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SIMULATION
THE FRENCH TOUCH

cea

DE LA RECHERCHE À L'INDUSTRIE

ccrt

Centre de calcul recherche et technologie

Un tremplin pour **L'INNOVATION** industrielle

Localisé dans le Très grand centre de calcul du CEA (TGCC), à Bruyères-le-Châtel (Essonne), le CCRT offre à ses partenaires la puissance de calcul nécessaire à leurs simulations, et les compétences des équipes du CEA dans toutes les disciplines scientifiques liées à la simulation numérique.

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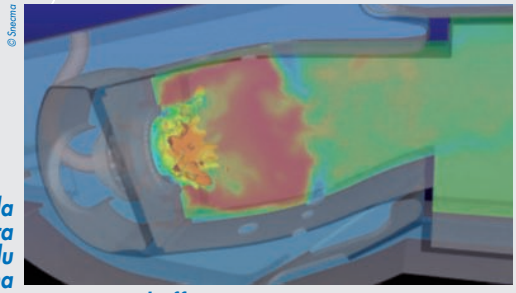
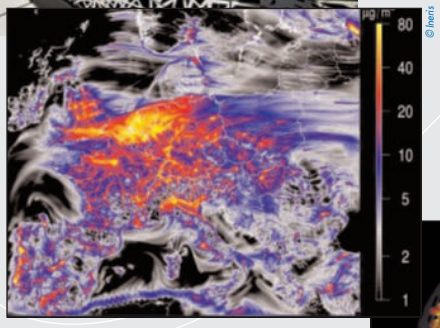
Airain, calculateur du CCRT (200 Teraflops).



© Snecma

Simulation de la combustion ultra low émissions du moteur Snecma "Silvercrest" pour avions d'affaires - Snecma.



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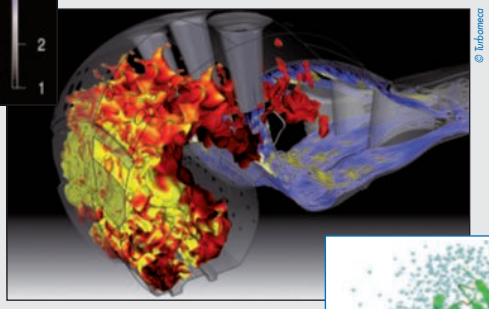
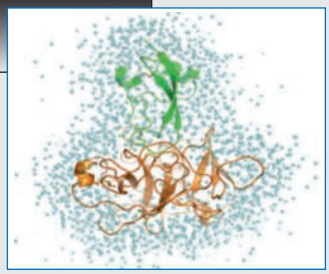
Simulation de la qualité de l'air à très haute résolution sur l'Europe - Ineris.



© Turbomeca

Simulation numérique de la combustion dans un foyer de turbomoteur d'hélicoptère - Turbomeca.

Nouvelles approches physiques pour simuler intensivement des systèmes biochimiques.



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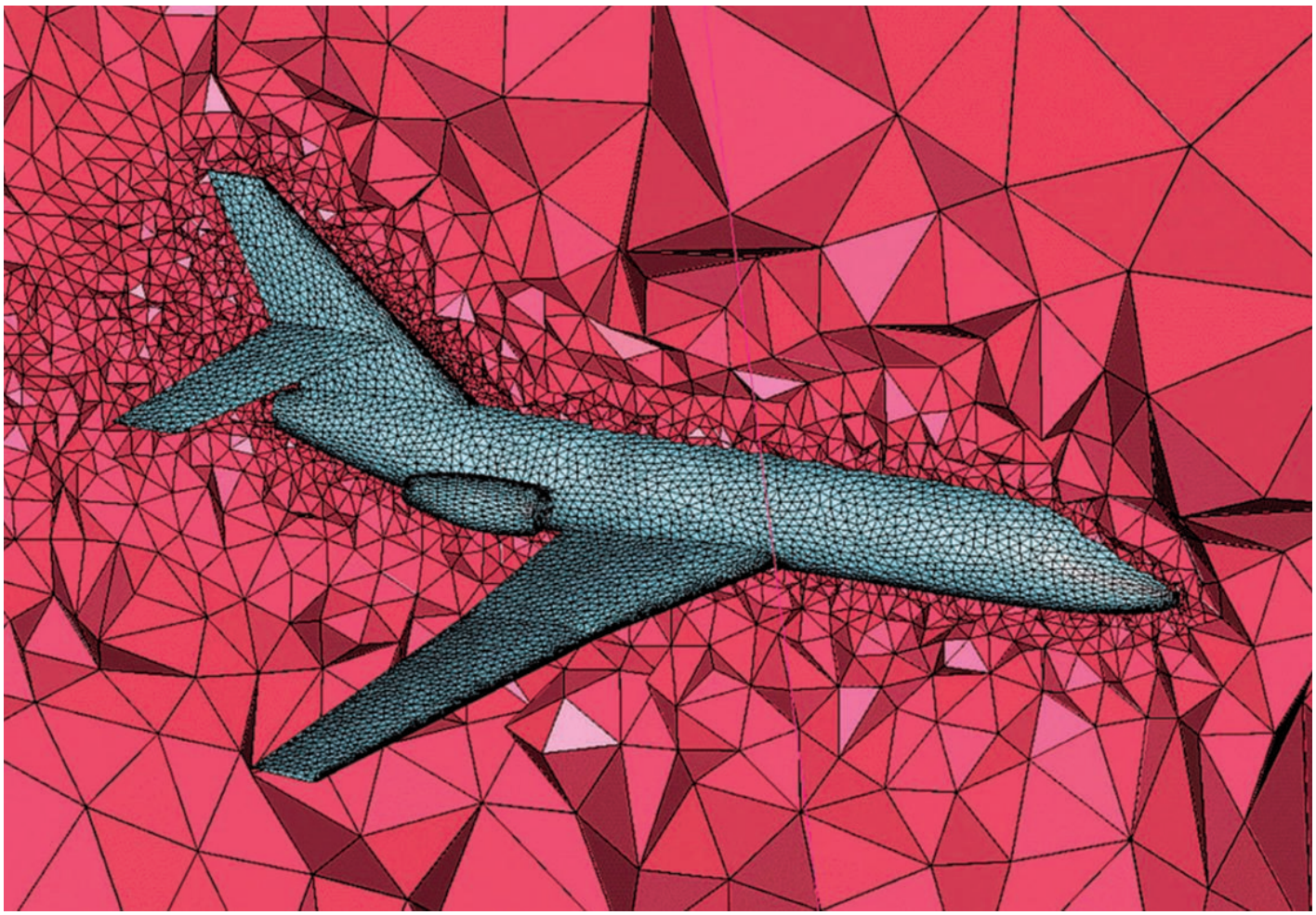
France, a hidden land of simulation

Our know-how is unquestioned, but it is still far from common knowledge. France is a land of digital simulation and high performance computing, a champion even. But who knows about it? Here are some of the facts: Bull has built three of the world's 20 most powerful supercomputers, making it the number-two global manufacturer in 2012 after IBM and the only European company in the field. Esi Group is a 40-year-old French company that has retained the agility of a start-up while becoming the leader in crash-simulation software and virtual prototyping. CGG (formerly CGG Veritas) can align 12 petaflops of computing power to process geophysical data on underground hydrocarbon reserves using its own software. There are at least nine computing centers open to small companies and the French government is now investing in new pay-per-use computation tools through Bull or SystemX, the new technical research institute. Well ahead of open source innovation and competitive clusters, French industrialists were already partnering with government research centers to develop Scilab open source digital computation software to ensure their independence from American proprietary tools. Our outstanding French researchers have always been on the cutting edge, with the conception of Grid 5000, they gave themselves a platform for grid computing with more than 8,000 cores, the only one of its kind in the world, designed to test innovations using parallel distributed processing. Every year, without any fanfare, state-run and university research laboratories spin off promising simulation start-ups in every area: health, environment, transport, energy and, of course, computing. But who knows about all this? We do. And so will you when you've read this special issue on simulation made in France, with articles by expert journalists on the editorial staffs of L'Usine Nouvelle and Industrie et Technologies. Don't keep this information to yourself. Pass it on by circulating this issue as widely as possible. It's the best way to convey our French expertise and resources to the audience it so justly deserves. ■

AURÉLIE BARBAUX

Every year, state-run and university laboratories spin off promising start-ups in every area.



Mechanics calculation of compressible fluids on airplanes (Inria).

INRIA

Technology

NO MANUFACTURING WITHOUT COMPUTING

Simulation tools are an essential addition to design tools. Everything can be simulated, whether to optimize performance, predict lifespan or promote innovation.

BY PATRICE DESMEDT

Anything is possible. “We can simulate anything, in any industry”, says a forthright Patrice Gommy, SGI’s director of marketing for southern Europe. This manufacturer sells supercomputers to the biggest users of simulation software. “The first consumers, such as the automobile, aeronautical and nuclear industries, and researchers, have been joined by the biomedical and nanotechnology industries”. We know how to simulate everything about a plane, including its flight performance. But simulation is also taking root in some unexpected places. For example, at Procter & Gamble, to develop their Pringles potato chips; at electrical appliance manufacturers, to check stability of functioning robots or the safety of electric fryers filled with hot oil; or at a sports equipment manufacturer, to monitor the performance of sports shoes.

Alexis Lapouille, director of computing at Aero Concept Engineering (ACE) adds: “Simulation has entered a new era, although many people were initially cautious towards or even suspicious of simulation and only used it for research, it is now widely used in industry, especially for separate studies. Today, we are even heading towards multi-physics

simulation. Industry is pragmatic and regards simulation as a time-saver during product development." "It is often combined with a tool for finding out whether or not a part is going to break," observes Delphine Genouvrier, director of product simulation at SolidWorks. "In reality, not many products break. Simulation is primarily needed to help innovation."

Three factors encourage the use of simulation. First, when a product absolutely must succeed (aeronautical, nuclear and medical products). Secondly, ensuring compliance with norms, whether checking hearing aids to make they are not distorting sound or the resistance of grain silos, and lastly, to obtain reductions in mass and lessen development time. Automobile manufacturers are trying to reduce fuel consumption and combat extra weight cars have acquired over the years. A decrease in weight that must be accompanied by a resistance at least equal to the shock. Mobile phones need to withstand being dropped and seat coverings on public transportation need to resist vandalism such as ripping and graffiti.

The end of computation offices

Engineers have no shortage of tools for their work, with a range of specialized products: Fluent from Ansys, Flowmaster distributed by EnginSoft, PAM-Crash and VA One from ESI Group, Simulink from MathWorks, Nastran from MSC Software, NCSIMUL from Spring Technologies, etc. Furthermore, general computer-aided design (CAD) software also includes adaptive modules: Catia and SolidWorks from Dassault Systems, NX from Siemens PLM, Inventor from Autodesk, Creo from PTC, and TopSolid from Missler, etc. Simulation 360 from Autodesk is encouraging democratization, with cloud access, pay-per-use and an interface with built-in simplified access. The widely used SolidWorks also has various modules. "Building simulation into CAD tools makes innovation easier", observes Delphine Genouvrier. "Product designers can start simulations easily from their CAD tool. There is no longer the need to use an external product requiring adaptation, which is synonymous with wasting time and the risk of data loss. We believe that simulation should be done in the design office and not in the engineering office next door."

Efficient software is boosted by breathtaking developments in computer performance. This has been further accelerated in recent years by the use of graphics processing units (GPUs) as calculators. Silkan, which was created by merging two start-ups, HPC Project and Arion Entreprise, offers an 'application in a box' solution with hardware and software to speed up calculations. But this improved performance has just shifted the problems. Discussion about computing power is no longer about time (a night, an hour, etc.), but

A new problem has arisen : access to data ; hence the need for results processing software.

GROWTH MARKET

SOFTWARE AND SERVICES

Global simulation market

3.5 billion dollars
Global market

0.4 billion dollars
French market

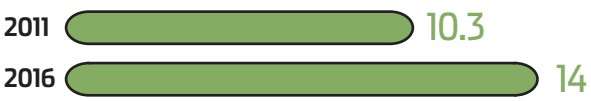
+ 14 % per year over the next five years

13 principal developers
Altair Engineering ; Ansys ; Autodesk ; CD-adapco ; Comsol ; Dassault Systèmes ; ESI Group ; LMS International ; MathWorks ; MSC Software ; PTC ; Samtech ; Siemens PLM Software

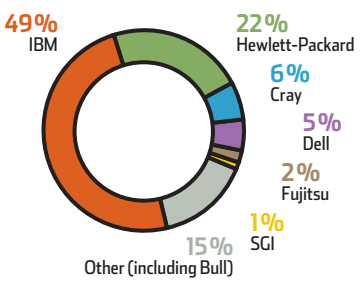
SUPERCOMPUTING

3,676 petaflops of peak cumulated power in the five machines of the GENCI partnership (state, CEA, CNRS)

Global Supercomputer market
(in billions of dollars)



Market share
By constructor for the first semester of 2012



Total market in Europe

4.5 billion euros of turnover in supercomputing in 2012 *

350 million euros for in the cloud HPC services in 2015 *

TRAINING

Market for military virtual training
9.03 billion dollars

Market for civil aviation training
3.2 billion dollars

RECHERCHE

500 million in **european financing** for the Human Brain simulation project for a period of ten years

SOURCES : IDC ; VISIONGRAIN ; * ESTIMATIONS BULL

rather about the proliferation of simulations that are now available. This vast quantity of results then needs to be analyzed and used wisely.

Today's software works on increasingly precise geometry and models can be easily modified. "In the 1990's, you had to go back to the model, revise the meshing and check everything", reminisces Hugues Drion director of the manufacturing division of Autodesk France. "Simulation was only used by big industries. Today, it is widespread and used increasingly for predictive work".

Results analysis

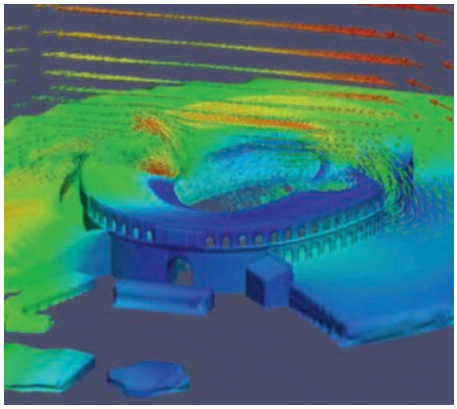
A new problem has arisen: access to data; hence the need for results-processing software. Car manufacturers work on whole components and use stochastic software to analyze results. It is impossible to view the results, as there are too many of them. Aircraft manufacturers have opted, along with their sub-contractors, to simplify the problem by breaking it down into simpler parts. Humans have a role to play in spotting red herrings. "If you want to optimize a structure, you need to understand physical phenomena. Software is not a black box that does whatever it wants. Simulation is very powerful, but it can bog things down". Explains Yves Biret, director of product design and computing at the design and engineering company SDEI Ouest.

Simulation does not claim to be absolutely accurate. "It is not indisputable," states Patrice Gommy. "But science is not indisputable. Many design offices ask if simulation is accurate. We should not be having this discussion." For Alexis Lapouille, "Digital simulation remains mathematics. It is an approximation of what reality might be like, obtained by imposing simplifying conditions. The engineers who design simulations significantly impact on the quality of results. In the field of aerodynamics, wind tunnels still play a decisive role." Yves Biret is even blunter: "You should never have blind faith in software, but rather analyze the results for coherence. Software is very good at applying stupid mistakes." The good news? Machines still need human beings.

SIMULATION IS EVERYWHERE

AS IN ANCIENT ROME

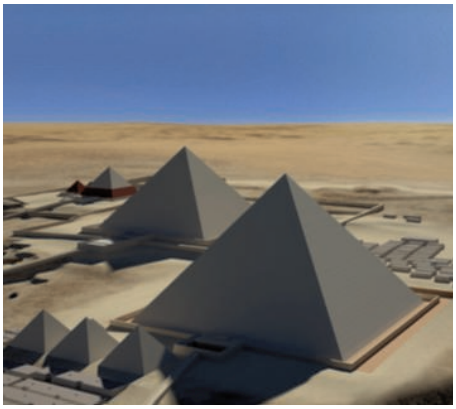
THE ROMAN CANOPY AT LE PUY-DU-FOU



The director of Le Puy-du-Fou theme park has devised a stadium canopy, like those in ancient Roman amiphitheaters, to protect spectators from the sun. It was designed by the design and engineering company SDEI using Soildworks, the CAD software from Dassault Systèmes, which was also used for simulation. The wind-resistance work was done by Meteodyn, a software vendor and research consultancy. Designing this completely novel canopy was complicated by the fact that SDEI had to take account of existing structures and comply with safety regulations for equipment intended for the public. Without simulation tools, Yves Biret, director of products and computing at SDEI Ouest, would never have convinced the inspection body of the system's compliance.

CONSTRUCTION MYSTERY

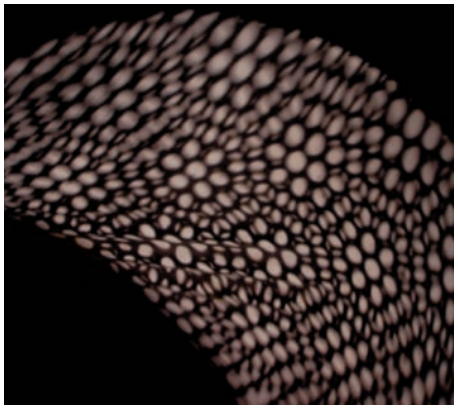
THE PYRAMID OF CHEOPS



How did the Egyptians construct pyramids? This question has given rise to many more or less bizarre answers, which have always come up against insuperable obstacles. The architect Jean-Pierre Houdin devised an innovative solution focusing on a ramp inside the pyramids. To confirm his hypothesis, he modeled the construction site using simulation tools from Dassault Systèmes. This included materials' physical features, the effect of the pyramid's own weight on itself, as well as modeling of mechanical systems used during construction. This software enabled him to prove that his theory was correct. The construction of the Pyramid of Cheops is no longer a mystery.

THE BEST AERODYNAMIC SHAPE

PRINGLES POTATO CHIPS



Pringles are the progeny of digital simulation on several accounts. Their complex hyperbolic paraboloid shape contributes to their attractiveness, while also preventing them from breaking in their can. Thousands of calculations were required to develop this perfect shape, which was changed after the first production tests. Since the Pringles blew off the production line, their aerodynamic shape was revised. Simulation was also used to optimize their thickness. Procter & Gamble wanted them to be as thin as possible, while also able to withstand salt addition without swelling up. Eventually, the manufacturer successfully optimized its production while also providing customers with a sensory treat.

D.R.; LUXPIX; DASSAULT SYSTÈMES

Interview

"SIMULATION IS A FACTOR IN COMPETITIVENES"

For **Gérard Roucairol**, president of the Académie des Technologies and the Teratec Association, simulation is a key element of innovation. By combining digital technology with design and manufacturing, we can relocate industry in France.

INTERVIEW BY THIBAUT DE JAEGHER AND PATRICE DESMEDT

Where does the French talent for simulation come from?

Originally, the interest came from a number of graduates of the French School of Applied Mathematics, founded by Jacques Lions, who focused on the finite element method. Their research was concerned primarily with applications, particularly in fluid mechanics. Engineers who, in turn, have made a significant transfer of knowledge to industry took up the movement.

What exactly is the role of simulation in industry?

Today we are seeing a wide diversification of simulation applications. In addition to the aerospace and automotive industries, it is increasingly used in healthcare and multimedia, as well as in the field of big data with a different data-driven approach to simulation. In these areas, researchers learn by producing statistical models of processes that we do not fully understand, processes that may be infinite such as human behavior. These diversified uses have led to a diversification of the players involved. And in this new wave of players, we are seeing smaller companies. But just because your company is small doesn't mean the problems it has to solve are small.

How can small companies gain access to the supercomputers required for simulation?

The solution lies in mutualizing. We have entered an era in which computing power is developed by accumulating resources. The cloud is part of that dynamic.

Now that remote access has been standardized, this solution can be offered to a broad market using a different business model: pay-per-use. Small companies can thus access high performance computing. The problem then becomes one of skills. That is the real issue today.

Can simulation become an industry that counts in France?

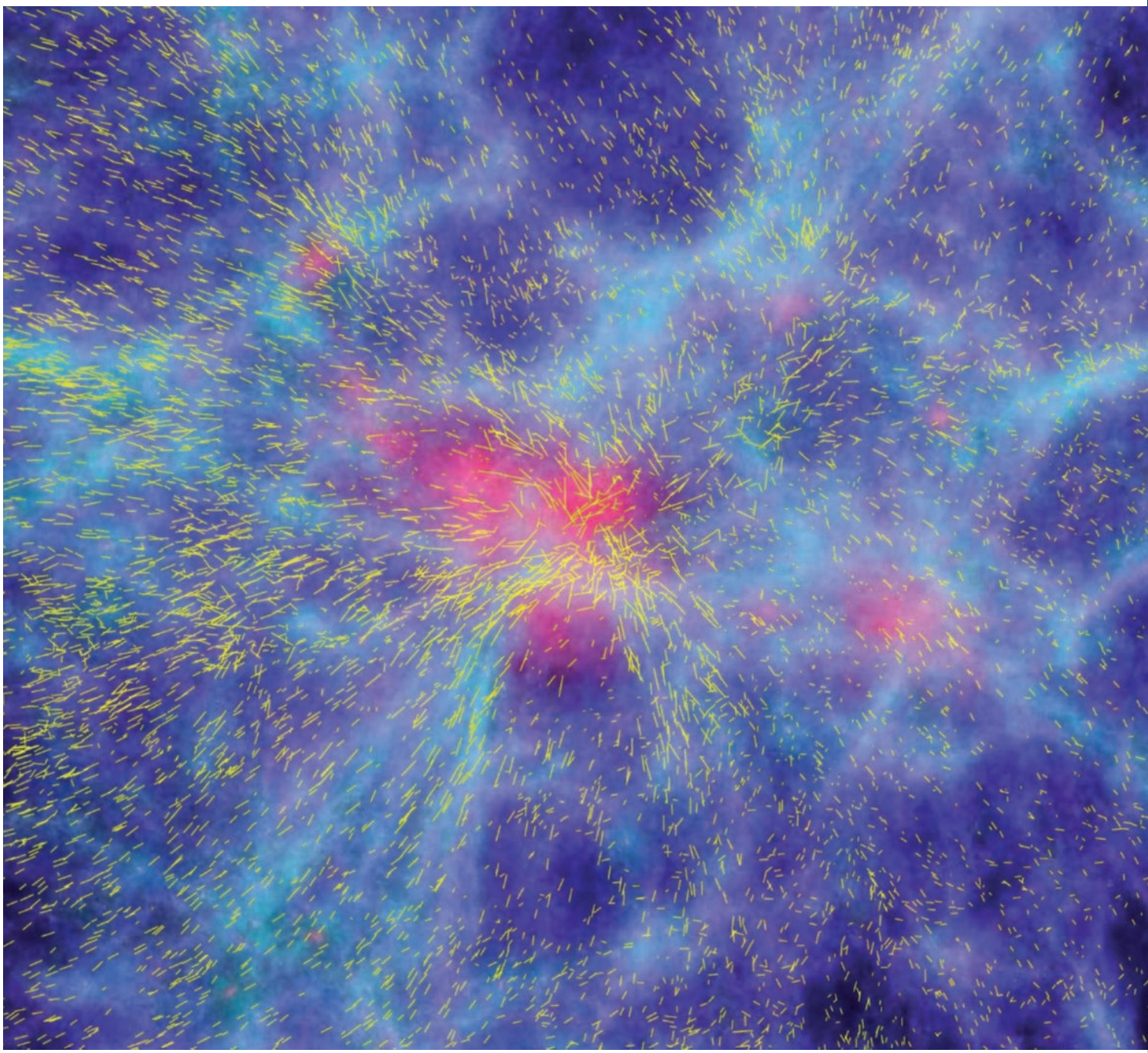
Simulation is becoming a key tool in innovation and competition because it enables shortcuts in design cycles. It is therefore a major factor in acquiring a competitive edge. The design cycle is where added value is produced. If we want to relocate factories in France, it is essential to integrate digital design and manufacturing. And even if we are in a period of breaking away from traditional machine architecture, manufacturers using simulation shouldn't wait for the new machines to get started. The French have to adapt now, even if the new frameworks force them to revise all their program codes. This is one of the challenges France faces. Fortunately, we are in a good position to do this because we have our own manufacturer – Bull – and start-ups like Kalray, a spin-off of STMicroelectronics and the AEC, working on these topics. Kalray has just completed a 256-core processor for embedded IT applications.

If you were to make an appeal to French manufacturers, what would you say?

Design and manufacturing can no longer be separated from the overall chain of integration. To me, that is absolutely essential. The integration process has to be expanded to include digital models and simulation tools. French manufacturers have to succeed in simultaneously reinforcing integration in the value chain and modernizing their facilities. ■

PASCAL GUITTET

"Simulation is becoming a key tool in innovation. If we want to relocate factories in France, it is essential to integrate digital design and manufacturing."



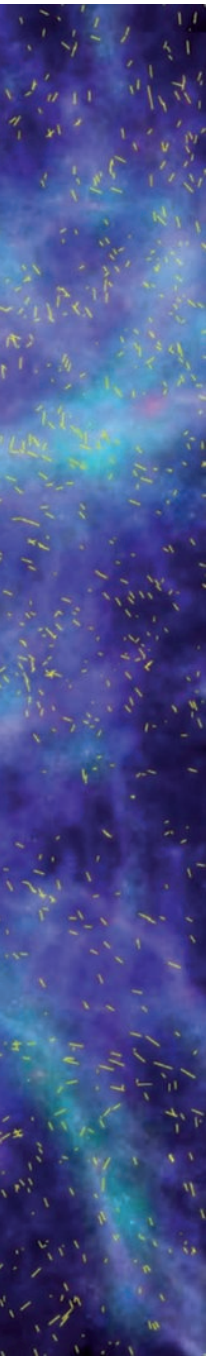
CNRS

Calculation

A FRENCH SCIENTIFIC EXCEPTION

The supercomputers of the future are opening up unprecedented possibilities for simulation. They are also forcing us to rethink mathematical models and digital methods.

BY THIERRY LUCAS



This sample of 100 million light-years illustrates the formation of the greater strucutres of the universe (CNRS).

A million billion instructions per second and a thousand times more by 2018. Supercomputers are so powerful they can simulate everything or almost everything, from blood flow to the operation of a nuclear weapon. And even how the universe was formed from the Big Bang to the present, which is currently being at tempted by a team of scientists from the Paris Observatory, the National Center for Scientific Research (CNRS) and Université Paris-Diderot at the Laboratory of the Universe and Theories (LUTH). To perform its calculations, the research unit is using the Curie supercomputer (2 petaflops) located at the offices of the Atomic Energy Commission (AEC) in Bruyères-le-Châtel, France. Running a supercomputer requires a mathematical model capable of simulating the phenomenon to be explored, along with software capable of achieving optimal use of the machine's resources. Both requirements signify vast areas for research, as the ever-increasing power of these computers opens up new fields for simulation calling for software that runs on tens of thousands of simultaneous processors.

Multi-scale and massive parallelism

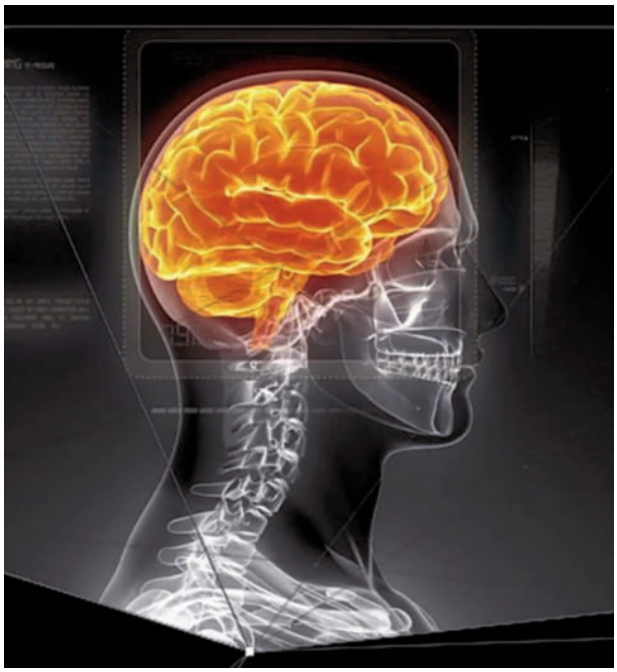
Digital simulation is based on equations that describe the phenomenon to be simulated and the methods to solve them. "French research continues to rank high in the field of applied mathematics, as demonstrated by the Fields medals awarded to Cédric Villani (2010) and Pierre-Louis Lions (1994)," asserts Grégoire Allaire, professor of applied mathematics at École Polytechnique. Mathematicians make up a large percentage of new recruits at the National Institute of Research in Computer Science and Control (INRIA). "The simulation teams bring together mathematicians and computer scientists that are also application-oriented," explains Jean Roman, Deputy Scientific Director in charge of "applied mathematics, computing and simulation."

Structural mechanics in the automotive and aerospace industries has long relied on simulation. Although a "traditional" discipline, it remains a research topic. Optimization is now undergoing rapid development. This no longer means calculating to verify that a design part corresponds to specifications, but rather carrying out dozens of calculations iteratively to arrive at the best possible shape. The research work of Grégoire Allaire, a specialist in shape optimization, has thus culminated in a joint project between EADS, Renault and software publisher ESI Group to develop software that produces optimized structures.

Today, simulation plays an important role in every major research project, from elucidating the operations of the brain to storing nuclear waste, and from nanomaterials to the future ITER thermonuclear reactor. In all these areas, simulation specialists are faced with a challenge best described as "multi-scale". Until now, different models enabled researchers to simulate what was happening on different scales (microscopic or macroscopic), for example, at the level of an individual neuron or of a cognitive function. The aim now is to combine these models. Consequently, the properties of porous materials such as cement or schist can only be understood using a multi-scale approach. An international laboratory, set up in 2012 by the CNRS and MIT, is presently working on this very topic. The same type of problem arises in the study of underground nuclear waste storage. But in this case, the multiple scales must also take the time factor into account: a microscopic phenomenon may have a larger-scale effect if one is thinking in terms of thousands of years. In France, the MoMaS research group working on mathematical modeling and digital simulations related to nuclear waste management has been focused on this particular subject for the last ten years.

Another key point of simulation is parallelism. "We no longer have a choice, it has become a requirement," emphasizes Victor Alessandrini, one of the managers of the Maison de la Simulation, a joint laboratory involving AEC, CNRS, INRIA, Université d'Orsay and Université de Versailles-Saint-Quentin-en-Yvelines. The laboratory helps researchers take advantage of supercomputer potential. Software that can adapt to breakdowns that are statistically inevitable when millions of processors are involved will be required for machines of the future. "Parallelism on a massive scale calls into question algorithmic and digital methods," says Jean Roman. A laboratory shared by the INRIA and the University of Illinois in the United States has been dedicated to solving these problems since 2009. Optimal operation of parallel systems will allow researchers to carry out multi-scale and multi-physical simulations that up until now were impossible. They will also produce equally unprecedented quantities of data that will have to be managed and processed. Science too, is entering the age of big data. ■

"French research continues to rank high in the field of applied mathematics."
Grégoire Allaire, professeur at École polytechnique



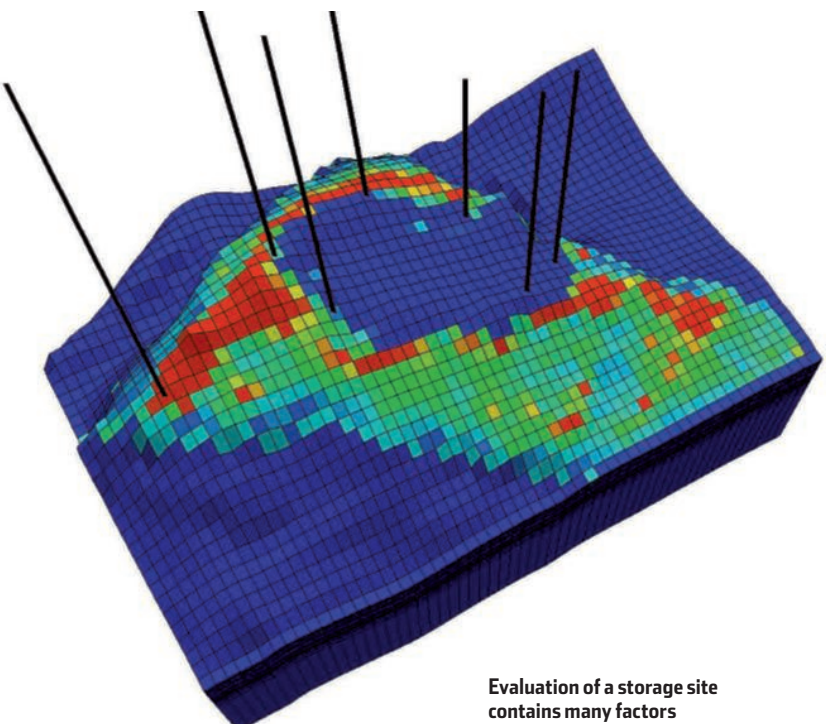
Modeling attempts to pierce the secrets of neurons.

EUROPE'S HUMAN BRAIN PROJECT UNDERSTANDING THE HUMAN BRAIN

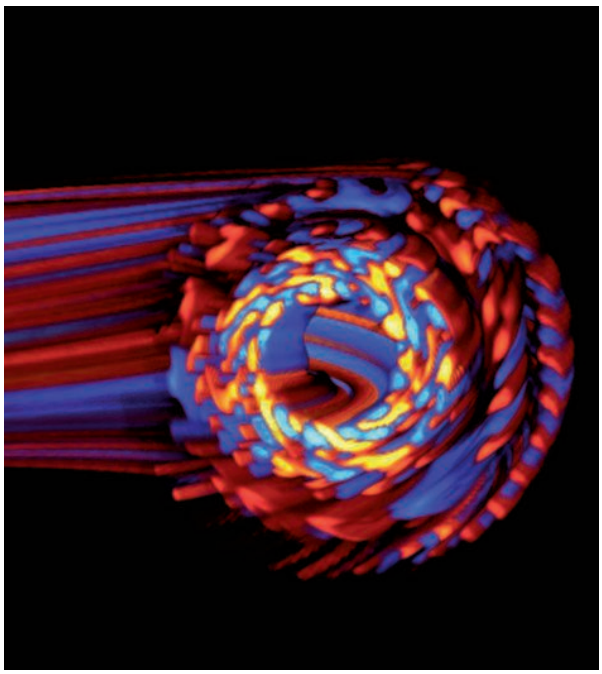
From 2013 to 2023, more than 80 research institutes participating in the European Human Brain Project will attempt to elucidate how the human brain works. Headed by Ecole Polytechnique Fédérale de Lausanne (EPFL) in Switzerland, the project is expected to receive a billion Euros in funding. "Simulation, which is now omnipresent in the neurosciences, is a very important part of the Human Brain Project," declares Alain Destexhe, leader of the computational neurosciences team at the National Center for Scientific Research (CNRS) in France. Several types of brain modeling will be implemented. Detailed simulation of neural networks, each modeled with its specific morphology and physiology, will be carried out by EPFL in line with its own project known as "Blue Brain". This part of the project, which will demand the most computational power and memory capacity, will be performed at Germany's Jülich Supercomputing Center. Other teams will simulate simplified neurons but on a larger scale. The French teams in the project will focus on simulating certain areas of the brain such as the visual cortex. "Our approach is more physiological, with models combining experimental results and theory," explains Alain Destexhe. A mixed approach will also be used at NeuroSpin, the center for research on brain imagery at the Atomic Energy Commission (AEC) to study cognitive functions (decision-making, spatial navigation, etc.). Finally, the huge quantities of data generated by the project, resulting from experimentation such as simulation, will necessitate the development of tools capable of managing immense databases and consulting them. ■

GEOLOGICAL CO2 STORAGE PROJECTING 1,000 YEARS INTO THE FUTURE

Subterranean modeling is something specialists in gas and oil exploration know how to do. But projects for underground CO2 storage – to avoid rejecting this greenhouse gas into the atmosphere – pose specific problems. "The models must be predictive, because it is necessary to estimate the evolution of a storage reservoir over a period of up to a thousand years," explains Frédéric Roggero, a simulation specialists at IFP Énergies nouvelles (IFPEN). Several time scales are taken into account: a few dozen years of underground carbonic gas injection, the evolution of the site after it closes and its sealing integrity (the guarantee against leaks). In fact, geological storage presents the whole spectrum of simulation problems. The system is also multi-scale in space, because it must mimic the reservoir and its possible impact on the environment at a distance of up to several hundred kilometers. Furthermore, the simulation must combine various phenomena: hydrodynamic (gas flow), chemical (the reaction of the gas in contact with rocks) and geomechanical (the evolution of rock properties). Finally a statistical approach is used to test the consequences of unforeseen events. Some models de veloped with input from laboratory experiments are currently in operation and have been validated at storage sites such as the one in Sleipner, Norway. At IFPEN, parallelization is under way to adapt the codes to computers that will enable intensive use of the models when the industrialization of CO2 storage eventually takes off. ■



Evaluation of a storage site contains many factors (leaks, type of subsoil, etc.)



Simulation, indispendable in mastering nuclear fusion.

EPFL ; D.R. ; JEAN-PIERRE BÉBERT

THE ITER FUSION REACTOR
AN UNPRECEDENTED MODELING FEAT

In 2020, the prototype of the ITER nuclear fusion reactor, now under construction in Cadarache, France, is expected to produce its first plasma, an ultra high temperature mixture of ions and electrons confined by magnetic fields. To understand and control what is happening, digital simulation plays a decisive role. With one major challenge: how to invent mathematical models and digital methods that can be run only on supercomputers that will not be ready until 2018! Researchers have been grappling with the task for years, notably in France with the team currently developing Gysela software (AEC, INRIA, universities) to simulate the plasma at the core of the reactor. "We are striving for exascale," explains Virginie Grandgirard of the AEC, alluding to the computers that will reach exaflops, i.e. 1,000 times the power of the largest machines in use today. Which presupposes running the program on tens of thousands of core processors (a partial test on 65,000 cores was conducted in 2012 on the Curie computer at the AEC). But dividing the work by limiting communication between processors remains problematic. To top it off, the teraoctets of data generated by each simulation will have to be managed and transmitted. The French compare their results with those of the European teams at EPFL and the Max Planck Institute. And they are presently working on a program to reproduce the plasma close to the reactor walls. The calculations are less complex but difficult to carry out by parallel computation. Finally, the two programs will have to be joined together to simulate the whole process. ■

"When digital simulation reaches its limits, we go back to experimentation."

PATRICK WAGNER, wind tunnel division director at Onera

Onera, the French aerospace lab, is making intensive use of digital simulation, but it is still resorting to experimental simulation. Why?
These two tools are complementary. Digital simulation reaches its limits when it becomes difficult to write the equations for the physical phenomenon to be modeled. Typically, in certain areas of fluid mechanics involving the study of turbulent or supersonic flows on the wing edge, the equations are highly complex and hard for mathematicians to solve. Even with improved digital codes, it would take extraordinary computing power to process such complexity.

Does that mean computers are going to kill experimental simulation?
Far from it. The United States, for example, which originally opted for the all-digital route, is now reinvesting in wind tunnels, the large installations we use to study the airflow around a model aircraft. Experimental simulation presents its own challenges, however. First, the experiment must faithfully reproduce future flight conditions. Second, to run it, improvements in metrology are necessary to develop new sensors and take the biases linked to the measurement environment more fully into account.

What is the future of simulation?
It will necessarily involve more frequent combined use of both types of simulation. They enhance each other through cross-fertilization. In the case of the Onera study on engines with contra-rotating propellers, the results of the experimental simulations are enriching the digital codes. Without this hybrid effort, it will be difficult to develop breakthrough technologies. ■

STATE-OF-THE ART DISTRIBUTION

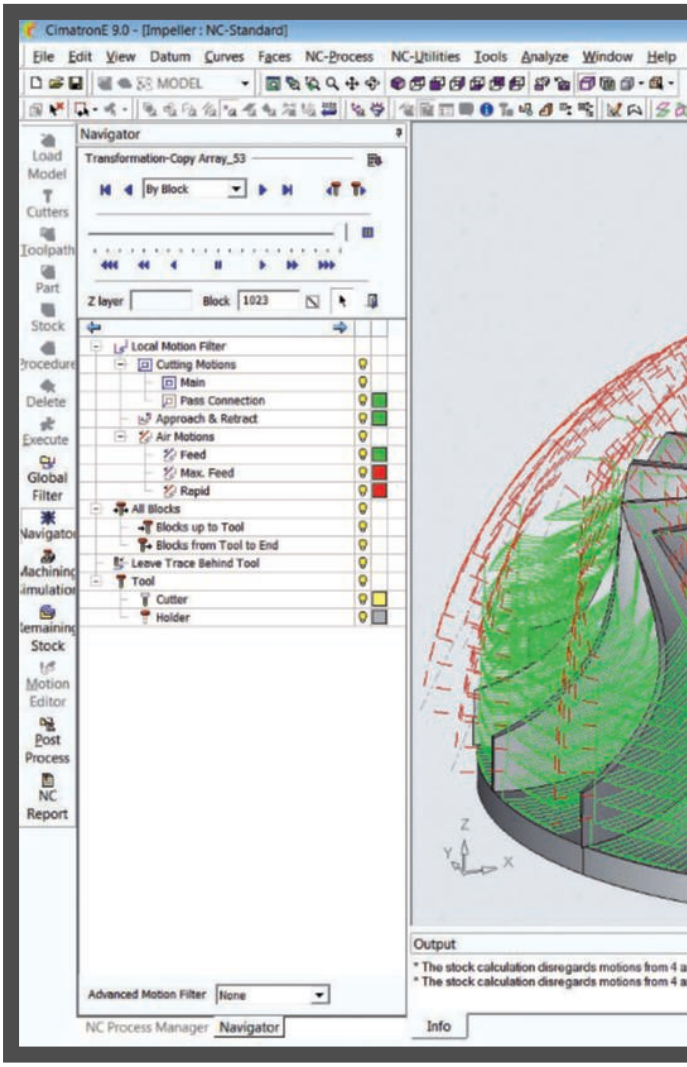
Using Grid5000, a computing grid with more than 8,000 core processors, French researchers are experimenting with innovative solutions for scientific calculation.

BY THIERRY LUCAS

More than 8,000 core processors are operating in ten different locations in France. French researchers have a virtually unique instrument to test innovations in distributed parallel computing thanks to the grid of computers, made up of clusters of PCs connected by the Renater Network (1 Gbit/s). "Grid5000 enables new concepts and algorithms to be validated in all the software layers from network protocols up to applications," says Frédéric Desprez, scientific director of Grid5000, which is funded by Inria (National Institute for Research in Computer Science and Control), CNRS (National Center for Scientific Research) and universities. Computing grids are an "economical" way to access high-powered calculation.

Remote access and pay-per-use

A grid is a boon to many disciplines such as physics, biology, cosmology, cryptology or database management. But running software efficiently on a distributed infrastructure requires innovative IT tools capable of managing parallel tasks assigned to thousands of central processing units or cores. In this regard, Grid5000 is designed to make life easier for users. In order to test what they have developed, researchers reserve remote access to computing resources. Their software applications are then deployed with a simple click. Better still, if the program "crashes" – which is not unusual in the research phase –, the system is automatically rebooted via the network, without having to call the system manager. "From the start, we were doing cloud computing without realizing it," explains Frédéric Desprez. Grid5000 has succeeded in setting up a genuine test bed for reproducible experiments comparable to what is done in physics, but quite new in the IT field. It creates an environment conducive to projects, including theoretical ones, which rely on a validation tool. Similar offers exist, for example the one proposed by Amazon web services. However, according to Grid5000 promoters, the French system has the advantage of guaranteeing network performance and hence experiment reproducibility. According to Frédéric Desprez, Grid5000 has inspired a counterpart in the United States called FutureGrid, currently funded by the National Science Foundation. French researchers are understandably proud of their grid, which has since given rise to several start-ups specializing in distributed computing. ■

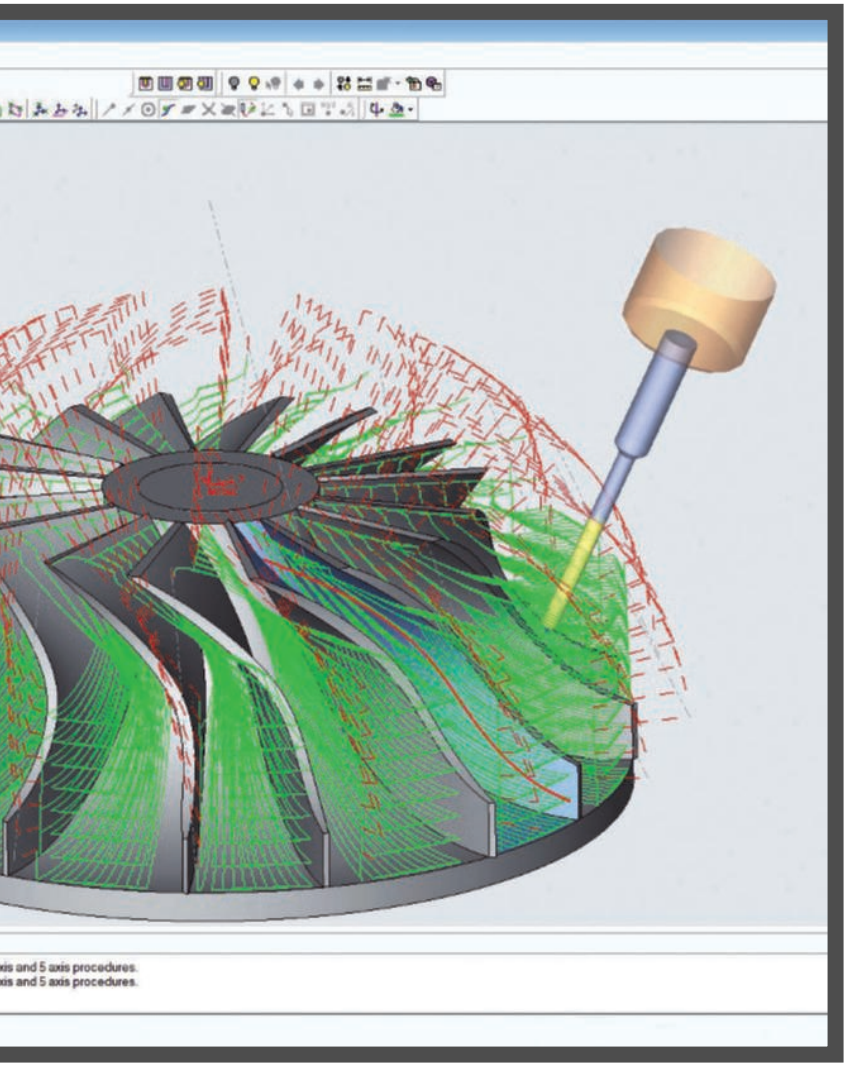


Spin-offs

35 START-UPS MADE IN FRANCE

Vive la recognition! Almost all our French simulation experts come from public or national university laboratories.

BY AURÉLIE BARBAUX



Reducing machining time is one of the key objectives of software designed by Spring Technologies.

D.R.

Machining, assembly, flow, navigation, buckling of thin shells, human vision, new medicines pollutant dispersion, waste treatment, wave propagation, complex embedded systems, electronic chips and telecom network design, multiphysical complex systems, microscopic vision, nanoworlds, heat optimization, power grid behavior and automobile crashes. The list goes on: virtual reality, optimized calculation, reproducing 3D images of organs, neurological modeling, 3D displays, crowd simulation and serious games. This catalogue, reminiscent of French poet Jacques Prévert's surreal "inventory", reflects the rich potential of the 35 French nuggets of simulation we have unearthed. Most come from public laboratories or research institutes and elite engineering schools. Three are offshoots of INRIA, two of the Systems Analysis and Architecture Laboratory (LAAS) at France's National Center for Scientific Research, two others of Mines ParisTech and another two of École Centrale de Lyon. Other experts are from École Centrale de Nantes, École Polytechnique de Nantes, INSA in Lyon, Inserm, Télécom ParisTech, the Center for Scientific and Technical Building (CSTB) and Université de Cachan. These spin-offs, most of them less than 10 years old, have a good chance of maturing, like Spring Technologies, Corys and the ESI Group, which is celebrating is 40th anniversary this year [see page 22]. Even if it means joining together to become stronger competitors in international markets. ■

MECHANICS, DESIGN

SPRING TECHNOLOGIES OPTIMIZES MACHINE TOOLS

Spring Technologies has just celebrated its 30th anniversary. The company, now a well-established machining simulation software publisher, has developed a successful international strategy and today one third of its 9 million Euros in revenues comes from exports. It has a hundred employees and offices in Germany, Switzerland, China and the United States. Spring Technologies has always sought to anticipate the needs of computer-controlled machine-tool users and has turned machine tool management into realistic simulation synonymous with saving adjustment time. Messier-Bugatti-Dowty for example, has reduced the machining time of titanium parts for its undercarriages by 20%. Spring Technologies boasts a client portfolio of famous companies such as Alstom, Areva, DCNS, Eurocopter, Safran, Snecma and Valeo. It has also forged ties with various machine-tool manufacturers. When buying a machine, a manufacturer can immediately begin preparing production and scheduling, well before the delivery of the machining unit. "It is quite possible to do this with a special machine," emphasized Gilles Battier, Chairman and CEO of Spring Technologies. "NCSimul software can predict the machine's specifications."

IMMERSION PROFESSIONALIZES VIRTUAL REALITY

Set up in 1994 by Christophe Chartier, Immersion, a Bordeaux-based company, has become a major player in virtual reality. Its stereoscopic visualization rooms – walls of very high- definition images and immersive environments – provide a realistic rendering to enhance simulation tools. Such rooms are found at PSA, Renault, Airbus, LVMH, the AEC, etc. Immersion is currently participating in the leading European research projects on virtual and augmented reality. It posts revenues of 5.4 million Euros and has 27 employees.

KINEO CAM DIRECTS ROBOTS

Kineo CAM, a spin-off from the National Center for Scientific Research Laboratory of Systems Analysis and Architecture (LAAS-CNRS) in Toulouse, was taken over by Siemens in October 2012. In the meantime, its software for calculating robot movements has won the recognition of all the world's major automobile manufacturers, before being adopted by the aerospace industry and manufacturers of precision robots for the nuclear industry. Kineo CAM sales reached 2.8 million Euros in 2011 and the company currently employs a staff of 14 people.

HYDROCEAN DIGITALIZES NAVIGATION

HydroOcean's hydrodynamic simulation tools are used to design high-performing boats as well as wind and tidal stream turbines. The fledgling enterprise in Nantes, started in 2007 by Erwan Jacquin, is a spin-off from the fluid mechanics laboratory of École Centrale de Nantes, with which it has developed a technological partnership. In 2011, HydroOcean recorded 1.275 million Euros in revenue

and employs 17 people. Its customers include DCNS, STX Europe, Multiplast, Technip and Total.

STRUCTURE COMPUTATION PROVIDES ACCESS TO SUPERCOMPUTING

By proposing a software suite for hosted new generation structural analysis, Structure Computation allows any company to access the power of the supercalculators and expertise at LMT-Cachan. The 2009 start-up is a joint venture led by Jérémie Bellec, PhD in structural analysis, in partnership with the Cachan laboratory to fill the gap between the structural analysis solutions available in the world of research and those used in the business world.

EC2 MODÉLISATION GUIDES COMPANIES

When it first started up in 1998, EC2 Modélisation carried out studies on the buckling of thin shells. Today, the company, set up in collaboration with INSA in Lyon, is performing engineering studies using digital simulation in mechanics, thermomechanics, heat science and fluid-structure interaction for customers including the AEC, Air Liquide, EADS, DCNS, Peugeot and EDF. EC2 Modélisation also works in partnership with laboratories in the public sector (INSA, Institut Carnot, etc.) as well as the private sector (Macanium, OptiFluides, etc.)

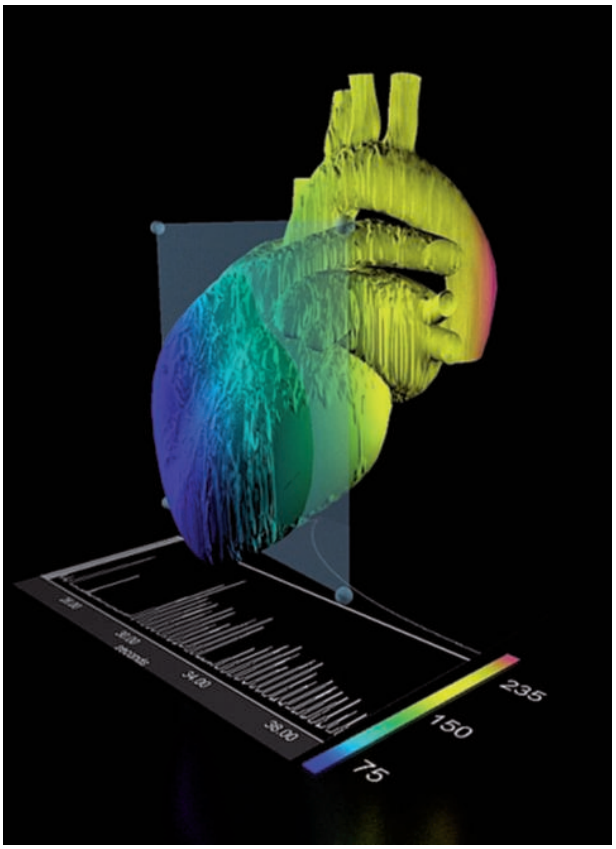
HEALTH

DIGISENS DEMOCRATIZES TOMOGRAPHY IN MEDICAL IMAGING

A spin-off from INRIA set up in 2002 in the French Alps, Digisens is considered the first company in the world to market software combining high performance computing with graphics processing. Using digital x-rays of an organ (tomographies), its software is capable of reconstructing large images in 3D and analyzing them. Digisens thus enables its clients – research institutes and European and American manufacturers – to optimize their scanner-type systems using x-rays or electronic microscopes.

RHENOVIA PHARMA UNDERSTANDS BRAIN DISEASES

Rhenovia Pharma, founded in 2007, is the combined result of the expertise of Serge Bischoff, a PhD in neurobiology with a background in the pharmaceutical industry, and the research work of a professor of neurosciences at a California university. Its modeling technology reproduces the cellular and molecular mechanisms of the brain and of neural transmission. It also determines which areas of the brain to block or activate in the treatment of neurological diseases. Its simulators allow laboratories and biotech companies to cut down on the long, costly animal experiments required to develop their medicinal products. Finally, it helps actors in the agri-food business, such as Sodiaal Candia, to emphasize the beneficial properties of certain foods for health. "We are also working with the French Armament agency on simulating neurotoxins in order to identify antidotes," adds Serge Bischoff. An acknowledged global leader in central nervous system biosimulation, Rhenovia Pharma, based in Mulhouse, employs 11 people. The company has reached the breakeven point and is now preparing a second round of investment (2.5 million Euros) to accelerate its development. It aims to triple its current revenue of 900,000 Euros within the next five years.



Digisens optimizes medical imaging systems with an integrated 3D function.

BRAIN VISION SYSTEMS SIMULATES HUMAN VISION

What happens when an electronics engineer with experience at Matra collaborates with a research biologist at Inserm? Answer: "bio-inspired" perception systems. When the system is embedded in an electronic board, it is capable of perceiving and acting like a brain. Brain Vision Systems, a Parisian company that has attracted the interest of Philips as well as the AEC, was founded in 2006. It has just unveiled its latest development: the Binobot robot, equipped with binocular vision similar to the human field of vision. The system can be embedded in all types of robots or vision and control applications, particularly for service robotics.

LIXOFT MODELS MEDICINAL PRODUCT DEVELOPMENT

Lixoft, set up in 2011 in Orsay, began by working with statistical data from research carried out by INRIA. Soon it was receiving support from pharmaceutical laboratories all over the world such as Johnson & Johnson and Novartis. To process masses of data from tests on humans and animals, the start-up developed Monolix software. It now striving to become a benchmark player in modeling and simulating medicinal product development.

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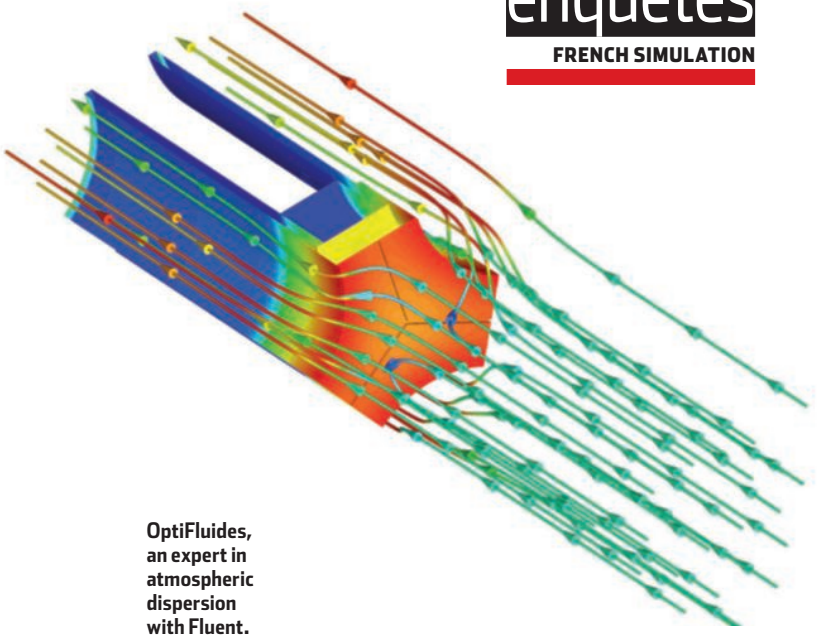
ENVIRONMENT

OPTIFLUIDES TRACKS POLLUTANTS

Specialized in fluid mechanics, the young engineering firm OptiFluides was founded in June 2011 by Nicolas Boisson, a former engineer at Rhône-Poulenc. The company, based in Lyon, uses Fluent software to study atmospheric pollutants and conduct research in the area of renewable energies. Fluent is a digital method that combines 3D models and meteorological data to assess, for example, the output of a wind turbine when its blades are covered with insects or it is located in the wake of another turbine. The company has four employees. One third of its revenue is generated by environmental activities, and the rest by modeling industrial processes for the aviation industry, healthcare, etc.



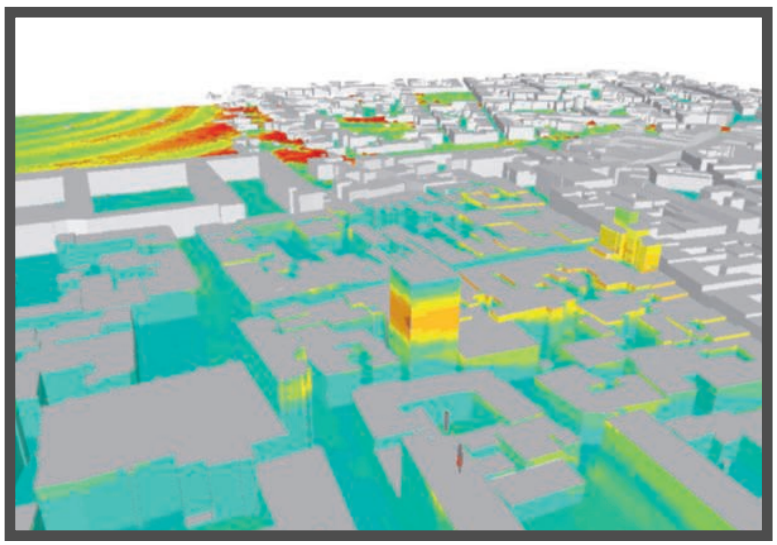
OptiFluides, an expert in atmospheric dispersion with Fluent.

SILLAGES ENVIRONNEMENT VISUALIZES ATMOSPHERIC POLLUTION

A spin-off in 2009 from laboratory work in fluid mechanics and acoustics at École Centrale de Lyon, Sillages Environnement is specialized in modeling the atmospheric dispersion of pollutants. Services include integrating data on pollutant discharges (chemical, microbiological or radioactive) to assess the dispersion of pollutant plumes emitted by industrial sites and determining building air quality. Incubated by Crealys, the company is part of the Seth group, which is comprised of four SMEs specializing in air-related disciplines.

GEOMOD MAPS ELECTROMAGNETIC WAVE PROPAGATION

Predicting human exposure to sound and electromagnetic waves is one of the challenges taken up by the software publisher and distributor Geomod. The company, a specialist in land and marine geomatics (collecting, processing and disseminating geographical data), has been co-developing a software suite named Mithra with the Center for Building Science and Technique since 2005. The tool simulates the propagation of electromagnetic waves throughout an entire city and calculates the impact of adding repeater antennas or reducing power.



Mithra-Suite software simulates wave propagation in an entire city.

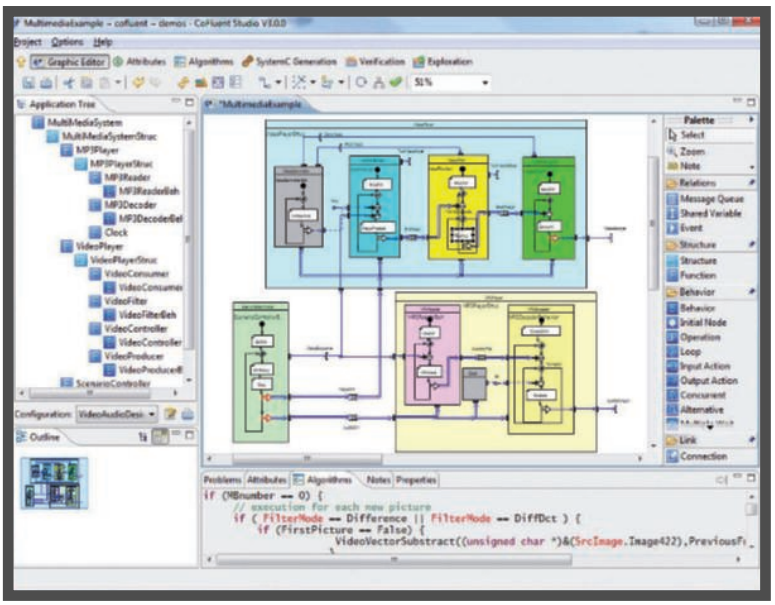
DATAPOLE SCALES WASTE MANAGEMENT

Set up in 2010, Datapole (five employees) has developed software known as Prediwaste to forecast waste management activity. Its distinctive feature lies in compiling specific criteria such as weather, daily waste production and the local consumption of mass-market products by 3, 500 families. This information is transformed into waste production data (e.g. the amount of plastic) for each region. The company can then help local authorities and private operators adjust the size of their teams, collection and processing facilities to correspond as closely as possible to real needs and there by reduce costs. "These resources are too often scaled to handle extreme events rather than to meet a service quality objective. Our approach consists in scaling down facilities and logistical flows to normal levels while maintaining the ability to predict and adapt to occasional spikes in activity," explained Frédéric Gagnaire, head of the Parisian start-up. Datapole has been conducting two experiments with its software since late 2012: one with the City of Paris, the other with the Intercommunity Household Waste Syndicate (Siom) in the Vallée de Chevreuse. The first is expected to last one year, the second three years.

TRINOV OPTIMIZES INDUSTRIAL WASTE

Trinov, a young Parisian company founded in 2007 by Dan Dassier, formerly with IBM, has developed online software called Nova to optimize waste management in industry, building and publics works, etc. The tools provides graphic mapping of how waste is produced at a site and proposes the best waste recovery solution for each category (feeding waste back into the production process, selling secondary raw materials, etc.). Trinov intends to expand its model to the scale of an entire region.

ELECTRONICS



CoFluent develops virtual electronic components.

COFLUENT DESIGN SIMULATES COMPLEX EMBEDDED SYSTEMS

A spin-off from Polytech Nantes in 2003, CoFluent Design publishes the simulation software developed at the school. The programs are designed to simulate complex embedded systems, taking all the data and the range of operating situations into account to improve their quality. The company, which has 15 employees and posted revenue of 534,000 Euros in 2011, boasts clients such as Nokia, RIM, Canon, Thales, Siemens and Nokia Siemens Networks. A sign of its potential: The company was taken over by Intel in August 2011.

DOCEA POWER PUTS COMPUTER CHIPS ON A DIET

Founded in 2006, Docea Power publishes software to analyze, model and simulate the power and thermal behavior of chips and electronic systems. The goal is to help manufacturers control the thermal behavior and energy consumption of their circuits right from the design phase. Its software, designed in partnership with R&D centers such as Imec (Belgium) and CEA-Leti (Grenoble, France), now equips a dozen customers including Ericsson and Microelectronics. The company plans to double its current workforce of 20 by 2015.

SYSFERA PROVIDES ACCESS TO COMPUTING-SIMULATION

Set up in 2010, SysFera simplifies access to computation and simulation resources. Its software, called Diet (Distributed interactive engineering toolbox), is derived from research conducted by Inria's Graal team at École Normale Supérieure de Lyon. The original idea: to transform access to servers into an on-demand service. Researchers and engineers no longer have to concern themselves with complex questions of resource reservation. When an application is launched from a remote workstation, Diet selects the machines best suited to execute it. The second advantage of Diet software is to enable optimized use of computing resources by mutualizing the infrastructures in a grid. "It can group together several requests on a single server and balance the machine loads, virtually increasing the capacity available to users," explains David Loureiro, Chairman and CEO and a co-founder of the company. The IT manager knows how the servers are used, who is using them and what they are used for." Diet currently supplies ten clients including Electricité de France. Located in Lyon, SysFera employs 14 people and generated nearly 1 million Euros in sales in 2011.

SILKAN OPTIMIZES CRITICAL EMBEDDED SYSTEMS

A spin-off of the 2012 merger between HPC Project and Arion Entreprise, Silkan focuses on the simulation of critical embedded systems. It uses internal and external technological building blocks to develop tailor-made solutions for high-performance modeling and simulation. The systems cover the entire life cycle of the product, from the design stage to testing, use and maintenance. They meet the need to ensure operational reliability in areas such as defense, aviation, energy, etc. The company also provides rapid financial modeling systems for banking. Par4Amm is one of its key technological building blocks. Developed jointly with Mines ParisTech and Télécom ParisTech, it is an open source platform that parallelizes the calculation code to optimize computer processing. The company has 70 employees and ten customers, among them Airbus, Arcelor-Mittal, Eurocopter, PSA and Safran. Thanks to its two-digit growth, it hopes to reach revenue of 20 million Euros by 2013, compared with 8 million in 2012.

REDWAY3D VISUALIZES 2D AND 3D IMAGES

Founded in 2004, Redway3D has developed a 2D and 3D graphic engine compatible with all Intel, AMD and Nvidia processors. Compared with the solutions of competing CAO software vendors, its REDSDK software tool improves display quality in real time and provides a photographic rendering of computer-generated images. Missler Software has integrated it in its TopSolid software suite. Airbus is using it in its maintenance simulator. The company, which became profitable in 2006, has six employees and has already sold twenty software licenses. Meca Distribution is also one of its customers.

QOS DESIGN ANTICIPATES TELECOM NETWORKS

Set up in 2004, QoS Design offers tools for service quality assessment, simulation, planning and telecom network design. Its software suite, Nest (Network engineering and simulation tool), is backed up by 25 years of research at the LAAS-CNRS laboratory in Toulouse, in partnership with manufacturers. Its originality lies in its unique technique of differential traffic modeling and hybrid simulation enabling low-cost network quality control.

D.R.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HPCSpot.
Décollage imminent. HPCSpot, l'offre Cloud HPC d'OVH et de sa marque Oxalya, est d'ores et déjà accessible en version bêta. Bien plus qu'un concept, le Cloud HPC est aujourd'hui une réalité alliant performance et simplicité. Réseaux d'interconnexions à faible latence, centre de données localisé en France, machines physiques spécialisées pour le calcul haute performance et la visualisation ou encore accès distant sécurisé depuis un navigateur web, sont autant d'avantages que vous pouvez découvrir dès maintenant, et en avant-première.
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CHEMISTRY

FLUOREM EXAMINES FLUIDS

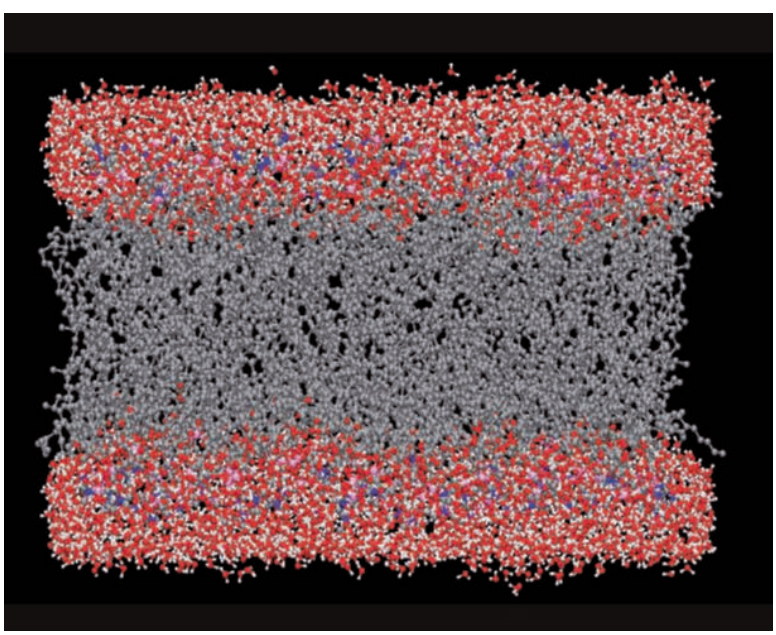
It is no accident that Fluorem, located in Ecully near Lyon, has acquired the expertise to produce digital simulations of fluid flows in cars and planes. Founded in May 2000, the company is a spin-off from the Laboratory of Fluid Mechanics and Acoustics at École Centrale in Lyon. Its software solutions, which reduce design time and experimentation costs, have won over groups such as Areva, Airbus, Total and Valeo. Fluorem's distribution network now extends to the whole of Europe.

THE COSMO TACKLES COMPLEX SYSTEMS

Young but ambitious, The CoSMo Company, which started up in June 2012, has designed a solution for modeling and simulating complex systems ranging from new compounds for the pharmaceuticals industry to urban development. The CoSMo is part of the Veolia Innovation Accelerator program (VIA), dedicated to spotting and rolling out the most prom ising eco-technologies. In September 2012, the company joined the IT Future of Medicine consortium, which groups together players in the pharmaceutical and IT industries.

SCIENOMICS MODELS THE MICROSCOPIC

Scienomics invites customers to plunge into the microscopic world in order to understand the macroscopic world using software adapted to a wide variety of industries including automotive, defense, agri-food and chemicals. The company, which posted 1 million Euros in revenues in 2012, is the fruit of an encounter between Xenophon Krokidis, a PhD in mathematical physics, and Joerg-Ruediger Hill, a PhD in chemistry. They crossed paths at Accelrys, the American software publisher specializing in biotechnologies, and decided to set up their own business in March 2004 in Nancy. "We spent the first years developing our solution using free software," recalls Xenophon Krokidis. "But in 2008, when our product was ready for the market, we lost numerous contracts due to the economic crisis." Nevertheless, Scienomics has built up a clientele of prestigious groups such as BASF, BP, Shell, ENI, Solvay and TetraPak. The company, which employs 10 people, plans to double its sales within the next three years. To reach this goal, it expects to hire a new sales team, make targeted acquisitions and forge partnerships with software publishers to mutualize sales offers.



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Reproducing the infinitely small – here a cell membrane – can serve a variety of industries from defense to automobile manufacturing

NANOTIMES SIMULATES THE INFINITELY SMALL

Graphene, carbon nanotubes, nanostructured particles... all these materials, which display complex behavior, have numerous applications in industry, such as nanorobots, molecular reagents and molecular circuits. These potential applications encouraged Nanotimes to develop a range of software for laboratory simulation and visualization of microphysical experiments. Set up in 2004 in Toulouse, Nanotimes is an outgrowth of co-founder Michael Magoga's doctoral thesis.

ENERGY

CORYS DUPLICATES THE EPR

In November 2012, Corys commissioned the first simulator of a third-generation EPR nuclear reactor in Flamanville. Delivered to EDF, the tool replicates the control center. It covers ordinary working operations as well as incidents and accidents, simulating both the reactor's technical parameters and the organizational and human factors. Four other EPR simulators are currently under production in France and China. This is the best-selling product of the Corys Company, set up in 1989 in a joint venture between EDF and the AEC (of which it is a spin-off). In 2011, it posted 30 million Euros in sales and 2 million Euros in profits. Corys' growth stems from rail simulation as well. Its 2012 contracts include 44 simulators of driving tilting trains for Queensland Rail in Australia. The company also won the contract to simulate the metro network in Rio de Janeiro, Brazil. Today, Corys boasts 500 simulators in use across the world. To support the new projects, the company plans to increase its current workforce of 230 employees by hiring some 20 engineers in 2013.

IZUBA ENERGIES GIVES HEAT SCIENCE A BOOST

Izuba Énergies has developed Pleiades+Comfie, a software set for dynamic simulation of building heat. Comfie, its computing core developed by the Center for Energy Efficient Systems (CES) at Mines ParisTech, accurately simulates heat storage in buildings and materials in roughly one minute. A formidable tool to surf the wave of bioclimatic buildings and RT 2012 heating regulations resulting from the Grenelle Environment Conference in France.

POWERSYS PROVIDES FOR NETWORK TRANSIENTS

Already a distributor of software for electrotechnical equipment simulation, Powersys changed gears in 2011 when it took over the development and marketing of EMTP-RV. Owned by EDF, Hydro-Quebec and other major utilities companies, EMTP-RV simulates the way power systems cope with rapid transients like lightning impacts. Working with software developers, the Powersys team is responsible for accelerating the dissemination of EMTP-RV worldwide.

RAYCREATIS GREENS ARCHITECTURE

A subsidiary of the HPC-SA group, RayCreatis, based in Toulouse, publishes ArchiWizard, software to simulate 3D energy profiles of buildings in real time. Intended for architects and engineering firms, ArchiWizard is a tool for computer-assisted building design combining eco-energy efficiency, architectural innovation and comfort. Its integration into architectural CAD facilitates dialogue among players in the building industry to help achieve the bioclimatic efficiency required by 2012 heat regulations.

HUMAN AND SOCIAL SCIENCES

GOLAEM STIMULATES CROWDS

Set up in 2009 at the initiative of an Inria research team, Golaem offers software capable of reproducing realistic crowd movements, showing thousands of people interacting with their environment. It signed its first contract with the French railway company SNCF to simulate the behavior of passengers between trains and platforms. Golaem has also developed a simulator for national defense and its software, GolaemCrowd can be integrated with Autodesk Maya to create crowd shots for animated films and special effects as well TV commercials.

SERIOUS FACTORY ANIMATES 3D CONFIGURATORS

The company, founded in 2007 by William Peres, a former manager at Dassault Systèmes, has developed software capable of simulating and configuring any type of product as well as visualizing it in an interactive and immersive 3D mode in its final environment. Its software tools use the CAD data of customer design offices with applications ranging from industry (Dassault, Renault, Peugeot, etc.) to real-time "serious games". Serious Factory has 20 employees and posts annual revenues of 1.1 million Euros.

6MOUV DEMOCRATIZES FLIGHT SIMULTORS

Established in Toulouse, 6Mouv is seeking to democratize customized flight simulators with affordable solutions starting at 150,000 Euros. Its products rely solely on software developed in C++ language and do not reproduce mechanical cockpit movements. Certified by the FAA and the AESA (the U.S. and European air safety organizations), its product offer is addressed to helicopter and airplane manufacturers as well as professional pilots in training. The simulator stands out by its graphic realism (with a resolution of up to 6,000 x1,920 pixels) and models the pilot's environment and obstacles (bridges, wind turbines, etc.) with a photometric resolution (60 cm) based on IGN and satellite data. Eurocopter selected the company to simulate its Écureuil model. The French army also uses the products of the Toulouse company at its base in Salon-de-Provence to train pilots on TB 20 single-engine models from Daher-Socata. The company's Chairman and CEO, Bernard Claudinon, former director of technical and commercial divisions at Matra Marconi Space, is also a co-founder of Gibcom Multimedia, which publishes 3D video games. Within four years, 6Mouv aims to reach 10 million Euros in sales compared with 1 million today.

6Mouv and its ultra-realistic flight simulators have been adopted by the French army.

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MADEACONCEPT SURFS THE WAVE

The surfing simulators invented by MADEAconcept, founded in 2009 by three water sports fans, send water under an inflatable mat to reproduce the sensations enjoyed by surfers and other boarding adepts. Its advantage: a control system that projects water while taking into account the user's movements, thereby saving energy. The Buthiers leisure activity center in the Paris region is equipped with a MADEAconcept simulator. ■

Scilab open source digital computation

For ten years, a community of contributors has been developing Scilab software, which offers hundreds of mathematical functions (optimization, statistics, systems control, signal processing, etc.) as well as 2D and 3D graphics. Scilab is an open source software tool that can be downloaded free of charge, but it is also used by the Cnes and major manufacturers such as Astrium, Sanofi, Arcelor-Mittal, etc. Initiated at Iniria, Scilab is continuing its development in Scilab Entreprises, a company set up in 2010 to provide professional services to users (consulting, deployment, development, migration). Graduates of École Polytechnique and École Centrale are flocking to join, among them Claude Gomez, the general manager, who oversaw the R&D team of the Scilab consortium starting in 2003 and then its head from 2008 to 2011. Denis Ranque, former chairman of Thales, is on the board of directors of Scilab Entreprises. ■

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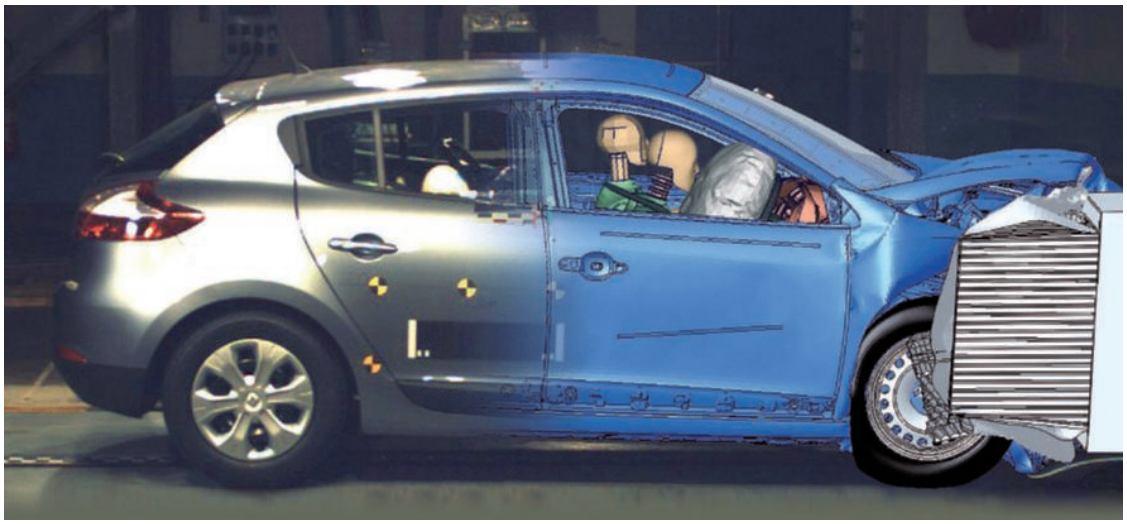

PAM-Crash, the industry standard for automobile crash simulation software.

Success story

ESI GROUP: THE START-UP SPIRIT

The French group ESI is among the world's top specialists in virtual prototyping. The story behind its success.

BY JEAN-FRANÇOIS PREVÉRAUD

Forty years old this year and still showing a start-up spirit. That's the best way to sum up ESI Group, the French leader in digital simulation and virtual prototyping. Yet, the company's key figures belie this de scription, with slightly more than 1,000 employees worldwide and revenues of around 100 million Euros in 2012. The story begins with four doctoral students in engineering at the University of California at Berkeley in the United States. Led by Frenchman Alain de Rouvray, the group's current Chairman and CEO, they discovered computerized scientific calculations. Their reaction was unanimous: "For once, we would be able to calculate things that resembled what we needed instead of having to simplify so that we could do the calculations by hand." Their Ph.D.s in hand, they settled in France and started up ESI. "We realized the fundamental difference between analysis, which consists in applying formulas found in reference books to try and reach the same result, and simulation, which creates digital models that are recalibrated through iterative tests carried out on physical prototypes," recalls Alain de Rouvray. It was an innovative approach at the time, allowing them to improve products faster with fewer prototypes, even limiting tests to reduced scale. The manufacturers in charge of French civil and military nuclear programs were the first to recognize the potential benefits. For ten years, ESI consulting and services focused almost exclusively on this sector.

Simplified simulation

But simulating a plane crashing into a nuclear power plant was not unlike a car hitting an obstacle, and manufacturers asked the group to apply the simulation techniques to their industry. ESI decided to launch the study of automobile crashes in the early 1980s and published PAM-CRASH, which soon became standard simulation software. "As our competitors complexified their analytical software to cover every possible case, we were simplifying our predictive simulation models by specializing them according to test category. All models are false, but some of them can be useful, provided you understand the circumstances and the acceptable limits of simplification," sums up Alain de Rouvray. The new simulation project required the collaboration of more than 250 international university teams and technology procurement.

Today, after thirty-five years of development, the group boasts a full range of models and solvers that can be chained together to produce virtual prototypes. "And that does not mean managing files, but integrating a real knowledge of physics, materials and disciplines in a platform that can be adapted to customer practices." Manufacturers immediately saw the advantages. Volkswagen has renewed its three-year contract for the eighth time with a clear strategy in mind: by 2018, the brand plans to develop its energy-efficient and therefore light, multi-material vehicles using virtual prototyping. Similarly, the Chinese aircraft manufacturer Avic, which aims to surpass Boeing and Airbus, has set up a joint venture with ESI Group to "virtualize" its laboratories and manufacturing and transformation processes. Looking back on the group's forty-year history, the Chairman concludes: "We achieved what we set out to do in terms of innovation and we succeeded in persuading our customers that our approach was sound." ■

D.R.

"As our competitors complexified their analytical software, we were simplifying our predictive simulation models by specializing them according to test category."

Alain de Rouvray, Chairman and CEO of ESI Group.

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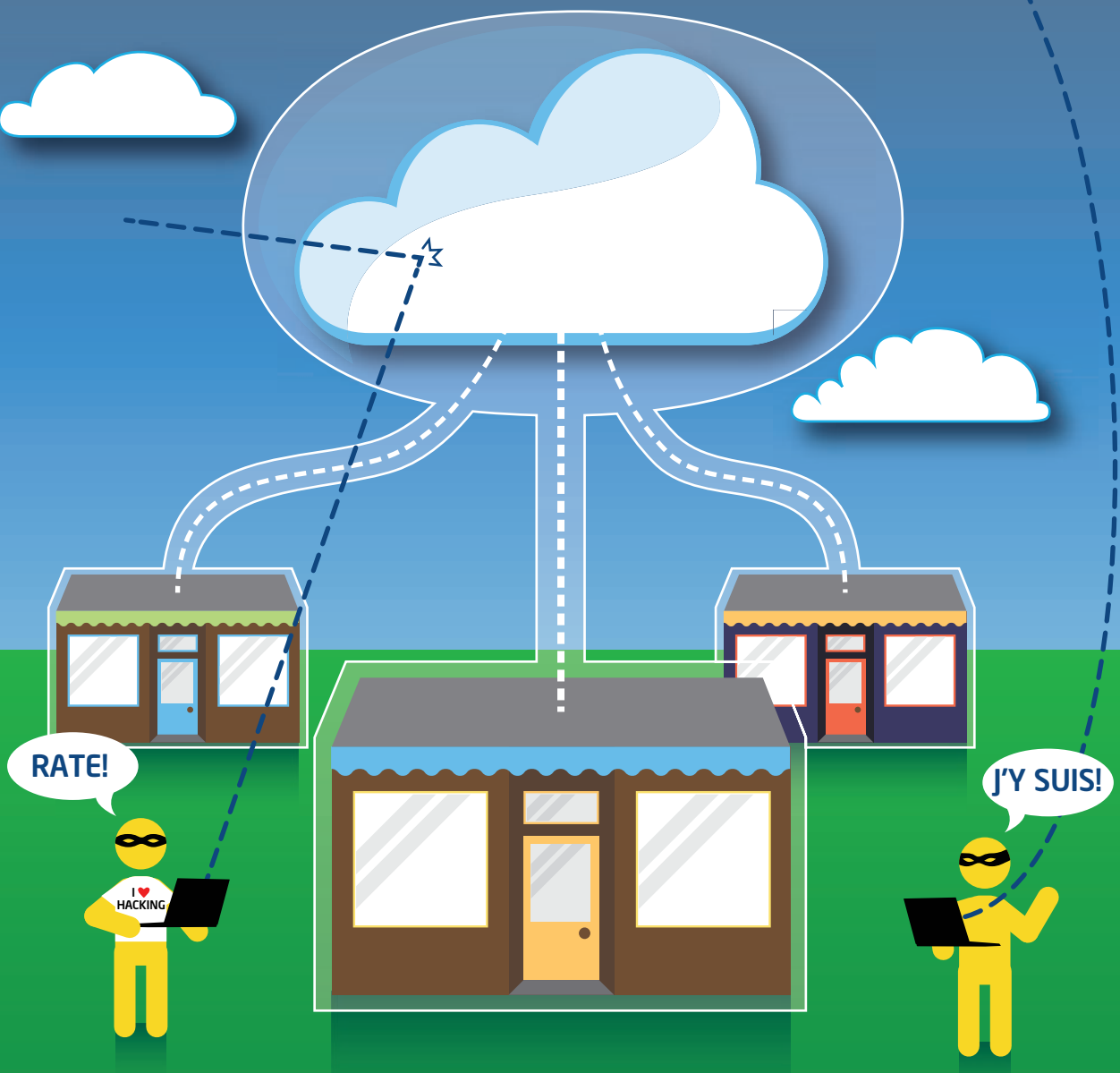

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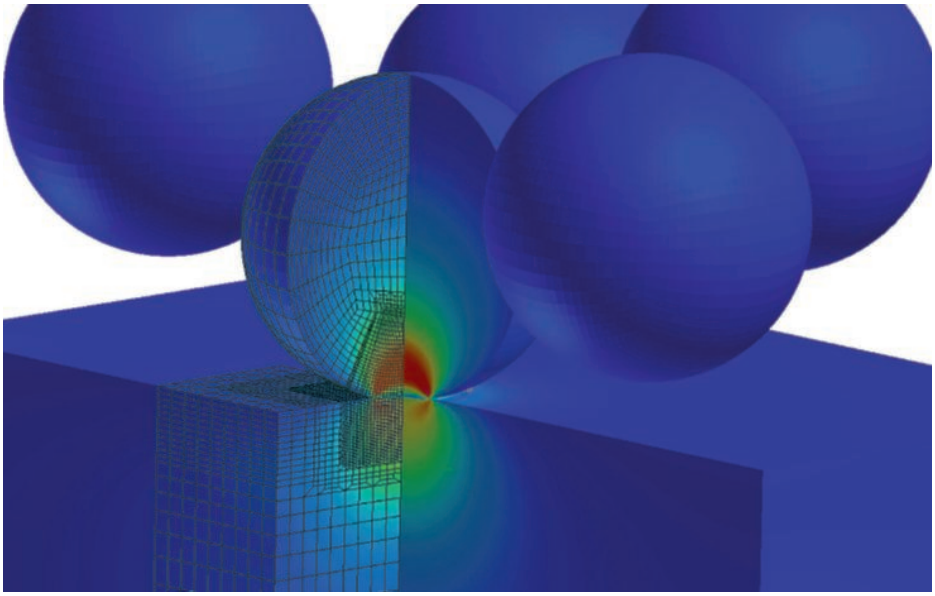
Portfolio

SEEING REALITY THROUGH DATA

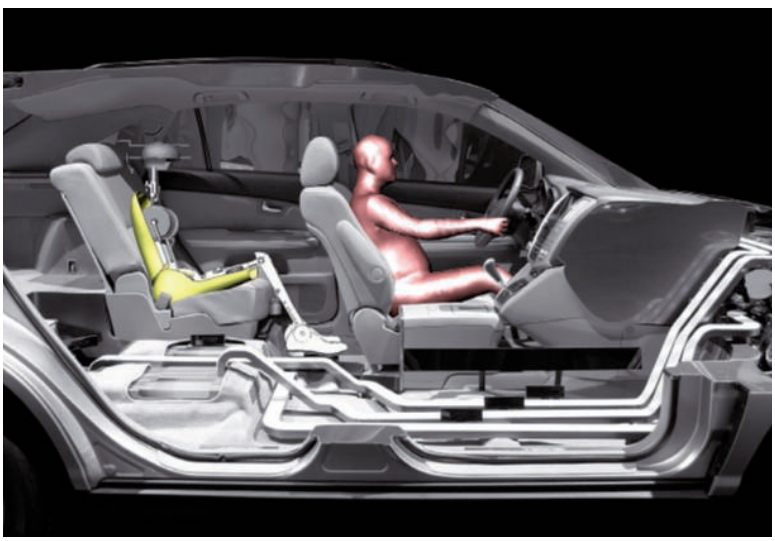
In simulation, a picture is not worth a thousand words, but it does make physical and biological phenomena speak.

BY AURÉLIE BARBAUX

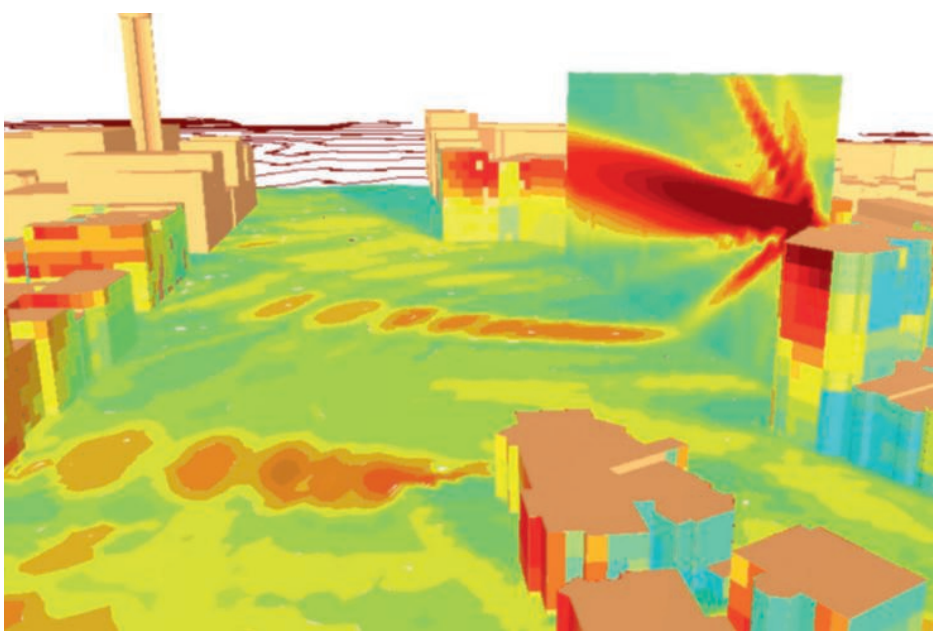
In what way do plants react to light in their environment? Answers with the Cirad and Imagis projects (Inria).



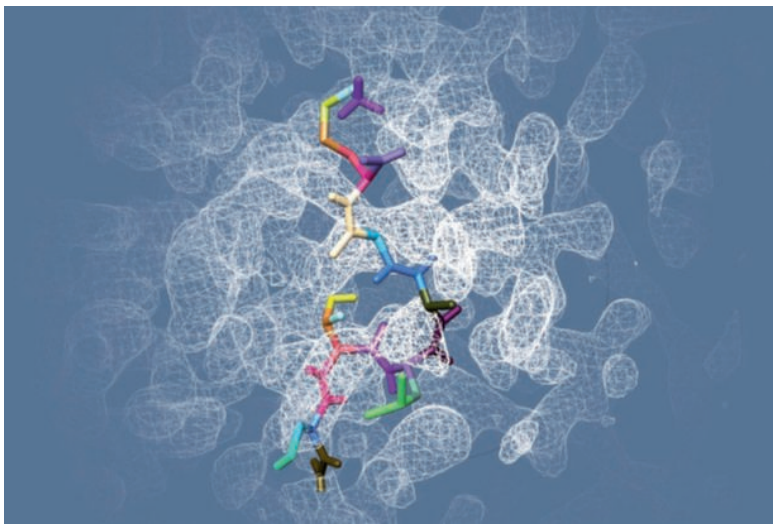
Simulation of a falling marble to improve the treatment of a surface (ESI Group).



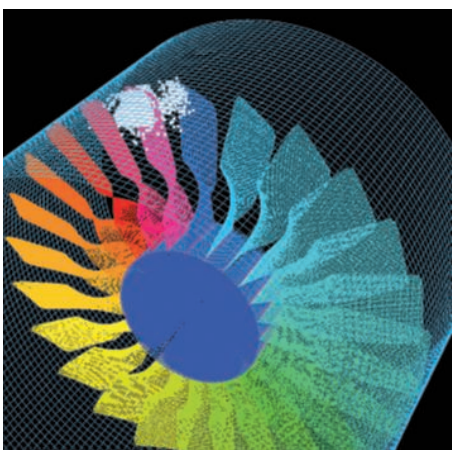
Simulating automobiles, calls for mechanics, but also passenger comfort (ESI Group).



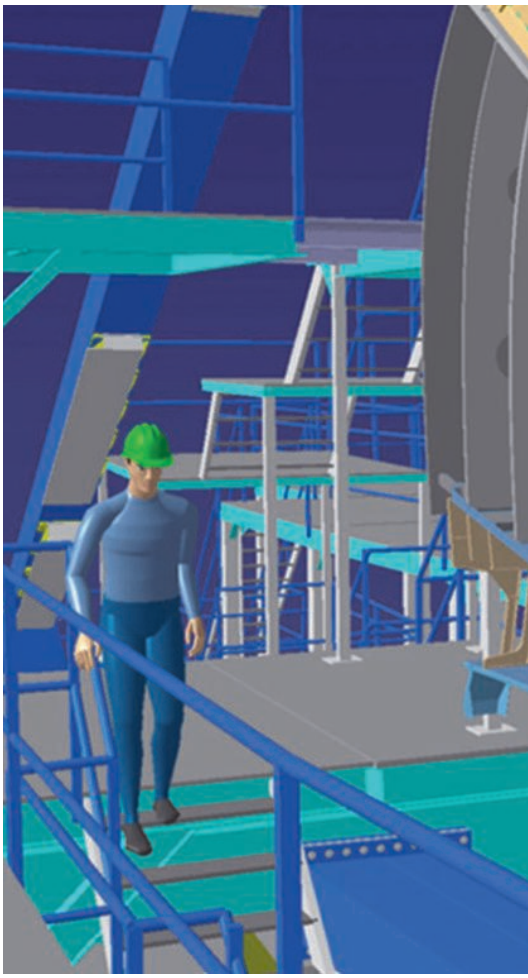
How do waves propagate in a city? Results with Mithra-Rem (Geomod).



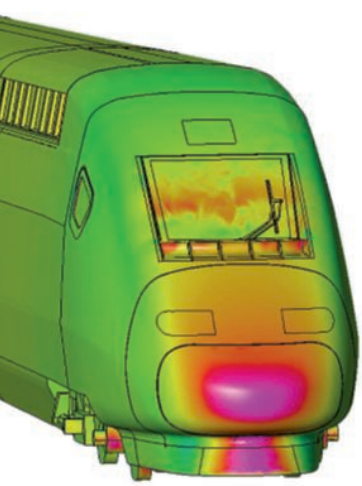
Protein shown in nanoscale, courtesy of Samson software (Inria).



What are the consequences of a bird strike on an engine? (ESI Group).



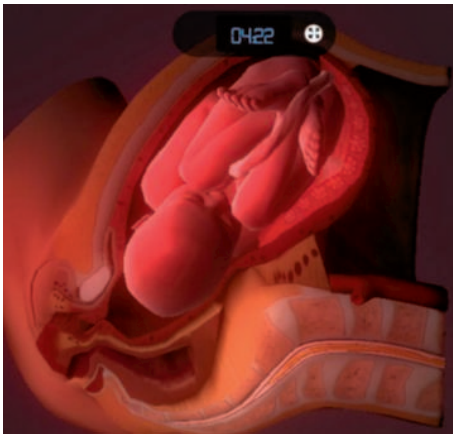
Digital factory with Dalmia (Dassault Systèmes).



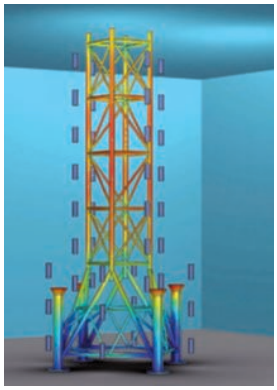
Study of aerodynamic flow on a TGV train (Alstom and ESI Group)

Staging of an avatar performing maneuvers aboard a frigate (DCNS).

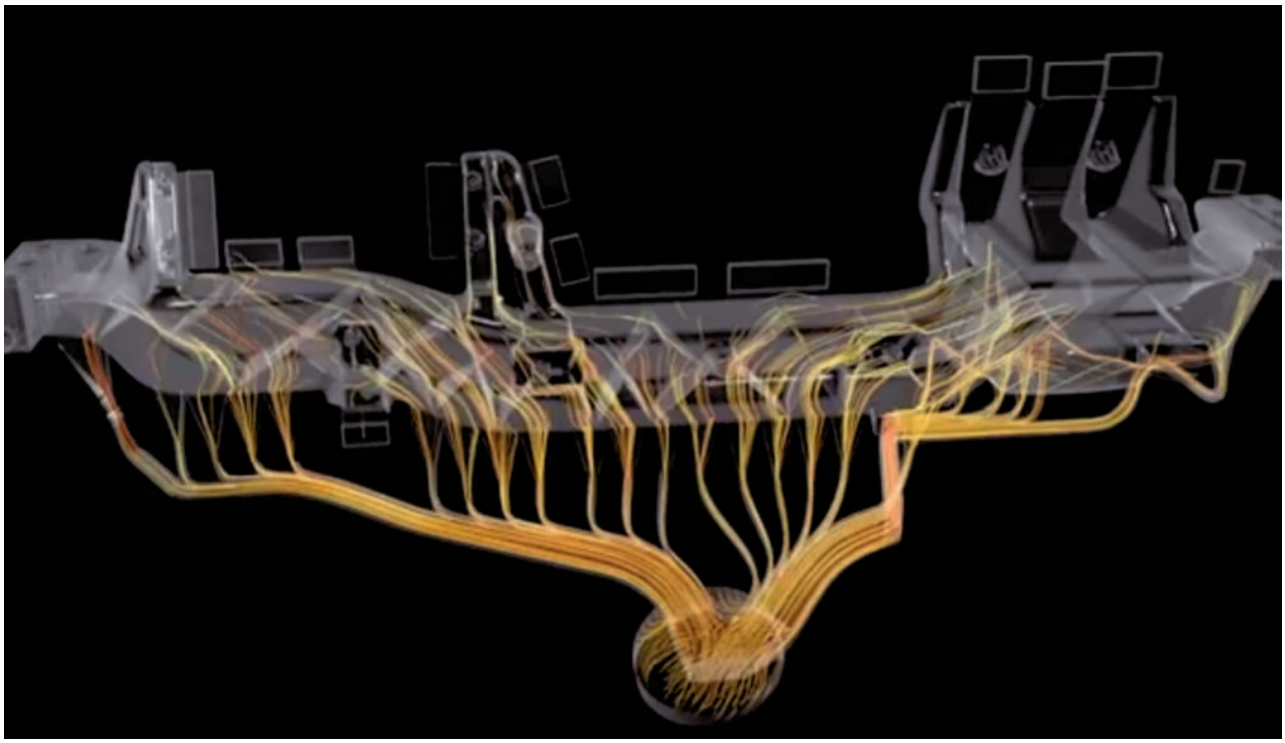
DCNS ; ESI ; DELHIA ; GE HEALTHCARE ; COMSOL ; D.R.



Virtual childbirth (GE Healthcare).



How do submerged anodes react to corrosion? (Comsol).



High pressure aluminum die casting (ESI Group).

Practicing goal kicks, nothing simpler (Inria).

IC. LEBEDINSKY ; D. R. ; INRIA.

In their CAVE virtual reality room, PSA installed the Holobench, a reduced scale device for working on driving skills in augmented reality (PSA).

The Sigran program offers maritime piloting, with enhanced geographical information (DCNS).

Studying driving on uneven surfaces, thanks to this giant simulator (DLR Institute).

The best in aquatic equipment testing (Madea Concept).

The AEC is home to Tera-100, the first European supercomputer to exceed petaflops.

Supercomputing

A COLLABORATIVE FRENCH EXPERTISE

Originally driven by the demands of the French nuclear industry, supercomputing is now being adopted by industry as a whole.

BY JEAN-FRANÇOIS PREVÉRAUD

There is no need to go as far back as the 1966 Computing Plan to find examples of French expertise in supercomputing; we can point to at least five examples in recent decades," declares Hervé Mouren, head of Teratec, the European center of expertise in high performance digital simulation. The five examples, he claims, are the Atomic Energy Commission (AEC), Bull, ESI Group, a network of specialized companies and the French School of Applied Mathematics. Together they formed a breeding ground for the development of a quality offer in high performance computing (HPC).

Through its civilian and military assignments, the AEC developed expertise in digital simulation, which it has continued to display as a global specialist for more than 30 years. "We developed our new skills after the French government announced the end of its nuclear weapons testing in 1995. We had to validate a weapon without testing it – a «first » in the scientific world," explains Jean Gonnord, head of the Computer Simulation and IT Project simulation in the AEC's Military Applications Department (DAM). This body also recognized the benefits of opening up to the outside world to

D.R.

share its strategic know-how in high performance simulation with major French manufacturers.

The transformation of Bull some ten years ago led the company into the area of supercomputers. "We already had expertise in hardware manufacturing, but we made rapid progress through our partnership with the AEC and the introduction of co-design to define an architecture adapted to specific application needs," acknowledges Jean-Pierre Panziera, manager of Bull's HPC product strategy. CNE Architecture took advantage of standard Intel processors to reduce costs as well as development cycles. It takes 12 to 18 months to design a motherboard, but a processor requires three to five years of development work. Hardware is not everything, however, and Bull has since become an expert in developing software to improve systems operation.

The masters of HPC

Another important aspect, which has made a difference, is keeping the systems from overheating. "Five years ago, it took as much energy to cool the processors as to run them. Three years later, the ratio had dropped to one-third (for cooling) and two thirds (for computing). Today, 95 % of our energy is used to operate the systems and only 5% to cool them, because we replaced the fans circulating air by far more efficient pumps circulating water," Jean-Pierre Panziera adds.

The change has had a decisive impact on the operating costs of data centers requiring 5 MW and soon 10 MW. Bull's real systems expertise has made the company the only manufacturer in Europe today capable of producing mainframe computers. This is an essential asset for France, in view of the growing trend towards co-design, i.e. defining architectures and their hybrid variations to meet the needs of major customers, which facilitates a local presence. And Bull does not plan to stop there. The company now wants to launch service solutions for HPC applications in the cloud, such as its Numminov project.

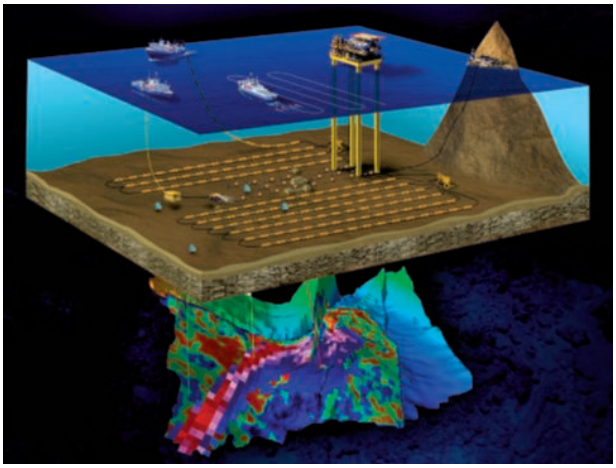
The development of application software plays an important role in improving HPC, which the French software publisher ESI Group, now the global leader in virtual prototyping, has amply demonstrated [see article page 22]. But there are other French companies working in the field that have also achieved world-class expertise. Caps Entreprise, for example, has succeeded in using research conducted by Inria (Rennes) to develop a directive-based programming language that optimizes the operation of standard codes on computing architectures involving graphic processing units (GPU). "What we do is mark – as unobtrusively as possible – the parts of standard code that can benefit from GPU acceleration," explains François Bodin, the company's technical director. The approach, developed in 2007, is now the focal point of the OpenACC consortium, which is working on its standardization. It calls for highly technical know-how in code compilation, parallel computing and optimization. OpenACC has only one competitor (in the U.S.), and it plans to bring out a new generation of products this year. "Until now, we have been working in a generic way on computing codes, which may have to be adapted depending on their application" Mr. Bodin notes. "With the new generation, our language will take into account the specificities of the main application families and of various types of target architectures to make the adaptations transparent for the user."

Scilab Entreprises another by product of Inria research, has been offering open source libraries of digital computing since 2010 [read box page 20]. "Our software, which natively uses massive amounts of parallel HPC, was downloaded more than 700,000 times last year and our installed database exceeds a million users in multiple areas of industry as well as services," Christian Saguez, company vice-president, says proudly.

Optimized simulations

Silkan offers a toolkit for creating and integrating simulated solutions using HPC to support design, operation, maintenance and dismantle complex systems. "We use HPC to accelerate and optimize the processing of very large models and manage test programs requiring tens of thousands of simulations," asserts Jacques Duysens, COO at Silkan. The company enhances its expertise through partnerships with French laboratories (Inria, École Centrale de Paris, Mines ParisTech) and American universities. The platform is also used internally to develop tailor-made simulators using HPC to process very large models realistically in real time.

And that's not all. Distene works on software components such as mesh technology entering the HPC chain. "Our pro-



CGG owns forty treatment centers to aid in discovering potential hydrocarbon reserves.

CGG aligns 12 petaflops to explore the earth

The task of the Compagnie générale de géophysique (CGG) formerly CGG Veritas is to describe the geology of the subsoil in order to detect potential hydrocarbon reserves. The job involves the generation, recuperation, and management of enormous amounts of seismic data. To manage it, the French group vaunts a computing capacity of 12 petaflops, and 70 petabytes of data storage. "Our calculation power is handled internally. We have about 40 treatment centers, worldwide", explains Laurent Clerc, IT director for processing and reservoir services. "To significantly accelerate certain calculations, we use graphic processing units. To optimize the cooling of our densest materials, we rely on liquid immersion cooling technology." In this context, CGG has signed partnerships with global IT firms such as IBM, DELL and video game company Nvidia.

Intel and the CEA get ready for an exaflopic future

The Exascale computing research (ECR) laboratory set up in 2010 will soon to be housed by Teratec. With a staff of over 30 people, working closely with European researchers to produce computers a thousand times more powerful than those available today. ECR is the fruit of a partnership between the AEC, Genci, Intel and the University Versailles Saint-Quentin (France). It specializes in two areas of research: first, to facilitate the migration of traditional or existing open source applications to exascale, along with those produced by industry and academic partners. Second, to develop and offer an environment of tools and methods to optimize the interaction between the application layer and the computer in view of exascale. ■

ducts are the fruit of 30 years of research in close collaboration with Inria. They have been integrated in all the computing software of the major publishers specializing in simulation. Our aim is to become the market standard in mesh generation, like Acis or Parasolid in the area of 3D modeling engines for CAD," states Laurent Anné, a cofounder of Distene.

In the area of application software, Numtech proposes software aided by HPC for the simulation of atmospheric pollution to monitor and forecast air quality. "Our software is used by manufacturers to check emissions at industrial sites as well as by regional authorities to monitor air quality. The use of HPC enables clients to process large models with the precision of ten meters in cities," notes Pierre Béal, the company's general manager. Once again the know-how is partly derived from Inria, but it also stems from partnerships with Université de Clermont-Ferrand, the National Center for Scientific Research, École Centrale de Lyon and the University of Florida.

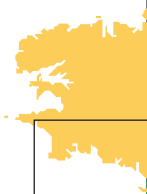
Further evidence of the predominance of France's expertise lies in its outstanding School of Applied Mathematics. Significantly, France has won 11 Fields medals since 1936, the most recent awarded to Cédric Villani in 2010, whereas the United States boasts 12 and Russia nine. The school is supported by the French School of Electronics and Computer Processing, also reputed for its research excellence.

France's HPC players intend to take advantage of the arrival of cloud computing through projects such as Numminov led by Bull and Oxalya, now taken over by the OVH Group, planned for 2013. The objective is to make high performance computing available to small companies. And the final proof of French leadership in the field: all three major European HPC projects are managed by French experts: ETP 4 HPC, by Bull and the AEC; EESI, by Total; and Prace, by Catherine Rivière, Chairman and CEO of Genci. ■

CENTERS OPEN TO COMPANIES

Supercomputing platforms are sprouting up all over France, putting digital simulation in reach of business, particularly small and medium sized companies. Some are available through research collaborations with public laboratories. Others are commercially oriented or receive government funding through the "invest for the future" program. A tour of France's operational simulation sites.

BY RIDHA LOUKIL



CAPS COMPUTE LAB

Implementation date 2009 by Caps Entreprise

Equipment Supercomputer Bull NovaScale with 10 Nvidia acceleration servers

Access Package or payment à la carte

Web site www.caps-entreprise.com

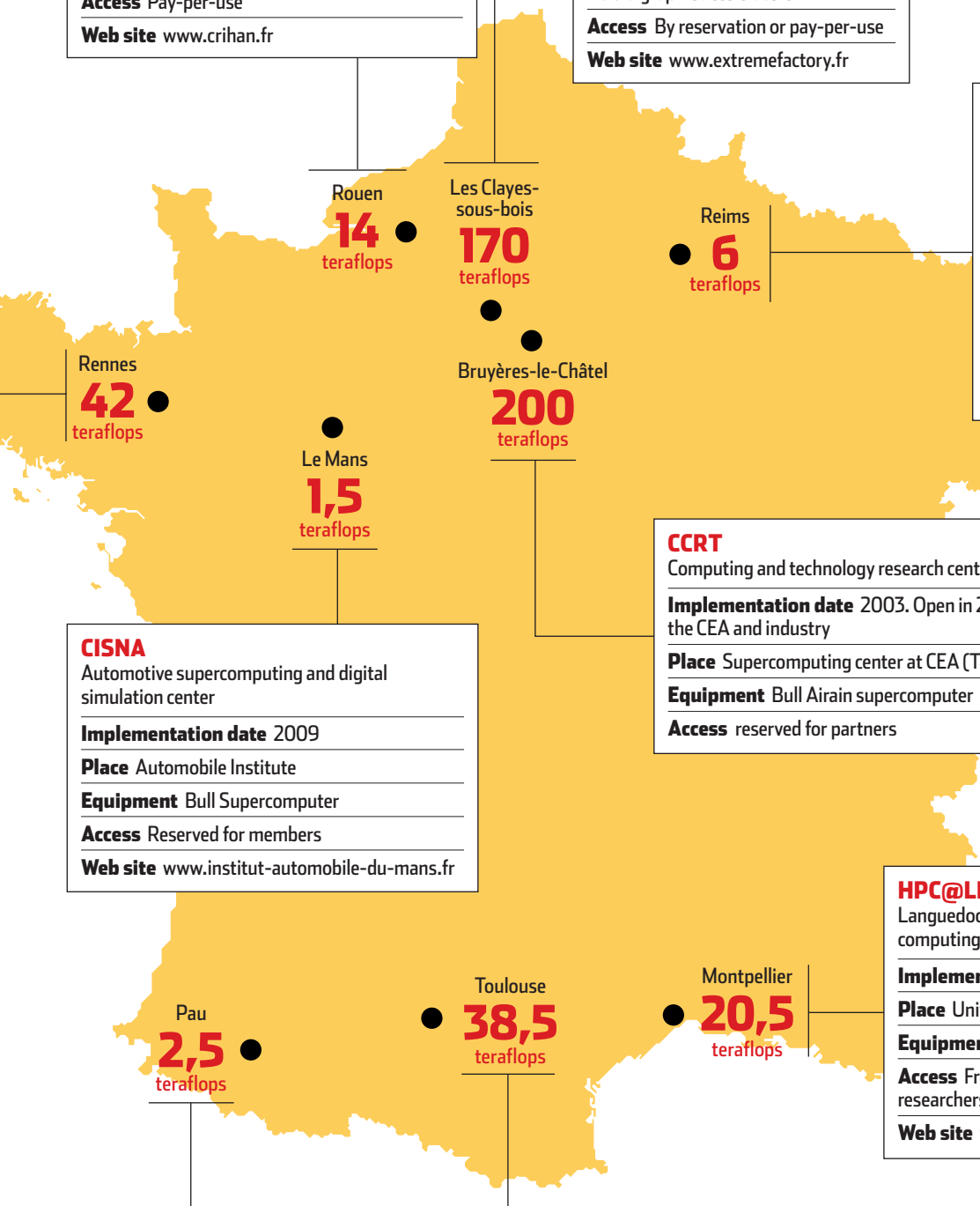
CSP

Palois Simulation Center

Implementation date 2010 by CS, Turbomeca and the urban community of Pau

Equipment Supercomputer hybrid GPU – CPU

Access On demand with priority to SMEs and R&D from consortium partners



CRIHAN
Haute-Normandie center for data processing resources

Implementation date 1991. New calculator acquired in 2011 with the Ecole centrale de Nantes

Place Technopole du Madrillet (Seine-Maritime)

Access Pay-per-use

Web site www.crihan.fr

EXTREME FACTORY

Implementation date 2010, by Bull

Equipment Bull supercomputer with Nvidia graphic accelerators

Access By reservation or pay-per-use

Web site www.extremefactory.fr

ROMEO
Champagne-Ardenne computing center

Implementation date 2002. Opened in 2007 to regional businesses

Place University of Reims Champagne-Ardenne (Marne)

Equipment Linux-Windows computing cluster, installed in 2010 by Bull with Microsoft

Access Payment à la carte

Web site www.romeo2.fr

CCRT
Computing and technology research center

Implementation date 2003. Open in 2012 to the CEA and industry

Place Supercomputing center at CEA (TGCC)

Equipment Bull Airain supercomputer

Access reserved for partners

CISNA
Automotive supercomputing and digital simulation center

Implementation date 2009

Place Automobile Institute

Equipment Bull Supercomputer

Access Reserved for members

Web site www.institut-automobile-du-mans.fr

HPC@LR
Languedoc-Roussillon high performance computing center

Implementation date 2010

Place University of Montpellier 2

Equipment IBM hybrid supercomputer

Access Free for local public or private researchers

Web site www.hpc-lr.univ-montp2.fr

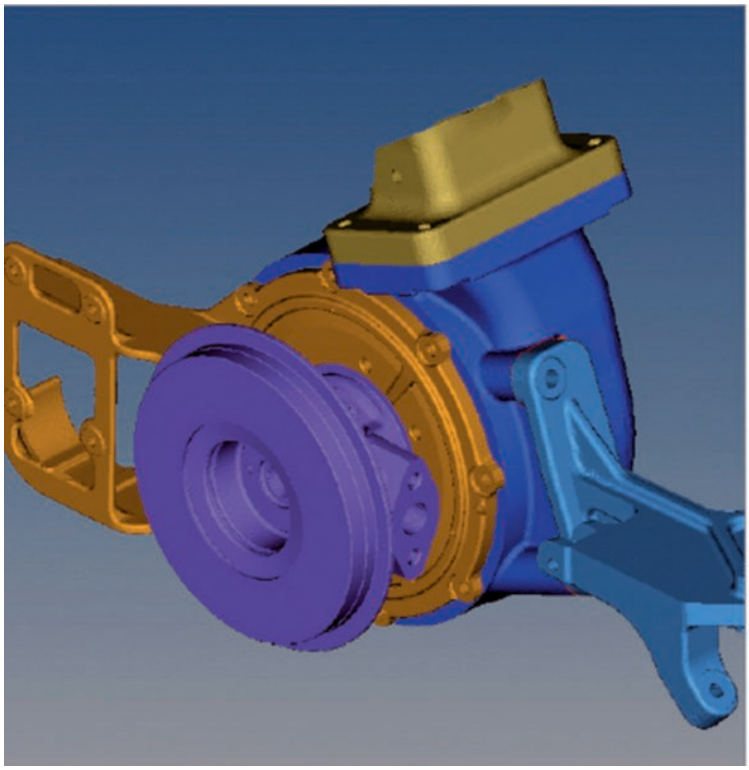
CALMIP
Midi-Pyrénées supercomputing center

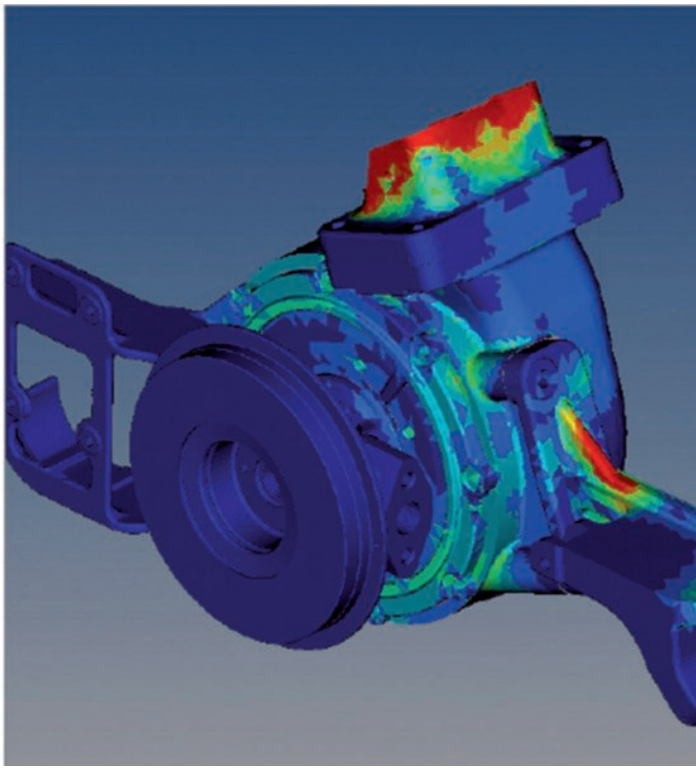
Implementation date 2007, 10% open to regional businesses

Equipment SGI Hyperion

Access Pay-per-use

Web site www.calmip.cict.fr





On-demand software

SMART COMPUTING IN THE CLOUD

Higher computing power and lower costs – this is what cloud computing can offer. Software vendors have developed technology components to enable cloud-based use of their computing and Product Lifecycle Management (PLM) solutions.

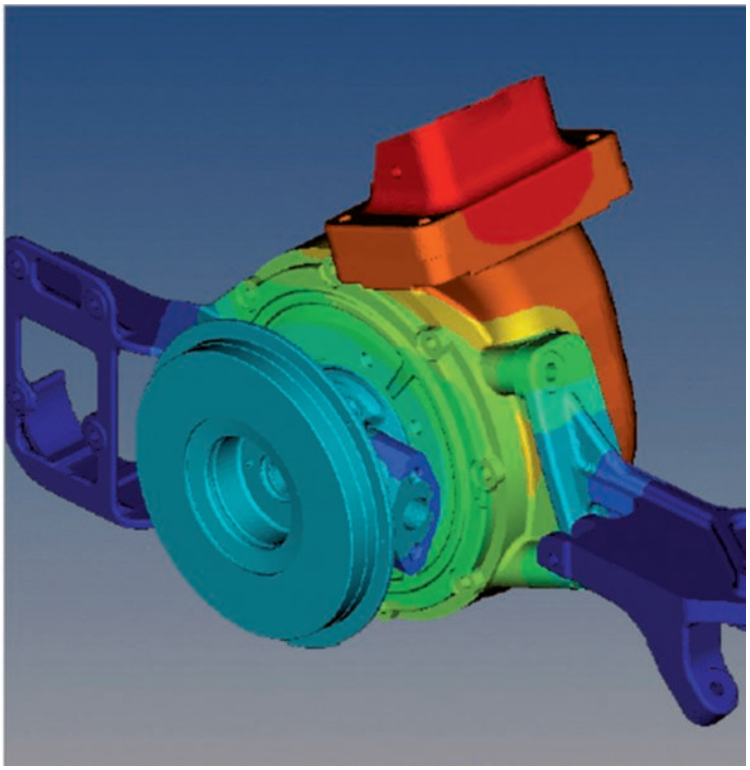
BY JEAN-FRANÇOIS PRÉVERAUD

It is the dream of all industries to reduce costs and delays in development. Software components developed by ISVs (Independent Software Vendors) to offer cloud solutions in High-Performance Computing, Product Lifecycle Management, Application Lifecycle Management and Services Lifecycle Management (HPC, PLM, ALM and SLM) could help them achieve this goal. These software solutions provide access to almost infinite computing power. In addition to addressing the issue of peak workload periods or making it possible to communicate with partners on group projects – already a lifesaver in itself – the cloud gives small businesses an opportunity to design products faster than they could with their own proprietary tools, and best of all, they only pay when they use the service.

HPC on demand

The field of scientific computing can be expressed in an optimal manner through cloud computing. "This is what we offer with Extreme Factory, our HPC on-demand solution, which provides a proprietary portal to businesses, giving them access to computing tools using the software and tools they want, to address regular or periodic needs in terms of workload peaks," explains Bull Group Cloud Computing director, Bruno Pinna. This offer will be extended to SMEs via the Numinnov project – prepared in collaboration with the French Caisse des dépôts et consignations (CDC) – which aims to create independent cloud-based HPC services in 2013 that will operate at European level. Besides high-per-

ALTAIR ; D.R.



By using Altair Engineering's simulation platform HyperWorks, automotive industry supplier BorgWarner has improved its turbochargers.

formance computing services, SMEs will be able to access offers from 25 partners in a secure environment. This offer could be provided by ISVs involved in the project.

In terms of price, moving to the cloud should mean investing half as much money on equipment, which represents approximately 25% of the cost of a PLM project. On the other hand, its impact on spending in terms of software and services is estimated to be less significant.

However, potential cloud users still tend to adopt a wait-and-see attitude, despite its promising aspects. "As is the case for all emerging technologies, new approaches and working methods will have to be invented in order to optimize its potential," says François Coste from NAFEMS France. NAFEMS is an organization that assists businesses in their choice of computer simulation technologies. There are also some prejudices to be overcome. One of these concerns the quality of the tools. "Industries don't want a low-cost cloud computing solution such as Amazon offers. Both large industrial groups and SMEs want top-notch services with performances that are guaranteed in terms of quality and uptime, as well as data security and resilience. And in that area, there is still a lot to be done," declares Gérard Roucairol, CEO of Teratec, the European Technopole dedicated to computer simulation and High-Performance Computing [see interview, page 6].

Another concern is confidentiality. In this respect, the predominance of American-owned datacenters raises questions. Subject to the Patriot Act, the law obliges disclosure of data stored on their servers to American authorities – if they so require – for domestic security reasons. In order to avoid having to abide by this law, the French State launched the idea of a sovereign cloud. Dassault Systèmes sought to participate in this project on two separate occasions in 2011, before abandoning it in April 2012. "These projects will go ahead without us, due to differences of opinion concerning the business model to be set up and the dispersion of government subsidies, which hinder the emergence of a strong French presence," declared regretfully the ISV's vice president of corporate communication, Pierre Marchadier.

Shared access

This setback did not discourage the ISV. In 2011, it invested in the creation of Outscale, a start-up that provides private cloud software geared towards the automotive and aerospace industry. "We also participated in the creation of AirDesign, part of the BoostAeroSpace project. It is an interface that enables partners to share a private working environment, and provides SMEs with tools and methods that are approved by Airbus, with High-Performance Computing systems, storage and security." Dassault Systèmes also plans to announce the possibility of accessing CATIA and SolidWorks on a temporary basis in SaaS mode (Software as a Service), and subsequently offering access to ENOVIA, SIMULIA and DELMIA via Nvolve. Siemens PLM Software is less ambitious, in that it only provides its technical PLM tool, Teamcenter, in cloud mode via their certified IBM, Microsoft or Amazon

"Extreme Factory, our HPC on-demand solution, provides customers with a proprietary computing portal where they can use the software and services they like."

Bruno Pinna, Bull Group Cloud Computing director

"We are committed to helping businesses avoid some of the disadvantages of the cloud such as dependence on cloud hosting companies."

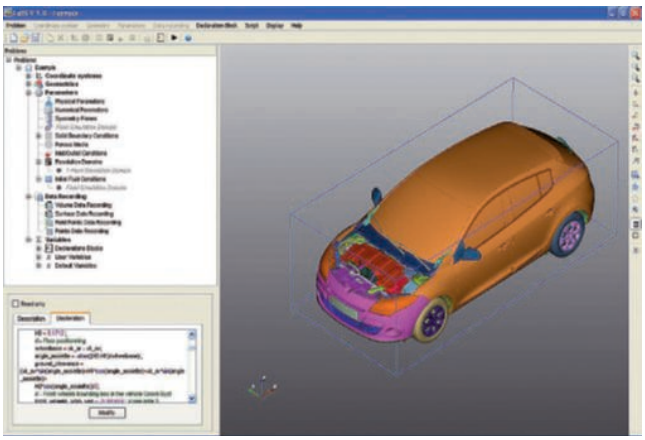
Marie-Christine Oghly, executive director of Micado

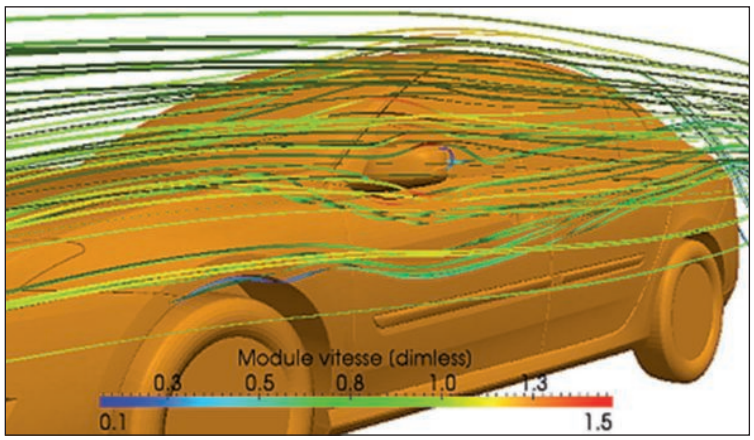
offers. "This is a technical and operational certification that we follow up with local service providers such as Orange, SFR or Atos," explains Christophe Iffenecker, the CEO of Siemens PLM Software France.

In addition to security problems, another subject for concern is the system's reversibility, in the event of wanting to go back to an in-house solution or find a new cloud host, as physical control of the data is lost when using third-party systems. "We are developing working methods to enable businesses to avoid some of the disadvantages of the cloud," explains, Marie-Christine Oghly, executive director of Micado, an association dedicated to PLM-friendly, collaborative digital engineering solutions. "We try to make them more user-friendly and limit their dependence on cloud hosting companies. We are committed to promoting transparency in terms of access: access to support for skills they cannot afford to maintain on an in-house basis; to quality assurance for simulations and data tracking." These changes could turn the tide in favor of cloud computing for those industrial engineering departments yet to be convinced. ■

CALCULATING AERONAUTICS AND CARS IN PAU

Pau Simulation Center opened in February 2010 the result of a partnership between Turbomeca, the Community & Systems group (CS) and the urban community of Pau. It hosts multiphysics R&D projects on aeronautics and cars.





The digital simulation software developped by LaBS should be commercialised this year.

Pau Simulation Center (PSC) admittedly has not had as many users as was anticipated. Opened in February 2010, the result of a partnership between Community & Systems specialist (CS) Turbomeca and the urban community of Pau.

The computing center was supposed to provide the region's SMEs and SMIs with cheaper, on-demand access to simula- tion tools that are usually too expensive for businesses of this size. Unfortunately, «There has not been the demand we expected, and it's not for want of commercial prospection,» says François Roudot, director of the HPC and digital simulation offer at CS, which runs the center. Nevertheless, PSC has not stood idly by. From the outset, its purpose was to host computing research for the Aerospace Valley cluster, more particularly the Osmoses project that ended in 2011. The primary aim of this project was to develop a collaborative multiphysics simulation platform for aeronautics [see page 40]. "It involved developing intermediate software to combine various computational codes," explains François Roudot. This has been achieved in part, even though at this time Osmoses is not fully operational. Although once rejected, a second R&D project, called Mosart is needed if the sector's businesses are to obtain real on-demand access to this technology. The project is expected to be presented again at the clusters' next project call.

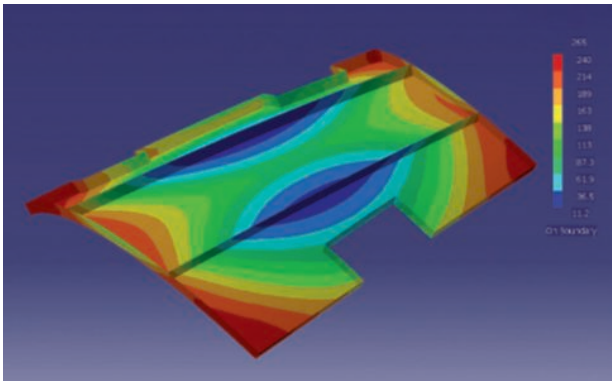
PSC has also been used for in-house computing needs at CS, and from time to time at Turbomeca, when its computers were overloaded. Above all, it has provided support for LaBS. This project has greater economic viability and will eventually be commercialized. An industrial consortium driven by Renault, but also including Airbus, Bombardier and Alstom carries laBS. It provides on-demand access to computational aero-acoustic codes, of particular interest to the car industry for protruding fittings such as rear-view mirrors and fittings inside vehicles. LaBS started in 2009 and will end in June of 2013. It may continue in other areas of technology, such as aerodynamics, electric motors and thermal science. In any case, PSC is ready to host them. Initially launched with a processing capacity of 2.5 teraflops, it now boasts over 10. [See chart on page 33]. ■

Components

THE COMPLEX ISSUE OF COMPOSITES

The structure of composites makes them difficult to model. Digital simulation of composites is required to develop their industrialization.

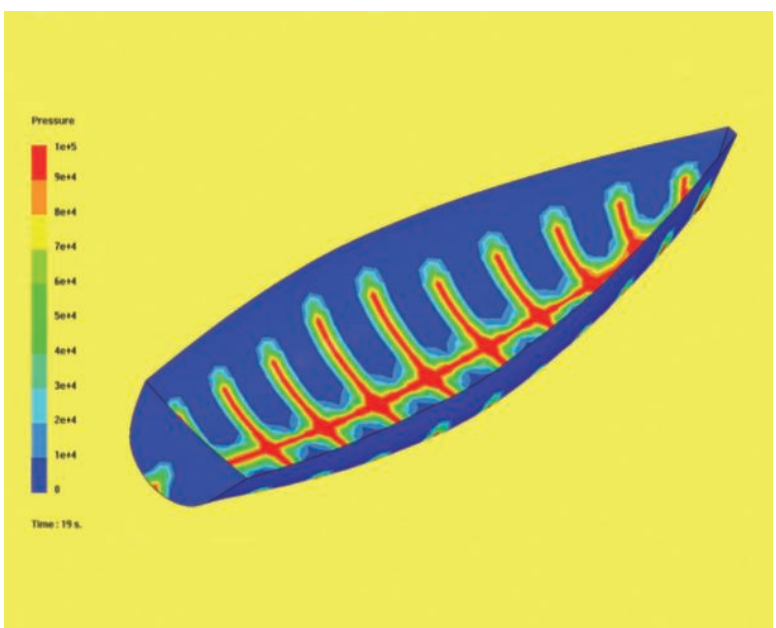
BY OLIVIER JAMES



PAM-RTM software, a specialized solution for challenges in modeling.

There can be no composites without simulation. After an era marked by empiricism, full-scale tests and small-scale production, composites must be digitally modeled. This is because, unlike metals, they are heterogeneous and anisotropic. In other words, they have a complex fiber and resin-structure and their mechanical properties vary according to the direction of stress. Another particularity is that composite materials are designed at the same time as the components themselves.

The wide choice of resins, number of material layers, direction and type of fiber, offers an almost infinite range of options. The ever-increasing size of components manufactured only aggravates the problem. "A lot of data is needed to describe how composites behave," confirms Patrick De Luca, director of composite solutions at ESI Group, a software vendor. But simulation offers real economic benefits. At the material-design stage, modeling can help improve the performance of composites. For example, advance determination of mechanical stress zones would enable fibers to be put in the right places.



Production simulation designed by the ESI Group facilitates the design of large components.

D.R.

Optimizing polymerization and injection

Sizing is an acute problem in aeronautics. "Generally speaking, industrialists oversize their composite components," says Laurent Delsart, director of composite partnership projects at Dassault Systèmes. This safety margin results in additional expense and means that the properties of these materials cannot be turned to full advantage." Modeling composite polymerization kinetics – resin cooking – and mold injection would be beneficial since these processes involve many chemical reactions and thermal phenomena. The issues at stake are controlling spatial distribution of materials and reducing gas-bubble formation. Here too, digital simulation would improve performance.

"We also need to simulate how industrial equipment behaves," claims Christophe Champenois, director of the department of polymer and composite engineering at the French Technical Centre for Mechanical Industry (CETIM). For example, modeling helps ensure correct temperature and pressure homogeneity in press molds and autoclaves. The requirements for greater production rates means models are being developed that take into account the interactions between materials and tools. The aim is to discover the ideal cycle times for producing a given component. Integrating all these parameters should result in a more accurate description of the finished component: its geometry, fiber direction, porosity, etc.

Software vendors are constantly adapting to the requirements of industrialists. Dassault Systèmes has developed a PLM software platform adapted to composites, incorporating every stage of a product's life cycle: from design to simulation to production. The ESI Group is marketing a version of PAM-RTM, its production simulation software. This will enable accurate modeling of very large components, such as wind-turbine blades or large aeronautical parts. The next stage for Airbus is developing a program able to model an entire aircraft and not just some of its components. This is a real challenge. ■ [FIRST PUBLISHED IN 2010]

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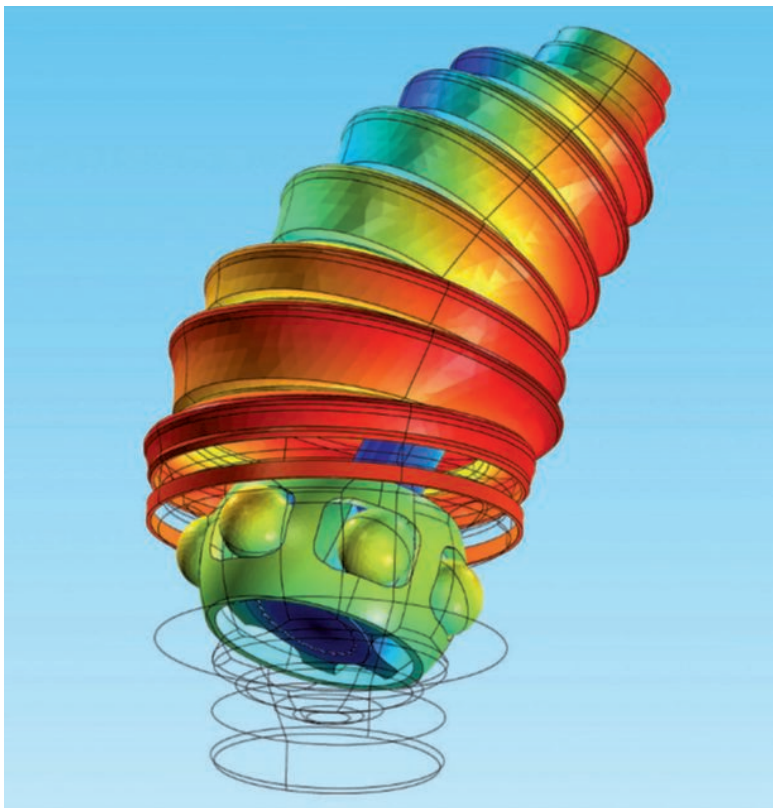

Comsol handles complex small size components, here a Rzeppa type joint.

D.R.

Platforms

MULTIPHYSICS: HOW TO MODEL COMPLEX SYSTEMS

Bypassing the prototype stage during the design phase requires simulation solutions that take into account every physical phenomenon applied in a system.

BY AURÉLIE BARBAUX

Industrial reality is complicated! Lab-on-a-chip, ultrasonic machining, airbags, radioactive waste storage, aquaplaning, composite materials and mechatronics are all fields and applications involving several simultaneous physical phenomena: mechanics, hydraulics, acoustics, electricity, magnetism, chemistry, and even biology. Each of these autonomous physical phenomena has its own laws and simulation models, which with perhaps the exception of tribology (the science of interacting surfaces in relative motion) are generally well understood. Nevertheless, a rigorous technological approach requires multiphysics coupling and simulations taking into account interactions to be implemented as soon as the model is constructed. For several reasons, this is easier said than done: algorithm design, available calculation capacity, and the scarcity of interdisciplinary expertise among engineers carrying out these simulations.

However, progress is being made. There are already models integrating two physical parameters that are considered to be fully developed. Coupled structure/fluid systems have been in large software publishers' catalogues for several years, although they do not always employ the best method. The iterative solution, which uses a sequence of loops to feed results from simulating one physical parameter into calculations for the next, is well mastered. "But this method was crude, we needed more accurate and better integrated multiphysics solvers," explains Jacques Duysens, who is assistant director of the HPC project in Montpellier, France. He previously ran the System@tic competitiveness cluster's IOLS research program, which closed in 2008.

Interfacing solvers

The industry has tried to develop strong couplings, in other words algorithms integrating different physical parameters into the same model, or models optimizing data exchange between solvers. The first of these two solutions is complicated. This is especially because meshes used to model the structural deformation of materials are usually nothing like those needed to simulate fluid flow. The trend has therefore been towards developing platforms that optimize interfaces between solvers. But it is taking a long time to develop them. Dassault Systèmes, which tested an initial fluid/structure simulation prototype in 2005, only began marketing its structure/fluid mechanics platform in 2010.

Comsol, a Swedish software publisher, has been offering this type of multiphysics simulation platform for over twelve years. It is suitable for small systems or straightforward geometry. Despite a toolbox very well stocked with multiphysics models, the software has its limitations. For example, it does not cope well with fast dynamics, such as those occurring in car crashes. The good news is that the computing capacity required to run calculations sometimes taking several days to converge is now widely available.

With existing supercomputers, all that's left is to process the immense quantity of data generated by these calculations. A new discipline, called SLM (Simulation Lifecycle Management), has arisen to put simulation results to industrial use. The first tools are available. ■ [FIRST PUBLISHED IN 2010]

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Simulators

LEARNING BY PILOTING AT THALES

The SimLead simulator mobilizes leadership abilities.

The aerospace and defense group improves the individual and collective performance of its managers through a serious game inspired by one of its flight simulators.

BY CHRISTOPHE BYS

At the controls of my helicopter, when it started snowing I could feel my stress level go up," recalls Patrick Hertrich. The legal affairs manager at Thales Optronics is neither a pilot nor a volunteer weekend emergency responder. He has just played SimLead, a flight simulator developed by Thales to train its executives and managers. The recreational tool plunges players into virtual crisis situations to teach skills such as handling stress, leadership, communication, dividing up work within teams, defining strategy, etc.

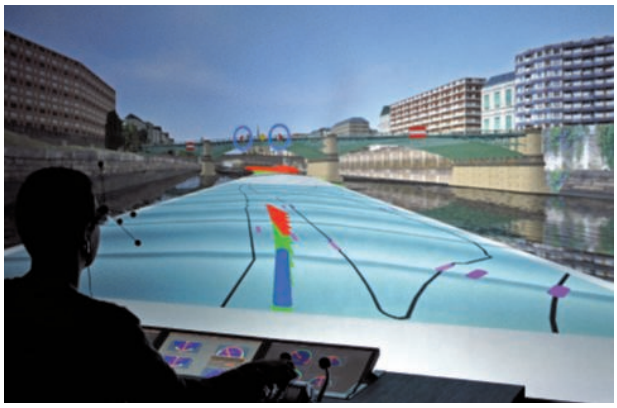
To test the software, we're off to Thales University, the group's training center in Jouy-en-Josas. A room has been set up in the basement to recreate the atmosphere of a helicopter cockpit. Three participants will be playing the roles of captain, pilot and navigator. Philippe Flandin, a former army captain, is the game leader, performing the role of Prefect of the Var Department, instructing the team down to the smallest detail on how to proceed as quickly as possible to rescue civilians threatened by flooding. The team has two helicopters, a Puma and a Gazelle. One of the captains coordinates the mission by issuing orders via a headset, which will be the only means of communication during the game.

Though participants enjoy themselves, the real aim of the tool is operational, which is why it was developed by the Thales training center from one of the group's flight simulators. "We didn't want to reproduce life in the workplace," explained Karine Le Joly, manager of HEC Executive Education, which partners the game. "When you take people out of their comfort zone and interrupt their ordinary routine, they can step back and examine their behavior."

Concrete challenges

The rescue scenario is adapted to the managers' demands. The training program is divided into a half-day of missions and a half-day debriefing session with the pedagogical team. For Patrick Hertrich, "The game is very good at reproducing the challenges facing project teams." Now when he selects his team members, he pays attention not only to skills "but also to personalities." 600 middle managers and 200 top executives from Thales have spent time in the SimLead cockpit. Executives from the BNP and Nissan as well. Strasbourg Airport recently began offering company team-building sessions in its Boeing 777 simulator. Knowing how to bank has become a new imperative for managers. ■

A simulator for apprentice bargemen



JEAN-MARC BIAIS ; D.R.

Reviatech's virtual 3D navigation makes learning safe.

Navigating rivers and canals requires expertise. What could be better than using a simulator to learn how to maneuver a giant-size barge? "The prototype is ready. All we have to do now is decide how to sell it," declares Mehdi Sbaouni, president of Reviatech, a small company specialized in designing 3D simulators. The company, set up in 2008, earned its stripes by developing a tool for DCNS to teach trash bin ejection from a submarine! As part of the OSE project for river transport training using an informed virtual environment, Reviatech partnered with the Compiègne University of Technology (UTC), and doctoral candidate Loïc Fricoteaux. The project was designed from an existing navigation simulator, to which an innovative module was added for customized training. The system observes the aspiring bargemen, taking into account their steering, navigation errors and stress levels. A decision-making module with visual aids and audio messages allows apprentices to determine the best maneuvers in real time. The scientific goal: to strengthen action- perception feedback between humans and their informed virtual environment. ■

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