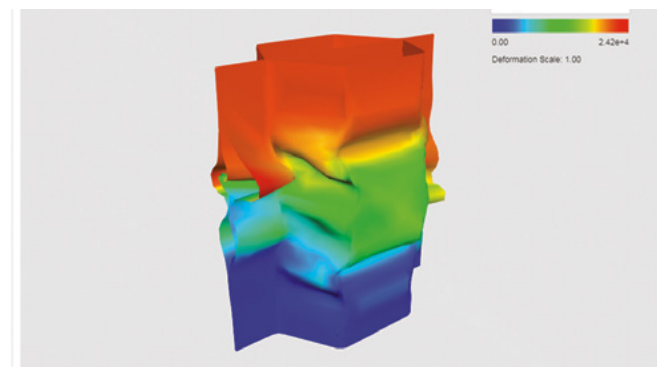
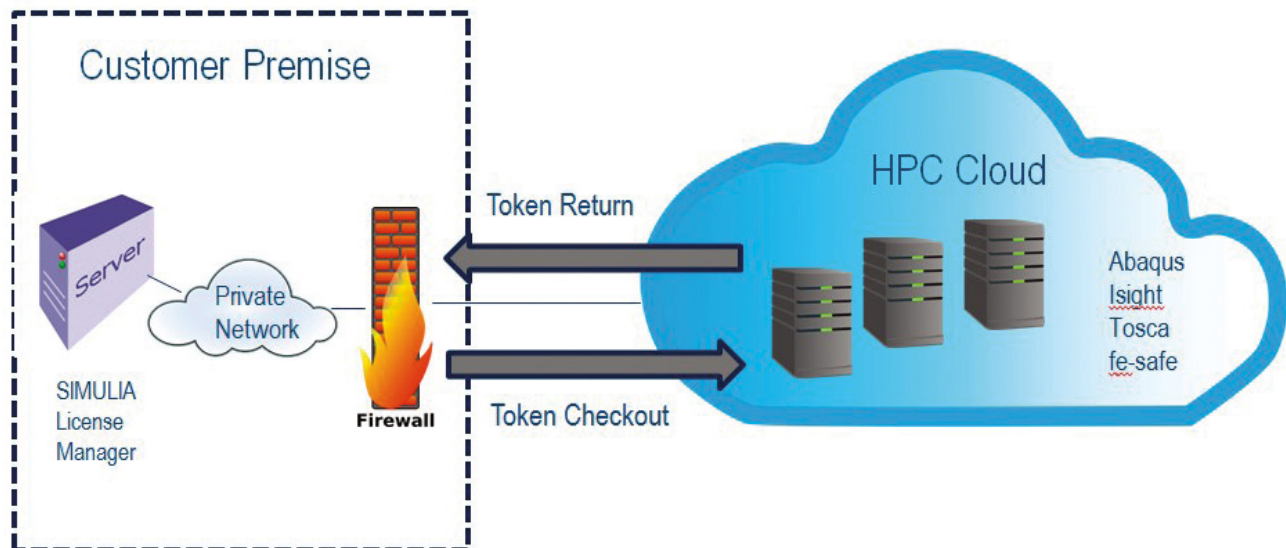


Figure 5: Results visualization within 3DPlay application

USING YOUR SIMULIA PORTFOLIO LICENSE ON THE CLOUD

Given the increasing adoption of the cloud for HPC computing, SIMULIA customers may want the flexibility to use a cloud provider to run Abaqus, Isight, Tosca or fe-safe. Utilizing a cloud provider eliminates the need to procure additional on premise compute resources that may not be needed on an ongoing basis. This option is available through one of the cloud providers mentioned later in this article using a bring your own license (BYOL) model approach. The SIMULIA software and tokens must be purchased from Dassault Systèmes, not the cloud provider.

Quite simply, this works by having the compute resources in the cloud and your existing license server on your corporate network. To run Abaqus, Isight, Tosca or fe-safe in the cloud, simply direct the software to check out tokens from your license server as depicted below. It is important to note that only standard or extended licensing tokens are supported in this scenario, not the recently announced **3DEXPERIENCE** Abaqus/CAE offering.



GOMPUTE A GRIDCORE COMPANY

Founded in early 2002, Gcompute has become a leading simulation and HPC solution provider. Gcompute is headquartered in Gothenburg, Sweden and has local offices in Lugo, Spain; Stuttgart, Germany and Durham, North Carolina, USA. Gcompute's team consists of engineers, computer scientists and CAE experts who bring the latest HPC technology to customers around the world. Gcompute provides services worldwide, with solutions developed for geographically distributed engineering teams. With Gcompute the customer gets a ready-to-use platform in an HPC system configured only for CAE. Gcompute owns and operates a secure infrastructure with their own software platform, which is focused to provide HPC for CAE.

For More Information
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iSiD IT Solution Innovator

Information Services International-Dentsu, Ltd. (ISID) provides consulting, system construction, package software, integration and operational management services to support the business areas of product development, manufacturing, service, sales and marketing for the manufacturing industry. ISID provides its services to Japanese domestic and worldwide Japanese manufacturing companies are ISID customers. As a pioneer of CAE solution providers, ISID provides user support services with a rich set of high-function analytical software, as well as for manufacturing companies in various fields. PLEXUS CAE provided by ISID is a SaaS system that facilitates analysis and execution of Dassault Systèmes products such as Abaqus, XFlow, 3D Electromagnetic Simulation Software, etc. in the cloud environment. ISID provides flexible customization and total support corresponding to individual requests.

For More Information
g-plexuscae-sales@group.isid.co.jp

Alliances

NIMBIX

Nimbix provides a purpose built compute cloud for big data and computation. Nimbix offers high performance applications as a service through the Nimbix Cloud, dramatically speeding up data processing for Energy, Life Sciences, Manufacturing, Media and Analytics applications. Nimbix services customers worldwide. Nimbix helps customers solve their toughest computing problems faster and easier than they thought possible. Nimbix was the first cloud computing provider to deploy computational accelerators as well as the first to utilize containerized environments on bare metal machines. Everything Nimbix creates is with a singular purpose—to deliver fast, economical solutions that help their clients solve their toughest challenges. Instead of relying on virtualization, as many cloud providers do, the Nimbix cloud is built on powerful bare-metal machines. This approach gives you the ability to complete complex tasks faster than ever before at a cost that's typically lower than alternative solutions.

For More Information
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Penguin Computing is a leading U.S. developer of open, Linux-based HPC, enterprise data center and cloud solutions, offering a range of products from Linux servers to integrated, turn-key HPC clusters. Penguin Computing on Demand (POD) offers HPC accelerated time to solution without the complexity and expense of owning a cluster. Penguin Computing services customers worldwide. SIMULIA customers enjoy the advantages of HPC, such as shorter run times or larger models, and continue to use familiar tools, such as Abaqus/CAE on POD. Penguin Computing offers HPC as a service. The keyword is service. Penguin Computing's ability to provide on-demand, cloud HPC resources as a complete service offering -- backed and supported by HPC experts -- is what differentiates them.

For More Information
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Rescale is HPC in the cloud. Rescale's ScaleX® platform connects SIMULIA product users to big compute resources in the cloud. SIMULIA products come pre-installed and tuned on the ScaleX platform and can be run on-demand using existing licenses. Scale out on virtually unlimited hardware to solve the most complex multiphysics problems with unparalleled speed. Run simulations in batch from a command line interface and interactively post-process on a virtualized cloud desktop without transferring large data sets. Rescale services customers worldwide. They offer a multi-architecture environment to ensure engineers always run on the best hardware configuration without queueing. Access thousands of cores and the latest NVIDIA Tesla GPUs and InfiniBand interconnect, to reduce turnaround time and use SIMULIA licenses cost-effectively. Rescale understands that successfully leveraging the public cloud can be challenging and time consuming. Their turnkey platform removes the burden from IT managers to build and maintain a cloud architecture. Users can be up and running with the Power of the Portfolio in the cloud within a day. Compared to other cloud providers, their multi-cloud infrastructure prevents cloud vendor lock-in, always ensuring the best price and performance.

For More Information
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UberCloud is the online community, marketplace, and cloud technology for engineers and scientists. They service customers worldwide. UberCloud makes Abaqus Unified FEA and other SIMULIA software available at engineers' fingertips, on demand, completely portable across private and public clouds, enabling ease of access and use, self-service, interactive and batch, and full control of users' complete hardware/software stack and data in the cloud. UberCloud started in 2012 with creating an engineering cloud community of over 5000 participants, performing 200+ engineering cloud experiments, and publishing more than 80 engineering case studies. Based on this vast experience, UberCloud has developed novel high-performance computing (HPC) software containers which enable familiar ease of use, self-service, interactive and batch, and full control of your application and data in the cloud.

For More Information
Thomas.Francis@TheUberCloud.com

For More Information
<https://www.3ds.com/products-services/simulia/alliances/>

DEMOCRATIZE ANALYSIS USING SIMULATION VERTICAL APPLICATIONS

We are seeing a change in mindset in industries: They are incorporating simulation earlier in the product development lifecycle. Recognizing this, SIMULIA is fashioning solutions focused on usability, ease and designers' requirements for design validation.

Industry-specific Vertical Applications created within the **3DEXPERIENCE** platform make complex analyses easy for design engineers and help drive their product design. The vertical applications can be set up using the Physics Method Reuse app in a simplified, top-down sequential, user-guided setup ideal for any scenario that has been standardized within an organization. The app comes with any role that includes a scenario app. It is available out-of-the-box with no additional license required, and the XML-based setup requires minimum scripting, facilitating straightforward vertical application construction.

EXAMINING A WORKFLOW ON THE 3DEXPERIENCE PLATFORM

Door hinges play an important role in automobile design. They are part of the door-retention component that holds the door in case of impact. These can become worn or damaged from wear and tear, which causes the door to sag. Door sag causes misalignment, which can prevent the door from shutting correctly and lead to safety issues. Automotive companies have been performing door-sag analyses for a long time now to optimize the door weight and the strength and weight of the hinge components.

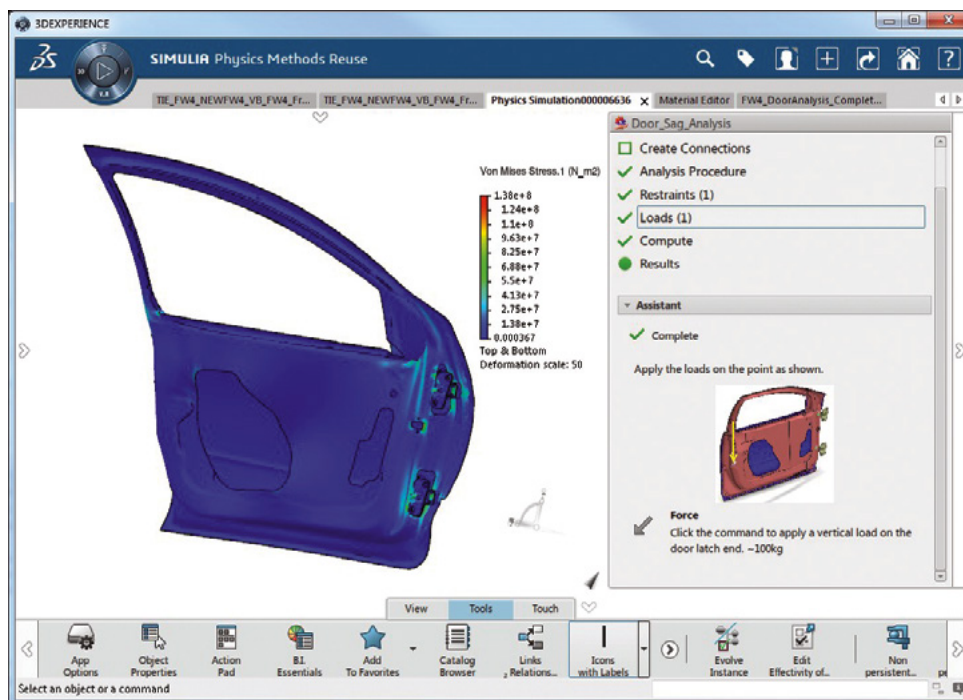
The traditional door-sag analysis workflow has been created as a vertical applications on the **3DEXPERIENCE** platform. This workflow provides ease of setup and uses our wizard-based vertical application to democratize finite element analysis to engineering designers creating door-hinge components.

This particular analysis was done using the Structural Analysis Engineer role and can be extended to any industry with doors in their assemblies. The car-door model contains the inner and outer sheet-metal panels, which are fastened using spot-welds, and the hinge components, which include the hinge parts and the hinge pin. A load is applied on the door handle side to mimic the weight of a person pushing down on it. Based on the stress results of the analysis, the geometry of the hinges is updated quickly with the power of design parameterization and knowledgeware. The custom vertical application method provides a streamlined way of setting up the simulation model, guiding designers to gain new insights, and offering a time-saving tool for engineers.

With this workflow applied in a vertical application, the design of the door-hinge components is quickly validated with the power of the platform reducing the design cycle time. Furthermore, this contributes to better understanding and collaboration between designers and simulation experts.

Discover all simulation roles for designers and product engineers

<https://www.3ds.com/products-services/simulia/disciplines/application-engineering/>



A published door assembly sag analysis vertical application

3DEXPERIENCE for Academia

FOCUS ON SIMULATION

Bringing Innovation and Industry into the Classroom



3DEXPERIENCE for Academia is an advanced product innovation platform designed for use across a variety of academic departments. It offers the ideal infrastructure for bringing industry-endorsed practices into learning. Encompassing comprehensive CAD, CAM and CAE capabilities, the platform provides powerful solutions for managing collaborative work and joint innovation. Fully modular, the platform can be adopted either in full or for a specific component.

Through an intuitive, web-based user interface, educators can easily create domestic or international collaborative environments, such as student projects or exams, and assign roles to participants. Students can start projects on campus, continue at home, and discuss issues over online communities or screen-sharing sessions. The platform ensures that they always have access to the latest version of their work.

3DEXPERIENCE for Academia provides a proven environment for deploying digital labs involving realistic virtual 3D equipment, coupled bi-directionally with real remote devices. By creating an Internet of Things (IoT) across dispersed pools of learners, educators, devices and content, the platform opens new horizons for innovative educational practices, such as distant learning, Massive Open Online Courses (MOOCs), and flipped learning.

While the cloud version is especially relevant for institutions with limited IT support, an on premise option is now available for those looking for extended integration within their own operating environment. Both options offer equivalent functionality, including social and collaborative capabilities. Both provide the same scope for scaling from focused to multi-purpose use.

3DEXPERIENCE ESSENTIALS

3DEXPERIENCE Essentials is a broad application set built upon the Business and Industry Innovation foundation, encompassing a vast set of Dassault Systèmes solutions.

The ideal basis for universities or technical colleges to support their transition toward project-based learning or student-centered learning, **3DEXPERIENCE** Essentials provides a complete digital framework for team-based ideation, contextual learning, collective innovation, solution creation and various methods for project evaluation.

New additions focus on various aspects of powder-bed fusion additive manufacturing, including nesting, automated support design and laser path optimization. New cutting tool design functions extend the broad set of subtractive manufacturing capabilities.

DESIGN AND ENGINEERING

Design and Engineering extends **3DEXPERIENCE** Essentials with the capability to automate the modeling of parts produced using specific manufacturing processes, such as sheet metal, composites, and molding or routed systems comprising pipes, tubes and wires. In addition, Design and Engineering automates the associative design of tooling which is required to actually produce such parts and systems.

Essential to teaching modern development practices in industries such as foundry, automotive, and aerospace, Design and Engineering is also an ideal solution for learning and teaching industrial design and styling. It brings advanced capabilities seen as critical in several national manufacturing initiatives: topological optimization in support of additive manufacturing, an end-to-end packaging solution to further reduce new product time-to-market, and various simulation capabilities for plastic injection parts, fluid dynamics and composite optimization.

ARCHITECTURE AND CIVIL ENGINEERING

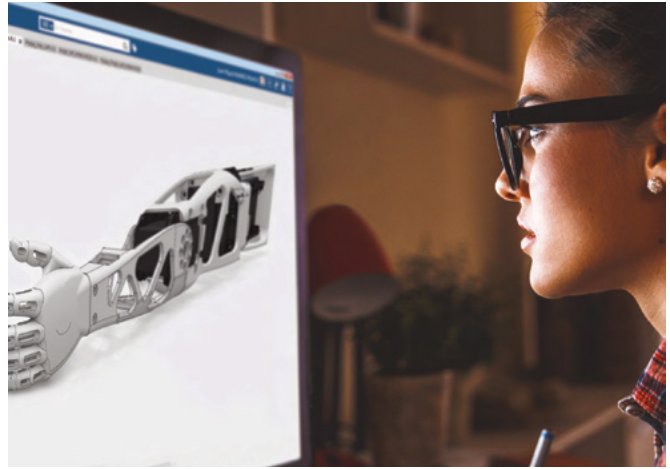
Architecture and Civil Engineering is a new set of capabilities expanding the powerful collaborative framework of **3DEXPERIENCE** Essentials in the construction and offshore and shipbuilding industries.

Especially targeting early project stages, it provides schools of architecture and departments of civil engineering with an integrative Building Information Modeling (BIM) environment to harmonize interactions between creative architects, architectural engineers, and fabrication and construction engineers.

Powerful methods for conducting multidisciplinary trade studies help optimize the overall structure of ships, buildings, dams, stadiums, and bridges. New steel structure analysis and routed systems modeling capabilities further facilitate structure, HVAC, fluid and electrical engineering.

For More Information

<https://academy.3ds.com/en/software/3dexperience-for-academia>



SIMULIA ACADEMIC PROGRAM

From undergraduate coursework to PhD thesis, the SIMULIA Academic Portfolio has what you need for Realistic Simulation, Optimization, Durability studies, and Multibody Simulation. We've taken our entire collection of commercial products and packaged them into 3 simple, affordable offerings for academic customers.

The SIMULIA Research and Teaching Suites include Abaqus, Isight, Tosca, and fe-safe. New XFlow academic products are now available as part of the SIMULIA Academic Portfolio!

1. SIMULIA Academic Research Suite

SIMULIA Academic Research Suite—Commercial-level functionality for highly sophisticated research and priced for academic budgets. Custom licensing options ensure the right license is available for a single user, an entire campus, and everything in between.

The SIMULIA Research Suite has the same functionality as our commercial code, and is a powerful tool for conducting state of the art research. Students in Masters and Doctoral level programs are able to analyze and solve realistic engineering problems. Powerful user-defined subroutines allow flexibility in modeling advanced research materials, and unlimited model sizes and parallel processing capabilities make all simulation jobs possible.

2. SIMULIA Academic Teaching Suite

The SIMULIA Academic Teaching Suite contains feature-rich educational licenses for classrooms and computer labs with minor limitations compared to the Research Suite.

The SIMULIA Teaching Suite also includes the same functionality as our commercial codes, but does not support user-defined subroutines and limits the model sizes of the Abaqus simulation to a very workable 250,000 nodes. The Teaching Suite contains a license size appropriate for supporting a classroom of users, and is priced with teaching and educational budgets in mind. Use of the SIMULIA Teaching Suite is limited to teaching and student project work and is priced with educational budgets in mind. It is not allowed for research, including research associated with graduate or post-graduate level thesis projects.

3. Simpack Academic Package for Research and Teaching

Simpack is a general purpose Multibody Simulation (MBS) software used for the dynamic analysis of any mechanical or mechatronic system. It enables engineers to generate and solve virtual 3D models in order to predict and visualize motion, coupling forces, and stresses. The Academic Simpack License includes commercial-level functionality available for use for both academic research and education.

ABAQUS STUDENT EDITION

A zero-cost personal finite element analysis tool for solving limited size non-commercial problems (1000 nodes) not requiring user subroutines. It is governed by a personal use license and may be used on a perpetual basis. The Abaqus Student Edition includes the full set of online Abaqus documentation and is supported on Windows 7 & Windows 8 (64-bit only). The Abaqus Student Edition is available free of charge at the SIMULIA Learning Community.

Did you know that SIMULIA offers free software to degree granting academic institutions for student competition teams such as Formula SAE, World Solar Challenge, and others?

Visit SIMULIA Academic Sponsorship to Learn More

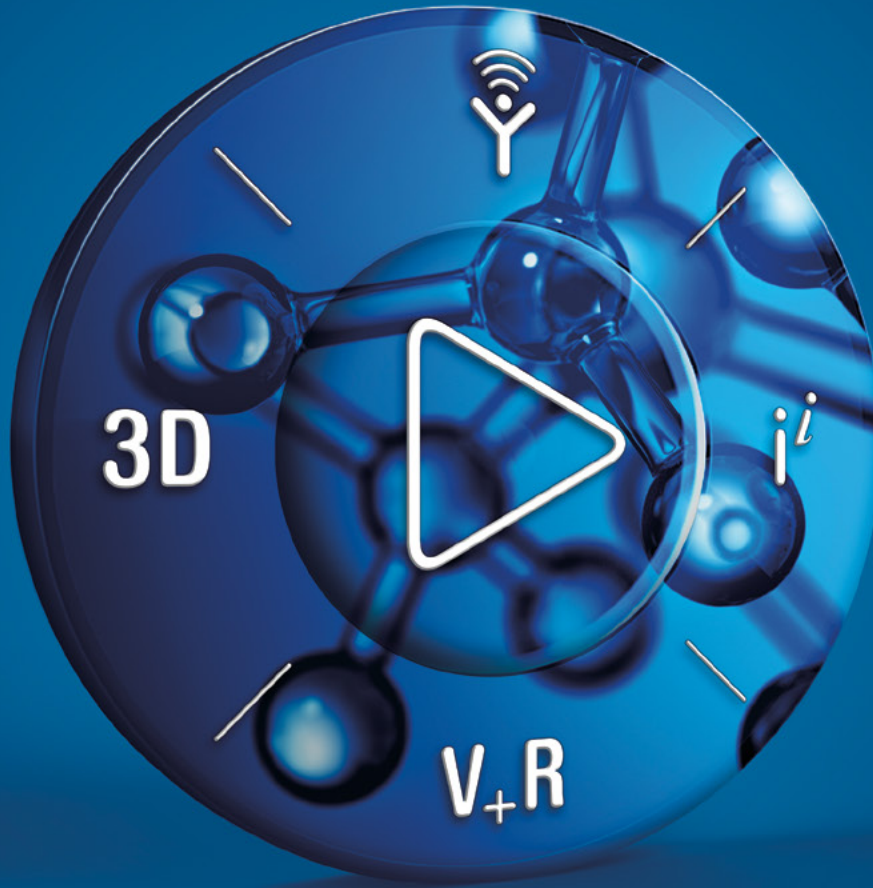
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We are bringing back many aspects of our long-running SIMULIA Community Conference in addition to the latest scientific and engineering innovations, techniques and customer applications. From a deep dive into Additive Manufacturing to Product Seminars and Hands-on Training Courses, this is the one event you cannot afford to miss.



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