2016 3DEXPERIENCE® ANNUAL REPORT

CORPORATE REPORT

VIRTUAL HUMAN
FROM NANO TO MACRO
HYPERLOOP
GENERATIVE DESIGN
HYPERCONNECTIVITY

THANKS

We would like to thank all those who helped us to create this corporate report: Zaki Abiza, Brian Baillargeon, Esther Bapsalle, Vanessa Bellaiche, Sylviane Bellorini, Aaron Berjohn, Jasmine Berthiaume, Laure Bocquet, Richard Boger, François-José Bordonado, Karen Buckner, Sacha Buliard, Rachel Callery, Karine Causse-Gobinet, John D. Cerone, Céline Chedru-Guigan, Tad Clarke, Cyril Cohen, Elodie Coquillat, Catherine Cousin, Karin Cudd, Pascal Daloz, Céline Dantzer-Delfino, Nicolas David, Maryann Dennehy, Allison Dolegowski, Frédéric Dot, Terrence Drula, Marc-Emmanuel Favre, Antoine Fermey, Valérie Ferret, Odile Forestier, Hillary Forsythe, Stéphanie Fournier, Anela Garcia, Rosemary Grabowski, Bernadette Hearne, Kristina Hines, Neno Horvat, Tim Houter, Yonggang Huang, Ed Huels, Yann Jaubert, Emmanuelle Jobic, Patrick Johnson, Pauline Jourdan, Sabrina Khouchane, Mathilde Lemaire, Tommy Leon, Pierre Leroux, Micaëla Leveillé-Nizerolle, Steven Levine, Alexia Limoges, Suzanne Locke, Maeva Mandard, Michael Marshall, Laura Marx, Aude Massoni, Emilie Matheron, Charlotte Matthews, Florence Mathieu, Victoria Maubrey, Kiren Mattoo, Marc Meili, Xavier Melkonian, Camille Menard, Freddy Mini, Solène Minjean, Ségolène Moignet, Marguerite Moore, Philippe Morel, Akio Moriwaki, Arnaud Nonclercq, Nancy O'Flaherty, Rob Parsons, William Pelletier, Fanny Pellier, Vanessa Perez, Vincent Picou, Jean-Baptiste Pinthon, Benjamin Proust, François Quentin, Ingeborg Rocker, Sébastien Rosel, Vincent Rossin, Todd Sabelli, Reza Sadeghi, Philippe Savignard, Ralf Schimmele, Edouard Schneiders, Therese Snow, Dimitri Steijlen, Kim Terca, Thierry Thibesard, Martin Timm, Jutta Treutlein, Clément Vezon, Cédric Villani, Tim Webb and Rachel York.

DASSAULT SYSTEMES | The 3DEXPERIENCE® Company

ZAHA HADID

By Ingeborg Rocker

While I was studying architecture in Germany, the works of Frank Gehry and Zaha Hadid for the Vitra Museum in Weil Am Rhein arrived as formal and intellectual counterpoints to the prevailing architectural discourses of the late 1980s. Together, Frank and Zaha shattered and distorted once and for all the intellectual approach and formal canon of Modern architecture.

Zaha's work uniquely exemplifies a discourse through practice: the practice of her paintings and the praxis of building. Zaha's deconstructivist painting envisioned an approach to architecture as the dynamic capturing of space, almost defying gravity, and certainly subverting the functional aspects of modernist simplicity.

Her paintings for the architectural competition "The Peak in Hong Kong," previewed this architectural ambition – yet the means for their realization had not yet caught up with the architect.

This would change soon with the realization of the Vitra Fire Station; the first proof, so to speak, that the imagined experiences of Zaha's architecture actually were realizable in the double sense of the word: buildable and experienceable.

Over the course of her career, Zaha became one of the most influential architects of the 20th century, a true visionary who enabled us all to believe that it is possible to realize and experience our dreams, even if they seem impossible at first. Zaha's painted architectural visions were unconcerned with the materiality, the tools and techniques of traditional architecture – and it was precisely this lack of concern, this thinking in reference to and yet out of the Modern box, that forced and enabled Zaha to find new paths for architecture. The combination of her unique talent and relentless passion, which forced new paths for architecture realization, was honored with the Pritzker Architecture Prize in 2004. Today we are left with the body of work she produced – and the discourse she fostered by making architecture. We are left to look ahead – in her spirit – to what is next.

ZAHA HADID – AN INSPIRATION IMAGINING NEW HORIZONS

"FOR ME, ZAHA HAS BEEN A GREAT INSPIRATION AND ROLE MODEL – AS A WOMAN, A DESIGNER, AN ARCHITECT AND, MOST IMPORTANTLY, AS A VISIONARY WHO REALIZED HER ARCHITECTURAL VISIONS WITH TALENT, PASSION AND RELENTLESS ENERGY, MAKING THE SEEMINGLY IMPOSSIBLE POSSIBLE. IN THIS SPIRIT – LET'S IMAGINE NEW HORIZONS!"

INGEBORG ROCKER

3DEXPERIENCITY VICE PRESIDENT, DASSAULT SYSTÈMES

"ZAHA HADID HAS MARKED THE WORLD OF ARCHITECTURE WITH BOTH BRILLIANT AND SPECTACULAR ACHIEVEMENTS. AS TRUE AESTHETIC AND TECHNICAL PROWESS, COMBINING ART AND SCIENCE, HER DESIGNS HAVE ALWAYS AROUSED GREAT PRIDE FOR OUR TEAMS AND FOR MYSELF BECAUSE THEY EMBODY OUR CONVICTION, WHAT WE HAVE ALWAYS WANTED TO ACHIEVE: PUSHING THE LIMITS OF THE VIRTUAL TO THE SERVICE OF REALITY, PLACING INNOVATION AT THE SERVICE OF THE HUMAN."

PHILIPPE LAUFER

CATIA CEO, DASSAULT SYSTÈMES

"BY THINKING ARCHITECTURE AS AN EXPERIENCE, ZAHA HADID DEVELOPED AN ENTIRELY NEW ARCHITECTURAL LANGUAGE. I AM VERY PROUD THAT DASSAULT SYSTÈMES WAS ABLE TO CONTRIBUTE TO HER SCIENTIFIC AND IMAGINATIVE JOURNEY, ENDORSING OUR SHARED BELIEF THAT THE VIRTUAL WORLD EXTENDS AND IMPROVES THE REAL WORLD. AND THIS ELEVATION WORKS BOTH WAYS: THE ARCHITECT'S VISION INSPIRES NEW TECHNOLOGICAL ADVANCES, WHILE TECHNOLOGY SPARKS NEW CREATIVE THINKING. LET US CONTINUE TO IMAGINE AND CREATE A WORLD THAT DOESN'T YET EXIST."

BERNARD CHARLÈS

VICE CHAIRMAN OF THE BOARD OF DIRECTORS
AND CHIEF EXECUTIVE OFFICER

ANNUAL REPORT 2016

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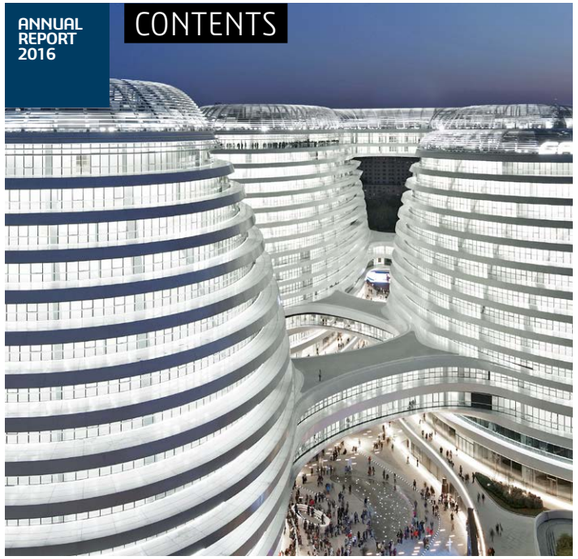
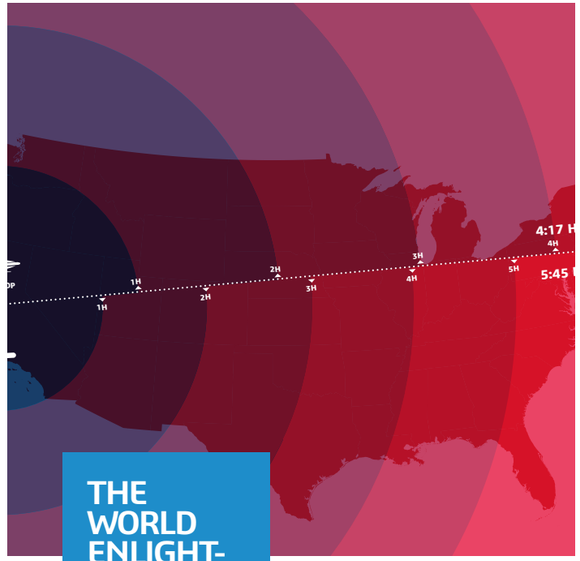


THE WORLD IS WATCHING US



THE WORLD ENLIGHT-ENS US

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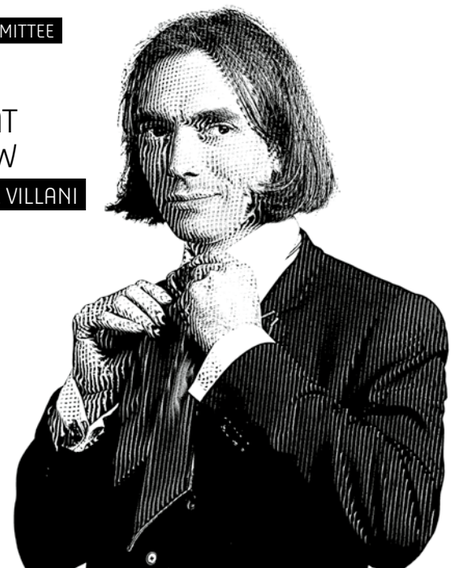
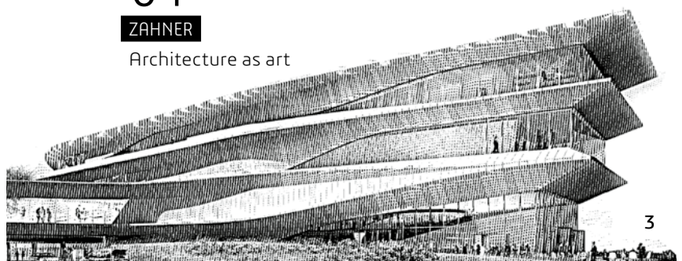
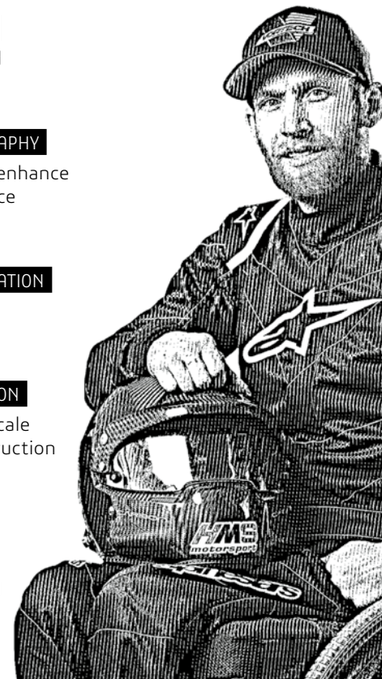
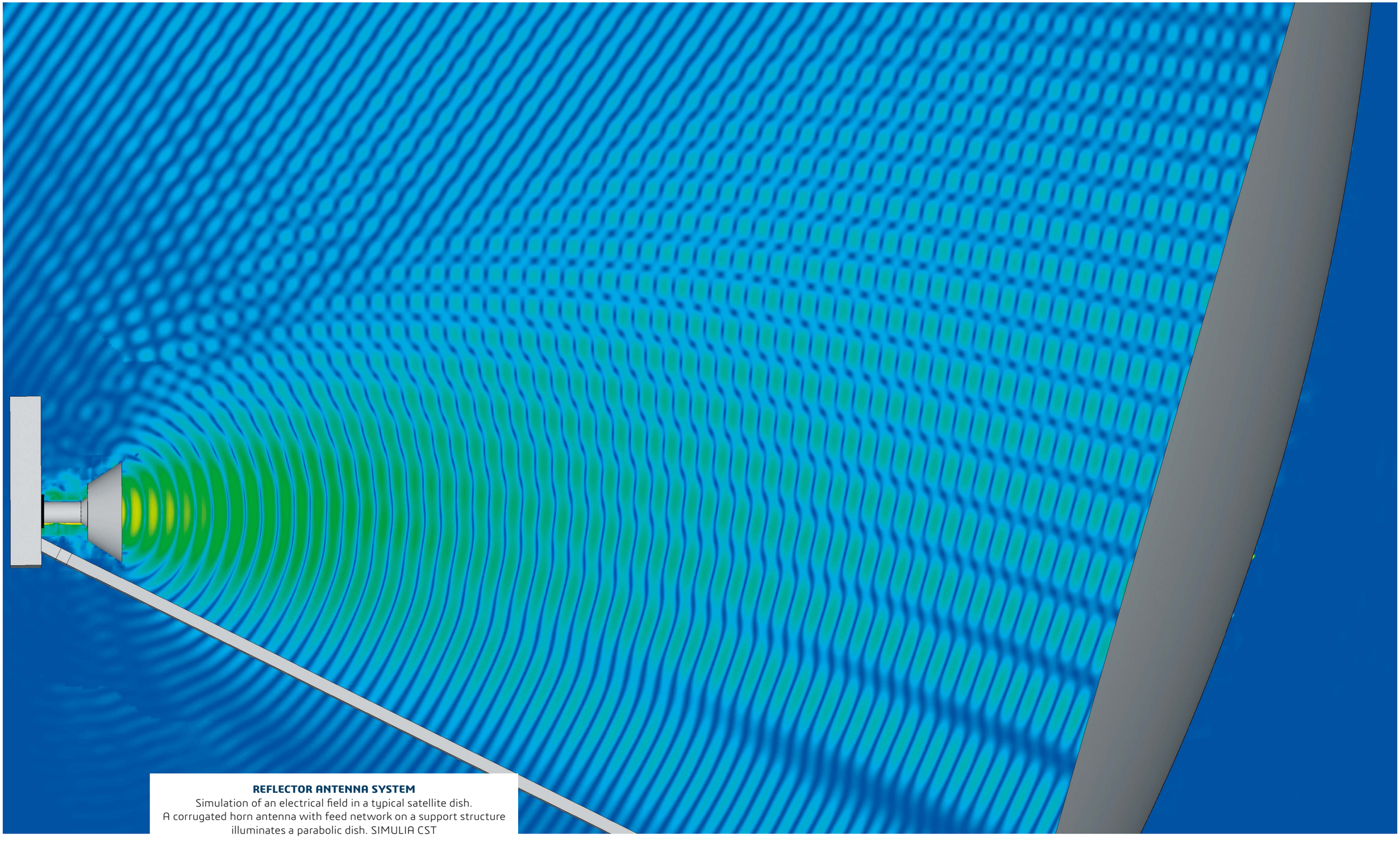






PORTFOLIO 2016

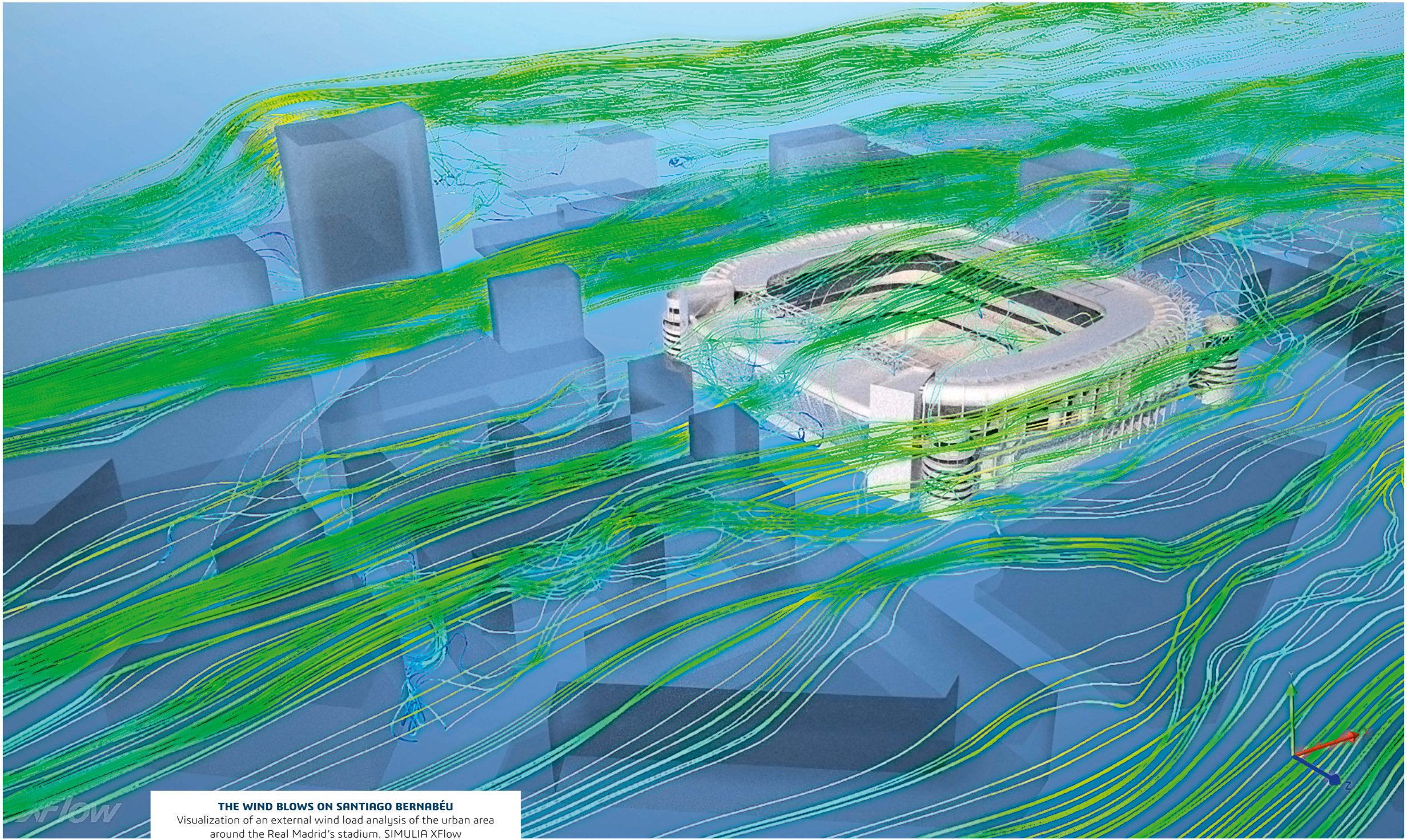


REFLECTOR ANTENNA SYSTEM
Simulation of an electrical field in a typical satellite dish.
A corrugated horn antenna with feed network on a support structure illuminates a parabolic dish. SIMULIA CST

PORTFOLIO 2016

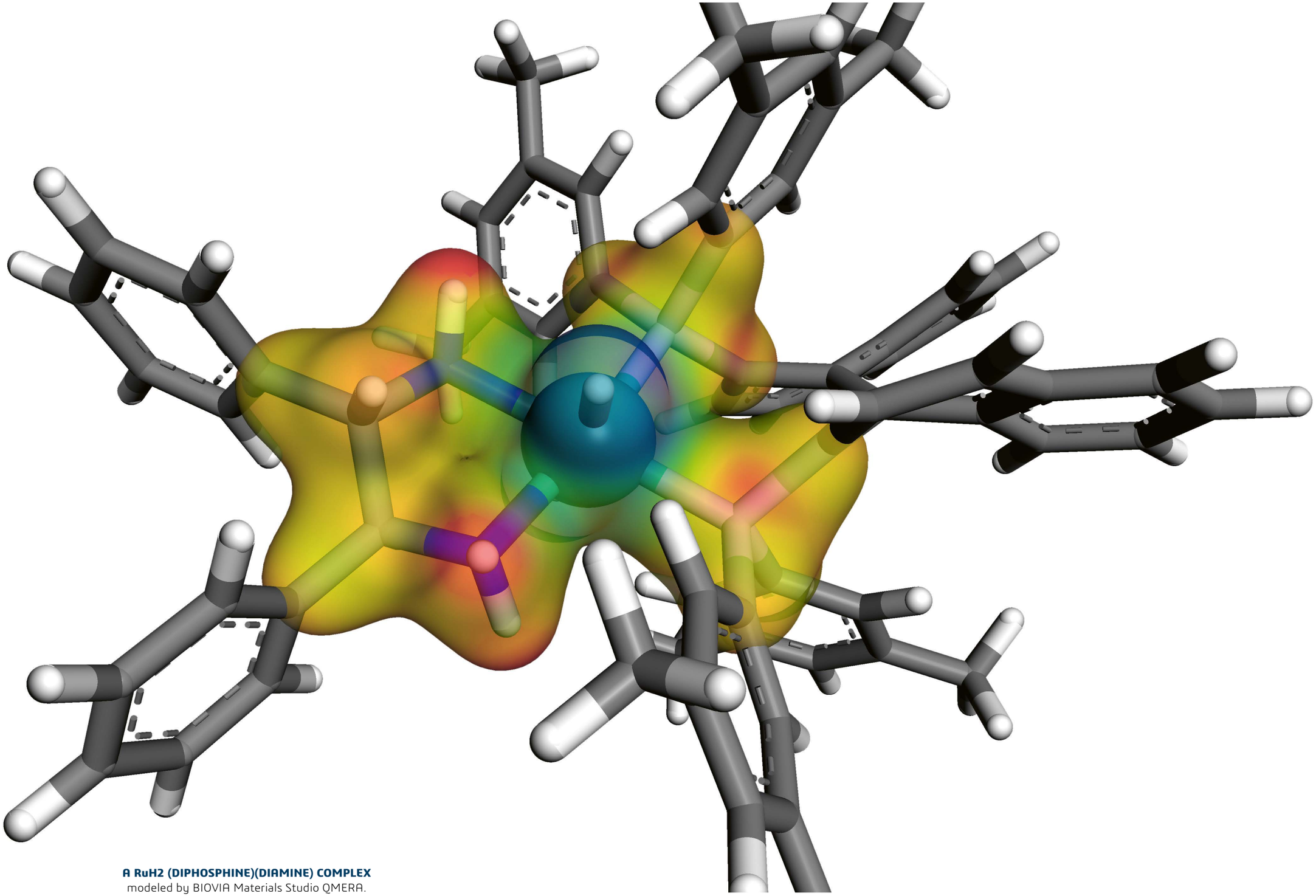
GINGKO SNEAKERS CONCEPT
Quickly express and explore new ideas through concept modeling and high-quality visualization. By the CATIA Design team

PORTFOLIO 2016



THE WIND BLOWS ON SANTIAGO BERNABÉU
Visualization of an external wind load analysis of the urban area around the Real Madrid's stadium. SIMULIA XFlow

PORTFOLIO 2016



A RuH2 (DIPHOSPHINE)(DIAMINE) COMPLEX
modeled by BIOVIA Materials Studio QMERA.

EDITORIAL

DASSAULT SYSTÈMES **3D**EXPERIENCE DRIVES ITS LONG-TERM GROWTH

BERNARD CHARLÈS
Vice Chairman of the Board of Directors
and Chief Executive Officer

CHARLES EDELSTENNE
Chairman of the Board
of Directors

For Dassault Systèmes, 2016 has been a crucial point in the journey to accomplish our ambition for **3D**EXPERIENCE. We are a scientific company, and since our inception our commitment has been to narrow, if not abolish, distance between virtual design and the physical delivery, not only of a product but of an experience for the end customer. During the year, we recorded a number of remarkable wins, expanded our industry and global market footprint and grew our market share; but first and foremost, this year has been one of sharp acceleration for **3D**EXPERIENCE platform deployment, reflecting its strong adoption by our clients. Determined to improve their innovation process, our customers are not only transforming their business models to meet their final clients' demand and deliver product experiences, but are also preparing the future, since it is true that our **3D**EXPERIENCE platform, encompassing all product information, can become a trading platform.

Furthermore, our customers are facing new challenges with the progressing revolution in the manufacturing domain. Enterprises want to improve the control of their production operations, gaining flexibility and reliability, establishing a digital continuity from ideation to user experience, and facilitating the integration of manufacturing in the product design process. This deep transformation is amplified by the changes arising from the expansion of additive manufacturing, which helps designers, who are relieved from traditional design constraints, to show more creativity.

3DEXPERIENCE ADOPTION DRIVING OUR GROWTH

The strong growth of **3D**EXPERIENCE new licenses, representing 36% of related non-IFRS new licenses, up 30% compared with 2015, demonstrates that leading companies across a number of industries see the strong value proposition of our **3D**EXPERIENCE business platform, enabling customers to bring their different disciplines together. This move to our platform is accelerated by increasing product complexity, need for connectivity and collaboration, and the necessity to make sense of an exponentially larger amount of data.

More broadly, this year's operational and financial performance as well as **3D**EXPERIENCE progress make us confident to achieve the objective of doubling non-IFRS earnings per share to €3.50 in 2019 – reflecting the expansion of our addressable market and the improvement of our efficiency. In 2016, we delivered double-digit non-IFRS EPS growth, explained by **3D**EXPERIENCE performance, with increased business in diversification industries, a solid performance from high-growth countries, and non-IFRS operating margin organic improvement.

MULTIPLE FACTORS SUPPORTING OUR GROWTH

This growth, led by **3D**EXPERIENCE adoption, is also supported by multiple factors. The key factor driving our industry value proposition is the capability of our **3D**EXPERIENCE platform to power processes across different disciplines, from ideation, design, scientific simulation and manufacturing to marketing and sales, using meaningful data analytics, thus enabling end-to-end digital continuity. This results in significant improvement in our customers' innovation capacity, evident by very large project deployments, both in progress or already achieved.

Our brand leadership and expanding brand scope continue to represent an important driver. This is visible, for instance, in manufacturing, thanks to the broader offering we have put in place through internal research and development and selected acquisitions such as Ortems, which added production planning and scheduling capabilities to the DELMIA global industrial operations offer. We continued in 2016 to expand SIMULIA's scope with the acquisition of CST, extending the simulation offering to electromagnetic emissions, critical to every stage of electronic system design. SIMULIA also strengthened its computational fluid dynamics (CFD) capabilities, with the integration of Next Limit Dynamics, a company solving challenging CFD equations faster than traditional methods, and Wave 6 in the domain of noise and vibration.

DELIVERING A BROADER OFFER DRIVING DIVERSE INDUSTRY ADOPTION

To illustrate the depth of our offer by industry, we recorded substantial successes in High Tech, with 16% non-IFRS software revenue growth. We signed major competitive transactions in 2016 with Telecommunication, Electronics, Semiconductors and Consumer Electronic companies. Ericsson notably embraced **3D**EXPERIENCE to improve its efficiency, putting in place full digital continuity and connecting progressively up to 100,000 employees around the globe. In Energy, Process and Utilities, where non-IFRS software revenue rose 12%, we have now a strong presence worldwide in nuclear energy, and we are expanding in hydroelectric dams, wind energy, as well as oil & gas and specialty chemicals.

In Shipbuilding, where non-IFRS software revenue growth was 55%, we recorded wins in commercial and naval shipyards, adding certification agencies to our client portfolio and expanding our offering with logistics. DCNS, the French world leader in naval defense, adopted **3D**EXPERIENCE and aims to improve collaboration and achieve a true digital continuity from early design activities to maintenance phases and refits by developing a virtual ship to optimize and test design choices.

During 2016, Diversification Industries delivered 11% non-IFRS revenue growth and now represents 31% of our non-IFRS total software revenue. For core industries, the best performance was recorded in Industrial Equipment. Lastly, our cloud offering is the broadest in the market and provides a vast range of industry solution experiences, processes and roles, improving clients' coverage, notably in diversification verticals.

2016 PROGRESS SUPPORTS OUR CONFIDENCE ON OUR LONG-TERM FINANCIAL OBJECTIVES

In 2016, our non-IFRS total revenue, software revenue and services and other revenue were up 7%, with total revenue crossing the three billion euros revenue milestone coming in at €3.07 billion. Growth was notably led by non-IFRS recurring software revenue, which was up 8% and represented 71% of non-IFRS total software revenue. Our non-IFRS operating margin increased to 31.2%, with an underlying improvement of about 70 basis points, partly offset by currency and acquisition dilutive effects. Non-IFRS earnings per share increased by 11% to €2.49 (including a 5 cent favorable impact from a reversal of tax reserves in 2016).

From a regional perspective, software revenue growth was well distributed, with Asia non-IFRS software revenue increasing by 8%, led by China with sharply higher growth, and India. In Europe, non-IFRS software revenue grew 8%, led by France and Southern Europe. In the Americas, non-IFRS software revenue increased 6%.

Finally, our leading brands offer a unique portfolio, in scope and in productivity delivered to clients. The best performers in 2016 were SOLIDWORKS, SIMULIA, DELMIA and QUINTIQ. CATIA reflected a shift towards its new version with strong growth in **3D**EXPERIENCE sales up 40%, and ENOVIA recorded double-digit new licenses revenue growth during the year.

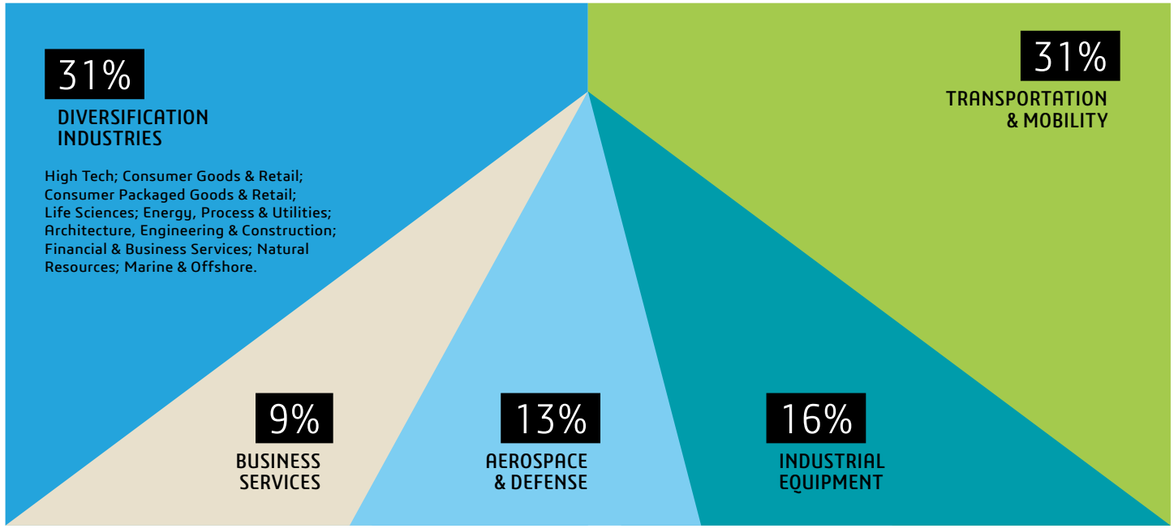
BUSINESS OUTLOOK

We look forward to further progress in 2017 with our strategic growth drivers headed in the right direction. We will continue to invest in Research and Development, as well as in Sales, to support **3D**EXPERIENCE growth acceleration in the coming years, providing unique value to our broad range of clients and also to our shareholders.

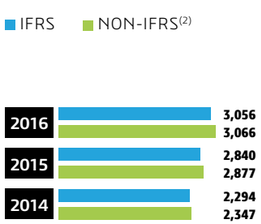
ACCELERATED REVENUE GROWTH FOR **3D**EXPERIENCE NEW LICENSES

- REVENUE GROWTH[1] **+7%**
- **3D**EXPERIENCE NEW LICENSES REVENUE GROWTH[1] **+30%**
- EARNINGS PER SHARE [1] **+11% at €2.49**
- DIVIDEND PER SHARE **+13% at €0.53**

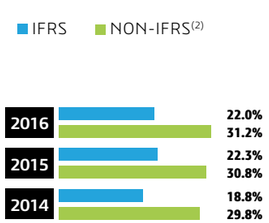
INDUSTRY **DIVERSIFICATION**



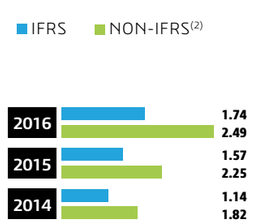
REVENUE (M€)



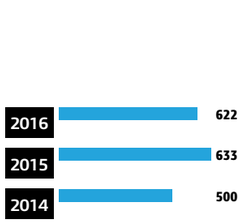
OPERATING MARGIN (%)



DILUTED EPS (€)



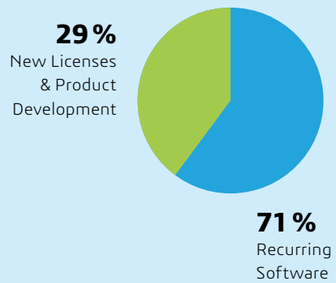
NET CASH PROVIDED BY OPERATIONS (M€)



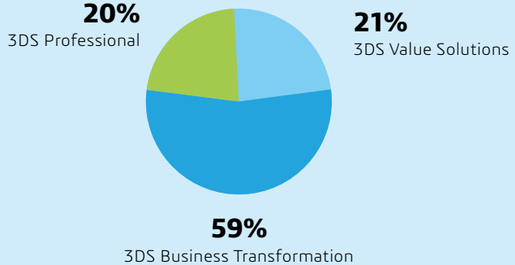
REVENUE BY GEOGRAPHIC REGION

WE ARE LOCATED IN MORE THAN **140** COUNTRIES

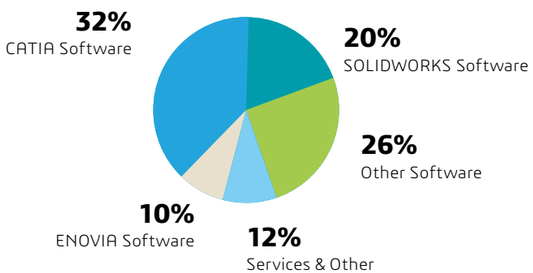
HIGH LEVEL OF RECURRING SOFTWARE REVENUE



WELL-BALANCED DIRECT AND INDIRECT SALES CHANNELS



LEADING BRANDS SERVING OUR USERS

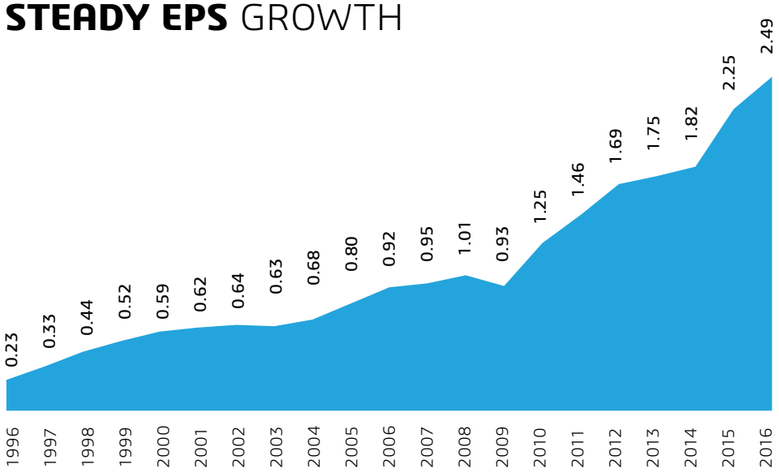


(1) Non-IFRS, revenue growth figures in constant currencies.

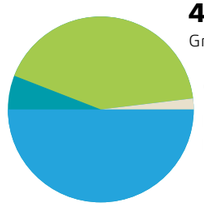
(2) All financial information is reported according to IFRS. In addition, the Company has provided supplemental non-IFRS financial information, which excludes the effect of adjusting the carrying value of acquired companies' deferred revenue, the amortization of acquired intangibles, share-based compensation expense, certain other operating income and expense, net, certain one-time items included in financial income and other, nets, and certain one-time tax effects and the income tax effects.

SHAREHOLDERS' INFORMATION

STEADY EPS GROWTH



SHAREHOLDERS' COMPOSITION



41.1%
Groupe Industriel Marcel Dassault

6.1%
Charles Edelstenne
Chairman of the Board of Directors

1.6%
Bernard Charlès
President & Chief Executive Officer

51.2%
Free Float

SPLIT OF FREE FLOAT

25%
France

35%
North America

16%
Continental Europe
(excluding France)

19%
UK & Ireland

5%
Rest of world

DASSAULT SYSTÈMES STOCK DATA

LISTED ON NYSE EURONEXT PARIS AND TRADED ON THE AMERICAN OTC MARKET

STOCK PRICE AS OF 31/12/2016
€ 72.39
$ 76.40

MARKET CAPITALIZATION
€ 18.4 BN
$ 19.3 BN

COMPARISON OF THE STOCK PERFORMANCE
DASSAULT SYSTÈMES
+1%
CAC 40
+7.5%
EURONEXT 100
+5.5%

DAILY VOLUME OF STOCK TRADED ON EURONEXT PARIS
258,005 SHARES

KEY 2017 SHAREHOLDERS' EVENTS

WEDNESDAY, APRIL 26TH, 2017
RELEASE OF FIRST QUARTER EARNINGS

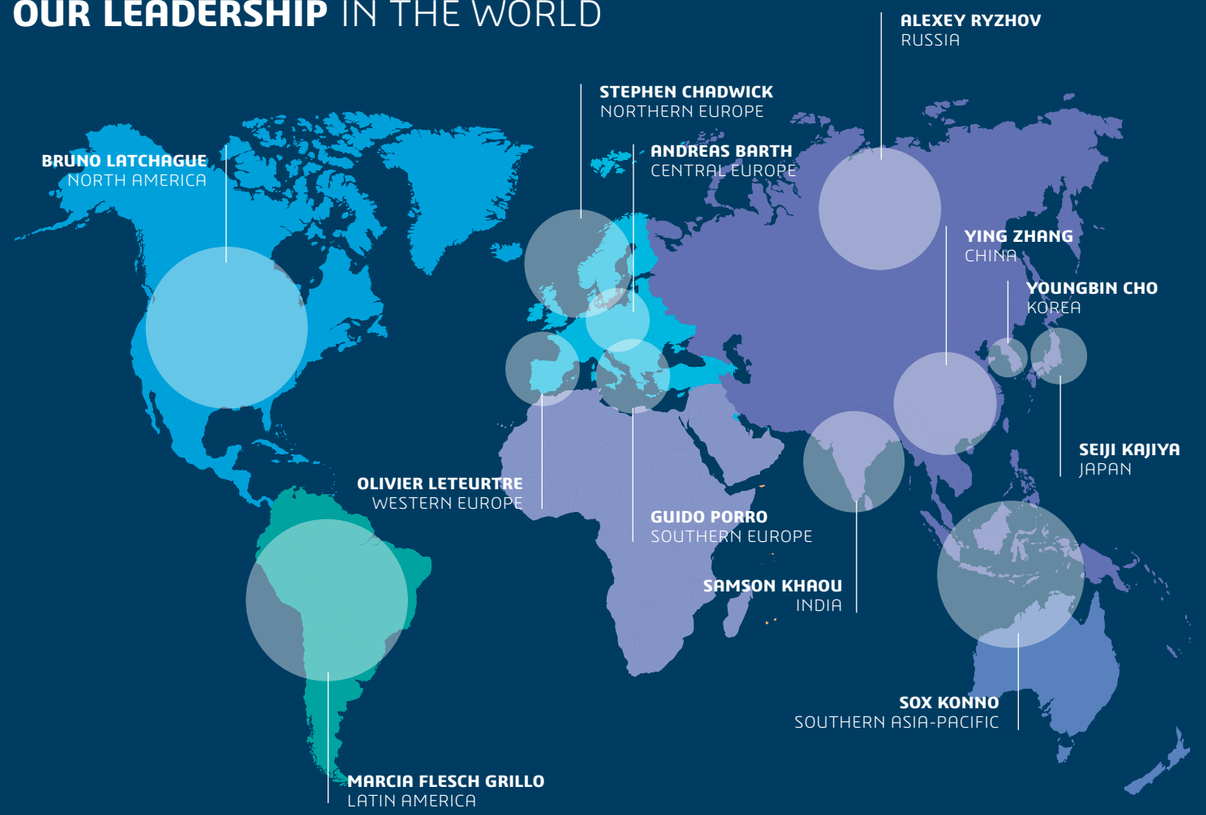
TUESDAY, MAY 23RD, 2017
ANNUAL SHAREHOLDERS MEETING

TUESDAY, JULY 25TH, 2017
RELEASE OF SECOND QUARTER EARNINGS

WEDNESDAY, OCTOBER 25TH, 2017
RELEASE OF THIRD QUARTER EARNINGS

SHAREHOLDERS CONTACT
TEL.: +33 (0)1 61 62 69 24
FAX: +33 (0)1 70 73 43 59
E-MAIL: INVESTORS@3DS.COM
WWW.3DS.COM/INVESTORS

OUR LEADERSHIP IN THE WORLD



OUR LEADERSHIP PER INDUSTRY

CONSUMER GOODS & RETAIL

CHRIS COLYER
VICE PRESIDENT

NATURAL RESOURCES

MARNI RABASSO
VICE PRESIDENT

AEROSPACE & DEFENSE

MICHEL TELLIER
VICE PRESIDENT

MARINE & OFFSHORE

ALAIN HOUARD
VICE PRESIDENT

FINANCIAL & BUSINESS SERVICES

GUILLAUME DUFOUR
VICE PRESIDENT

ARCHITECTURE, ENGINEERING & CONSTRUCTION

MARTY DOSCHER
VICE PRESIDENT

TRANSPORTATION & MOBILITY

OLIVIER SAPPIN
VICE PRESIDENT

LIFE SCIENCES

JEAN COLOMBEL
VICE PRESIDENT

ENERGY, PROCESS & UTILITIES

THOMAS GRAND
VICE PRESIDENT

HIGH TECH

OLIVIER RIBET
VICE PRESIDENT

INDUSTRIAL EQUIPMENT

PHILIPPE BARTISSOL
VICE PRESIDENT

CONSUMER PACKAGED GOODS & RETAIL

PHILIPPE LOEB
VICE PRESIDENT

ORGANIZATION

OUR ATTENTION TO USERS

3DEXCITE
KATHLEEN DONALD
Americas (Detroit, United States)
DOMINIC KURTAZ
EMEAR (Munich, Germany)

ENOVIA
STÉPHANE DECLÉE
(Boston, United States)

CATIA
PHILIPPE LAUFER
(Paris, France)

SOLIDWORKS
GIAN PAOLO BASSI
(Boston, United States)

BIOVIA
MAX CARNECCHIA
(San Diego, United States)

GEOVIA
RAOUL JACQUAND
(Vancouver, Canada)

SIMULIA
SCOTT BERKEY
(Providence, United States)

DELMIA
GUILLAUME VENDROUX
(Detroit, United States)

3DVIA
VINCENT PICOU
(Paris, France)

EXALEAD
MORGAN ZIMMERMANN
(Paris, France)

NETVIBES
FREDDY MINI
(San Francisco, United States)

INSPIRING INNOVATION — SOLIDWORKS

3DEXCITE — MARKETING IN THE AGE OF EXPERIENCE

ENOVIA — COLLABORATIVE INNOVATION

EXALEAD — DATA IN BUSINESS

NETVIBES — DASHBOARD INTELLIGENCE

SIMULIA — SIMULATION FOR PRODUCT, NATURE & LIFE

DELMIA — GLOBAL INDUSTRIAL OPERATIONS

3DVIA — THE CONSUMER EXPERIENCE BRAND

GEOVIA — VIRTUAL PLANET

CATIA — SHAPE THE WORLD WE LIVE IN

BIOVIA — VIRTUAL BIOSPHERE AND MATERIALS

EXECUTIVE COMMITTEE

Driven by their passion for virtual worlds, the Dassault Systèmes management team nurtures talent throughout the **3D**EXPERIENCE Company.
They guide their customers' transformation with sustainable innovation solutions that harmonize products, nature, and life.

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Chief Executive Officer

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CÉDRIC VILLANI

MATHEMATICS, TOMORROW

A proud representative of France's mathematical achievements in international research, Cédric Villani sat down with Dassault Systèmes to explore the future of the discipline, its contribution to industry, the potential for missteps and the challenges he faces as a professor.

DASSAULT SYSTÈMES: MATHEMATICS HAS ADDED A NEW DIMENSION TO INDUSTRY, PARTICULARLY IN TERMS OF INNOVATION. IN YOUR VIEW, WHAT HAS BEEN THE IMPACT OF THIS RUSH OF CREATIVITY?

Cédric Villani: Firstly, mathematics is by definition an abstract science, which means that it can come into play in many different situations. A single subject, algorithm or mathematical theory can have applications in many different fields – it's their very essence. What's more, the digital transition is making many tasks more abstract, which is leading many processes to turn to mathematics.

At the same time, we are witnessing the rise of artificial intelligence, which has disrupted the traditional paradigm of the scientific process and the research and development process by focusing on analysis of examples and the search for correlations. The issues raised by these methods could lead to disaster if taken in the wrong direction. But they also have the potential to develop unforeseen solutions to certain problems. Artificial intelligence was used to beat a human at a game of Go, and the next question is whether it can be used to develop "unprogrammed tricks" to solve problems at companies.

MATHEMATICS HELPS ENTREPRENEURS TO SWIFTLY GRASP HIGHLY TECHNICAL CONCEPTS THAT NORMALLY REQUIRE YEARS OF EXPERIENCE. WHAT IS YOUR TAKE ON THE DO-IT-YOURSELF APPROACH?

CV: It's an area where we should tread very lightly. On the one hand, when used properly, mathematics can indeed be used to replace certain tasks and skills. Sometimes the right solutions emerge without ad hoc expertise necessarily being present. On the other hand, replacing expertise by sheer objectivity causes disasters in terms of assessment. Take the example of the American cities that put faith in algorithms to improve their education system by separating the "good" teachers from the "bad." That produced completely aberrant results: unreliable scores, clear-cut cases of unfairness, etc.

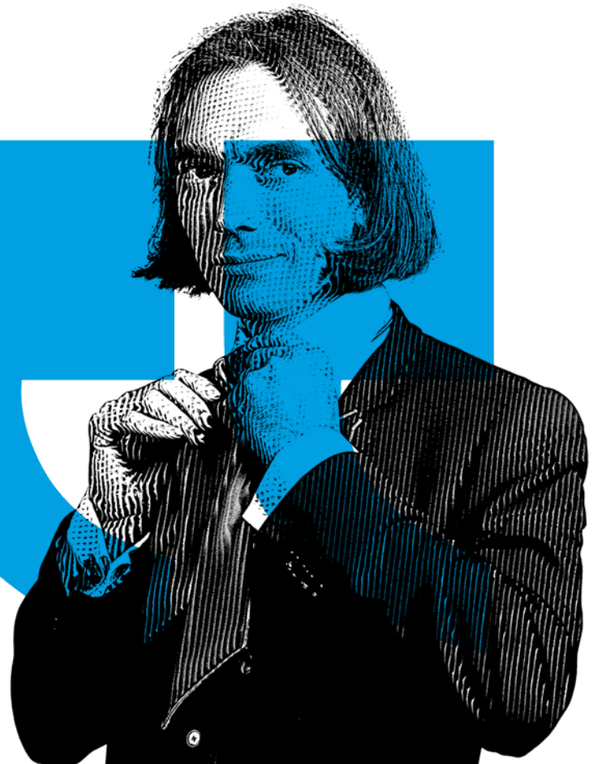
HOW CAN THESE FAILURES BE PREVENTED?

CV: A number of rules and best practices are emerging with regard to the use of mathematical expertise, such as the creation of reliable feedback loops. We are moving more toward "augmented human"-type systems in which human decision-making is supported by mathematical information.

MATHEMATICAL PRACTICES ARE BEING DEMYSTIFIED, IN LARGE PART THROUGH THE DEVELOPMENT OF DIGITAL TECHNOLOGY. WHAT DO YOU THINK OF THE TREND?

CV: A broader audience is indeed being exposed to mathematical techniques. Algorithms have worked their way into just about everything, as has programming. Coding is a discipline built on mathematical thinking – you have to be clear as to how you structure objects and the processes you apply to them. At the same time, you also need to be very pragmatic and able to "feel" how things should be done.

However, it's important to exercise caution with opportunities for bringing mathematical methodology to the masses. A troublesome trend has emerged since programming became more widespread and complex: our students think too much about "fiddling around" and not enough about structure. People across the world are speaking out against the trend. I've heard cybersecurity officials, in particular, complain that their discipline has been overrun by "patching," meaning that when a problem arises, people patch it and move on to the next problem, which they also patch, and so on. That's precisely what they deplore – the lack of systematic, structured thinking. So it's important to strengthen the culture of the "system," in the mathematical sense of the term, among those who work in digital industries, especially cybersecurity.



QUICK BIO

CÉDRIC VILLANI

Villani's main research interests are kinetic theory (Boltzmann and Vlasov equations and their variants) and optimal transport and its applications. More broadly, he is fond of topics that combine several of the following themes: evolution of partial differential equations, fluid mechanics, statistical mechanics, probability theory, "metric" Riemannian geometry, and functional inequalities with geometric content.

1973
Born in Brive-la-Gaillarde, France

1992-1996
Studies at École Normale Supérieure in Paris (and spends four more years there as an assistant professor)

1998
Defends Ph.D thesis on the mathematical theory of the Boltzmann equation

2000-2010
Professor at École Normale Supérieure de Lyon, Université de Lyon, and visiting professor in Atlanta, Berkeley and Princeton

SINCE 2009
Director of Institut Henri Poincaré in Paris, an institute dedicated to welcoming visiting researchers

2010
Awarded the Fields Medal at the 2010 International Congress of Mathematicians in Hyderabad, India

ONE COULD BE LED TO BELIEVE THAT MATHEMATICS HAS BASICALLY BEEN TAUGHT THE SAME WAY FOR A LONG TIME. HOW DO YOU THINK THE SITUATION HAS CHANGED? ARE TEACHING METHODS BASED ON ROBUST, RELIABLE, LONG-TERM STRUCTURES, OR HAVE THEY ERODED?

CV: The world of mathematics is trying to find its footing because of the competing end goals of education in the discipline. One aim is to structure the mind through devotion to a methodological approach. Another is to focus on society's most pressing needs, like learning about formulas and tools. There is a marked tension between these two perspectives in France and elsewhere.

There is also hesitation between teaching technical mathematics and cultural mathematics. To give one example, even if you explain to a student that mathematics is very important for a search engine, he will ask how his studies relate to the search engine. There might be 10 years of study between the two, so it's very difficult to explain the connection.

This situation has led to the emergence of two major interconnected challenges in education. The first is reduced hours. In France, class time for students studying for a scientific high school degree (mathematics and physics) has been reduced by a quarter over the past 15 years. Paradoxically, as we just mentioned, expectations for advances in the discipline are rising. It's become an unsolvable conundrum.

The second challenge involves human resources. How can we find more math teachers? It's an issue in France, but in other places as well. It's the downside of the growing reach of mathematics. It has led many to industry, which offers more attractive career options than education.

WHAT ARE THE KEYS TO THE FRESH IMPETUS YOU ARE GIVING TO MATHEMATICS THROUGH YOUR WORK AT INSTITUT HENRI POINCARÉ?

CV: We do both national and international work at the institute. Research forms the core of our international efforts; we aim to delve into every field of mathematics, from the purest to the most applied. For instance, we're going to spend a quarter studying climate and climate change soon, before moving on to image processing. There is great demand for an institute such as ours to become involved in the field of scientific culture.

At the national level, we have put a great deal of effort into working with society as a whole. Our initiatives take place at a cultural setting that puts citizens in contact with scientific content through formats like film clubs, exhibitions, books, etc.

WHAT FACTORS ARE KEY TO THE SUCCESS OF MATHEMATICS IN FRANCE?

CV: First of all, you can see that the cultural element counts for a lot. In addition to its mathematical tradition and great respect for the field, France is very good at abstract thinking compared with the rest of the world. But what may be most important is that we have institutions that support and organize this mathematical excellence. I'm thinking of the various departments of École Normale Supérieure, the National Center for Scientific Research (CNRS) and certain preparatory exam entrance courses that have maintained a very high level of mathematics education. It's the legacy of structural investments made a very long time ago, and today we also need to think very far into the future. At the same time, we are also seeing some individuals with very unique skill sets emerge from other universities, and their role clearly remains vital.

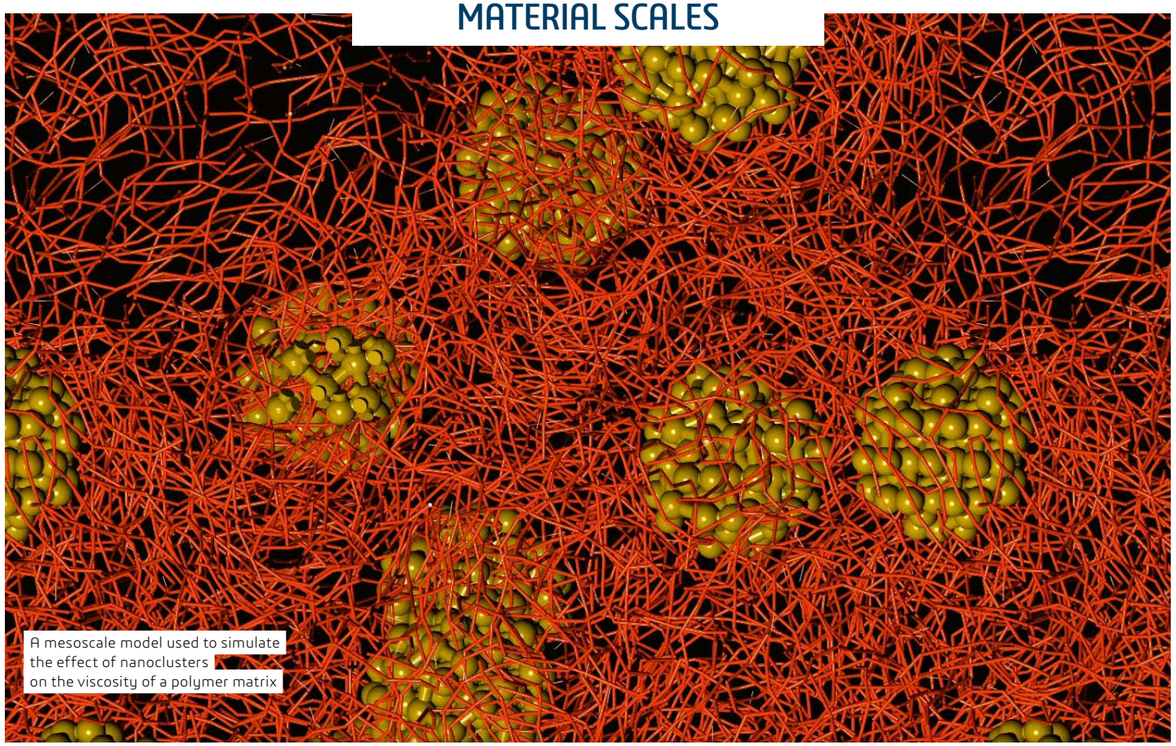
IT SEEMS, THEN, THAT WE MISTAKENLY VIEW MATHEMATICS AS ISOLATED, BOTH AS A DISCIPLINE AND IN TERMS OF ITS RESEARCHERS. WHEN YOU EXPERIENCE IT FIRSTHAND AT DASSAULT SYSTÈMES YOU REALIZE THAT THIS COULDN'T BE FURTHER FROM THE TRUTH. THE DISCIPLINE CAN DRAW FROM ITS OWN INHERENT COLLECTIVE MINDSET AS MUCH AS NEEDED.

CV: Absolutely! Out of all the misconceptions about the discipline, that might be the falsest. It's undeniable that you spend time working alone. However, the public doesn't realize the extent to which we continually have discussions, communicate and exchange ideas. This dynamic forms part of a larger, momentous trend in all sciences: a shift toward a more collective approach. In mathematics, we come up with new ideas all the time. It's the material we work with – ideas are exchanged and worked on as a group. This is all the more true given the level of specialization nowadays, which means that you have to seek out the skills of various experts, who then have to work together. Specializations are causing fragmentation and, the same time, creative work is being done across disciplines and through meetings between people. That's why we're in a collective era!

THE WORLD IS WATCHING US

Front foot (tarsus) of a male beetle

MATERIAL SCALES



A mesoscale model used to simulate the effect of nanoclusters on the viscosity of a polymer matrix

FROM NANO TO MACRO

HOW BIOVIA IS EXPANDING THE FIELD OF MATERIALS DESIGN

BIOVIA is in the vanguard of the materials-by-design revolution and offers modeling solutions on several different scales. Reza Sadeghi, chief strategy officer at BIOVIA, tells us more.

COULD YOU GIVE US SOME BACKGROUND ON YOUR RESEARCH IN MATERIALS BY DESIGN?

A parallel can be drawn between what we call "materials by design" and the rapid, broad-based proliferation of breakthrough approaches to manufacturing, such as additive manufacturing, which require a new generation of innovative materials. Generally speaking, the demand for faster innovation and more efficient products has outstripped what can be achieved with the materials currently available.

Dassault Systèmes is at the leading edge of this research movement, offering biology, chemistry and materials modeling software on several scales, including nano and molecular, as well as collaborative discovery, laboratory management and fabrication process management tools. Natural materials, which are intrinsically multiscale, are organized and grouped into layered hierarchies, from the nanometric level to the microscale, mesoscale and macroscale. Changes in each of these layers modifies their structural and material properties. The use of multiscale and multiphysical modeling techniques is a natural adjustment that enables us to develop proven materials design models with parameters that we can regulate and optimize for avant-garde applications.

WHAT IS THE PURPOSE OF WORKING IN DIFFERENT SCALES?

We often describe our daily experiences from a macroscopic perspective. However, there is a hidden micro world that supports these life experiences. Scientific advances now enable us to exploit the macro and micro worlds simultaneously. In the past, biological evolution – the R&D of life – advanced via accidental discoveries and gradual improvements, just as our engineering solutions do today. For nearly four billion years, living systems alone could assemble structural and functional units on a nanometric scale into larger architectures and complex functional systems. BIOVIA is offering something new: the ability to produce targeted, preconceived results instead of random variations that mainly end up being rejected. BIOVIA's multiscale, multiphysical modeling, simulation and prediction capabilities allow scientists to simulate the system of dynamic interactions in nature, with selection criteria adapted to specific functional needs. Natural selection may favor beetles with solid, lighter, more colorful wings that improve their mobility and chance of survival, while artificial intelligence produces larger fruit with fewer seeds and sheep with softer, warmer wool, to meet performance targets based on human needs. BIOVIA's multiscale modeling – from the nanometric scale to the macroscopic scale – enables scientists to develop targeted, customized solutions that meet and exceed the functionality, efficiency and durability of today's living materials. Multiscale modeling gradually optimizes chemical makeup and composite nanostructures to create synthetic, bio-inspired materials with material functions that can be similar to or radically different from those found in nature. And we can choose to use completely different raw materials to achieve these results.

IN WHAT RESEARCH AREA ARE THE INTERACTIONS BETWEEN MICRO AND MACRO PARTICULARLY FRUITFUL?

It's especially true in biomedical innovation. Our body functions differently as we age and our parts deteriorate. Illness such as cancer and cardiovascular disease have points of origin, and then spread and advance. These dynamic processes occur at the micro, meso and macro levels, with very different physics in each. The structural dynamics at the nanometer level and microscale create properties that affect larger scales. Multiscale modeling can help us connect the forces at play in the body to mecanobiological processes at the cellular level. Dynamic simulations can help us to design targeted procedures on cells and advanced applications in tissue engineering. Understanding how tissue develops normally and responds to mechanical stimuli will provide us with a better understanding of and ability to predict how tissue will respond to a wound or illness, as well as to develop new prevention and treatment methodologies.

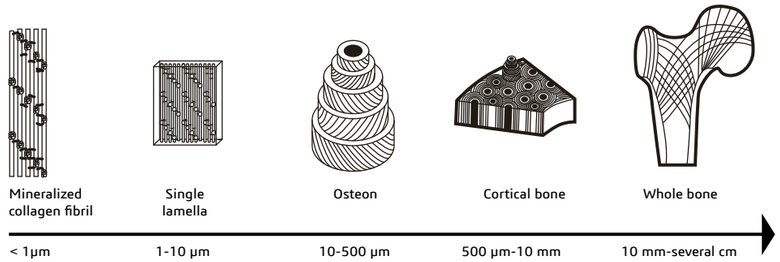
WHY IS THIS APPROACH SO INNOVATIVE?

BIOVIA has revolutionized materials engineering by helping scientists to design and select specific molecules, biological products and materials, and refine their application through modeling, simulation and predictive analysis, to produce smart coatings, lighter composites and sustainable polymers. We are fast approaching the point where materials will be considered variables instead of constraints. Materials science will soon reach the point of composing the properties needed and then designing and formulating the material to achieve the desired performance levels. The selection of materials is a major breakthrough.

WHAT DO YOU DO TO FACILITATE COLLABORATIVE RESEARCH?

Designing and creating products requires the skills, talent and intellectual prowess of many specialists, who all need to communicate effectively to ensure that everyone is working from the same information and shares the same goals. The **3D**EXPERIENCE platform ensures that all stakeholders work from a single official version. The platform also guarantees that product development is traceable from the concept to the scientific discovery and throughout fabrication.

BONE STRUCTURE THROUGH SEVERAL SCALES



FIND OUT MORE

More information on Dassault Systèmes website

UNDERSTANDING OUR BODIES

A COMPLETE MODEL OF THE HUMAN BODY

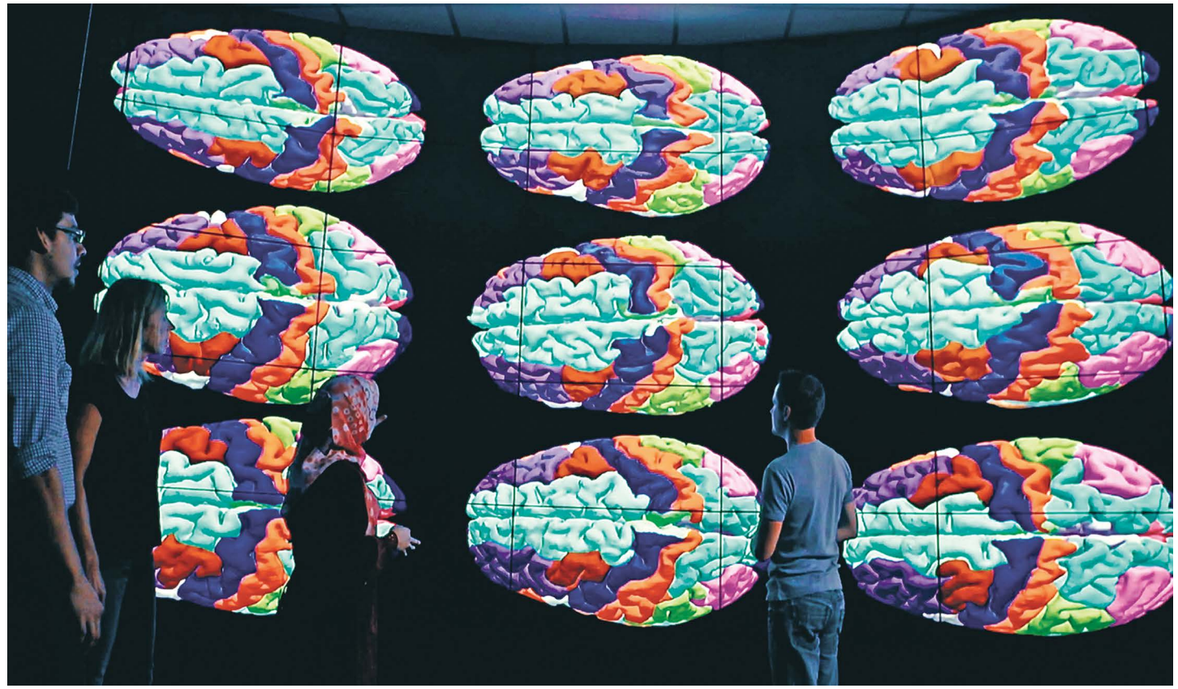
Brian Baillargeon, specialist in Virtual Human Modeling solutions

"Unfortunately, the human body doesn't always follow the rules of physics." Physicists may not agree with this statement by Dr. Jeffrey Olgin of the University of California, San Francisco (UCSF), but giving life to a virtual human is clearly a complex affair. The body is a machine that was fine-tuned over the course of millennia and, as such, shares many characteristics with our most advanced manufacturing techniques.

With this synergy, Dassault Systèmes is in the unique position of being able to provide **3D**EXPERIENCE solutions for modeling a virtual human being. Read on to learn about some of these impressive feats at the leading edge of biomechanical engineering.

MECHANICAL FORCES EXERTED ON THE BRAIN

Dr. Kuhl's team has also started to study the role of mechanical forces on the human brain. The project, which began with students taking MRIs of their own brains to compare their size and shape, has quickly grown in scale. The students created a model of their professor's brain and even printed it in 3D. A postdoctoral researcher simulated the brain under different scenarios and clinical procedures, including a decompressive craniectomy, an operation that involves the surgeon opening up the skull to allow a swelling brain to expand and relieve excess pressure. The study could help neurosurgeons to pinpoint the optimal size and location to open up the cranium in order to minimize tissue damage.



TENNIS AND BONE GROWTH

Stanford University professor and doctor Ellen Kuhl and her students at the Living Matter Laboratory are working on personalized models that can predict the interplay between form and function in different parts of the human body. A tennis player suffering from shoulder problems provided the ideal subject for the simulation of altered bone growth resulting from overuse of an athlete's dominant arm. The team chose to study the humerus for its structural simplicity and used the other arm as a control.

The students used high-speed videos of the serving motion and bone mass density analysis to create a model and determine muscle force vectors, muscle attachment points and boundary conditions. The results showed twisted bone growth caused by contractions during the serve, which explained why the athlete experienced pain in his dominant arm. The group offered guidance on how tennis players can optimize training strategies in order to prevent irregular bone growth.

FIND OUT MORE

To find out more, see the *SIMULIA Community News* #14

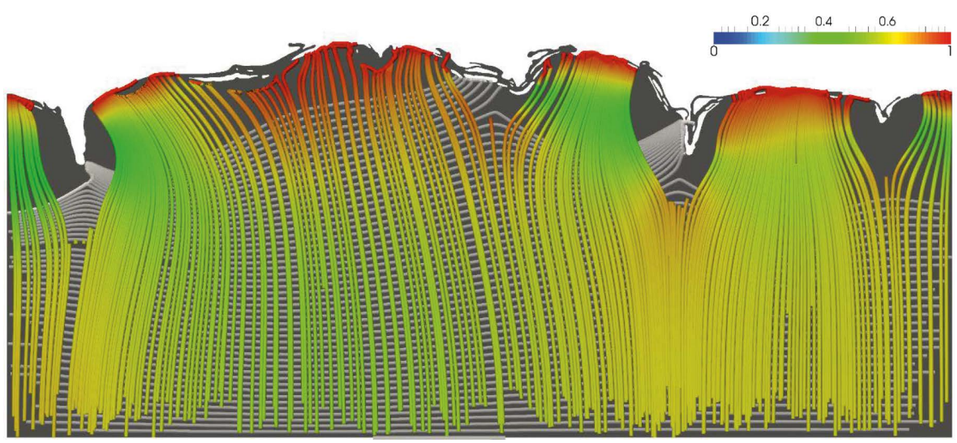
IN-DEPTH SKIN TISSUE MODELING

There is an intimate relationship between the structure and function of the skin with, as a corollary, close interplay between material and structural properties that is constantly evolving with age and shifting environmental conditions.

Georges Limbert of the University of Southampton (UK) and Maria Fabiola Leyva-Mendivil of the University of Southampton and the University of Cape Town (South Africa) are conducting a systematic study of this tremendously complex structure, which is multiphasic, multi-scale and multi-physical. The researchers are using the advanced modeling capabilities of SIMULIA Abaqus, combined with experimental methods and custom imaging techniques. Simulating the mechanics and physics of the skin is one of the most demanding applications of computational physics; it involves manipulating material, geometric and contact nonlinearities, highly anisotropic properties that are nearly incompressible, degradation, surface instability and multiple scales of space and time.

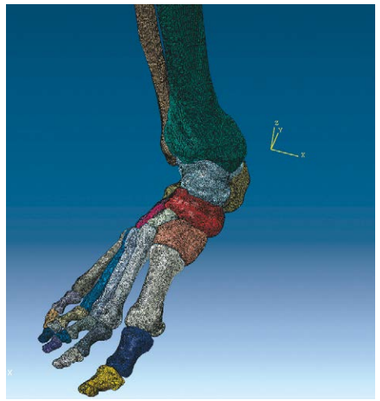
"In Georges Limbert's work, he may not answer the question of whether beauty is skin deep, but he does demonstrate that we can understand the underlying physics that control the appearance of our skin and use this knowledge in new and exciting ways."

Brian Baillargeon



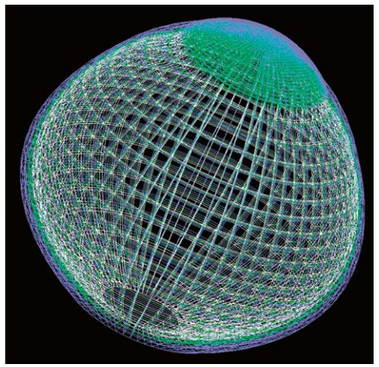
DIGITAL ORTHOPEDICS

The current practice in foot surgery is an approach almost entirely based on "geometry." People without any specific problems have normal geometry, which means that they can move without experiencing pain and do not suffer excess pressure on their feet. A patient with an aching foot has "divergent" geometry that has to be corrected to relieve the pain. Digital Orthopedics believes that the advanced use of imaging, modeling and simulation can improve orthopedic treatment substantially. The innovative startup has developed a comprehensive clinical decision support system (CDSS) for musculoskeletal illnesses, which offers optimal personal treatment and surgical therapeutic strategies for nurses, surgeons, patients and medical device manufacturers. The CDSS is backed by a knowledge base and a diagnosis support platform that enables healthcare professionals and patients to examine clinical reports that aid in understanding the illness and choosing a course of treatment. The startups second platform, for personalized surgical simulation, helps orthopedic surgeons develop procedures tailored to the patient's illness. A third platform dedicated to learning and training via clinical cases will draw from the knowledge collected on the other two platforms.



"Digital Orthopedics is bucking the trend of how foot surgeries are traditionally performed, instead relying on advanced uses of imaging, modeling and simulation to evaluate personalized treatment and surgical therapeutic plans."

Brian Baillargeon



OPTOQUEST PREPARES SURGICAL EYE PROCEDURES

Founded by Dr. William J. Dupps, a researcher at Cole Eye Institute, OptoQuest is working with industry partners to develop personal patient care technology. The company's corneal surgery guidance software, SpecifEye, leverages SIMULIA Finite Element Analysis (FEA) solution to create personalized 3D renderings of the cornea and analyze the structural impact of procedures. SpecifEye uses complex material formulas that analyze the direction and elasticity of the collagen fiber in the cornea to predict refractions after a surgical procedure. The software is currently being used on an experimental basis, but could be used directly by physicians or integrated into diagnosis or treatment systems.

"OptoQuest provides patient-specific modeling for refractive eye surgery to provide ophthalmologists and ophthalmic industry partners solutions for surgical screening, treatment planning, and outcome predictions."

Brian Baillargeon

INDUSTRY OF THE FUTURE

THE NEW INDUSTRIAL REVOLUTION

Dassault Systèmes helps industrial companies take back control of their manufacturing processes, guarantee quality and repeatability, and connect all those elements to the customer experience. In areas ranging from generative programming to industrial simulation, optimization and manufacturing, additive manufacturing and digital continuity let designers unleash their imaginations and reshape the world of industry.

DIGITALIZATION

DIGITAL CONTINUITY PLACES CONCEPT AND CUSTOMER EXPERIENCE ON THE SAME CONTINUUM

In industry, digital continuity expresses the idea that the digital world of product engineering and the real world of manufacturing can share a single data model. Digitalization does not stop at reshaping manufacturing; it also offers the resources needed to take full advantage of this transformation. The **3D**EXPERIENCE platform and DELMIA solutions provide industrial companies with a centralized database and advanced tools – a single, digital source for comprehensive management of design and manufacturing activities.

All companies – even global corporations – can monitor every last detail of their industrial operations for every product and process. This fosters continuous improvement, innovative design and precise traceability. Digital continuity also promotes collaboration, operational excellence and agility.

Dassault Systèmes is offering its customers a new approach that revolutionizes how manufacturers do business. Digitalization is the future of manufacturing and the **3D**EXPERIENCE platform enables companies to begin building that future now.

THE THREE PHASES OF DIGITALIZATION

THE EVOLUTION OF DIGITIZATION

The economy started off on the road to digitalization by digitizing most forms of media and operations in many sectors: e-books, financial transactions, online games, digital products and manufacturing, e-commerce, etc. More recently, the concept of the "quantified self" emerged, denoting both social media and, especially, how the Internet of Things is being used in health care to allow people to share physiological data with their medical practitioner. In many cases, digitalization has substantially improved productivity at a time when the world is becoming more globalized and open. The way that companies compete has changed profoundly as the business world has grown more digital and global.

THE POWER OF SIMULATION

In 1999, Michael Schrage, a research fellow at MIT Sloan School's Center for Digital Business, published his famous work *Serious Play*: *How the World's Best Companies Simulate to Innovate*. Schrage describes this as the second phase of digitalization, in which the companies that digitized the world's products, factories and processes are able to use modeling and simulation to adapt their product selection to competitive pressures at lightning speed. Schrage asserts that the winners in the globalized world will be the companies that can simulate in real time in sync with their entire supply chain. That, in turn, will enable these companies to capitalize on the economics of simulation and use the power of open markets to dynamically reorganize their supply chains based on competitive pressures. This is sometimes referred to as the "hypersimulation society."

THE EXPERIENCE ECONOMY

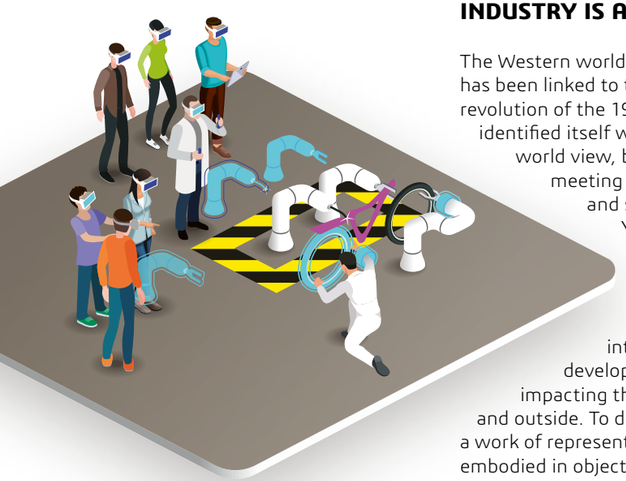
B. Joseph Pine II and James Gilmore introduced the concept of the "Experience Economy" in 1998. In addition to using supply-chain hypersimulation to offer the best products, companies that want to prosper in the Experience Economy have to offer emotion-provoking products that, alongside their labeled purpose, elicit a special feeling in users that results in a memorable experience. Iconic experience-based products include the iPad, Nespresso coffee machines and, as would be expected, most luxury goods. The underlying idea is that products offering personalized experiences can command a higher price from consumers, who are willing to pay extra for something many view as much more valuable than the product alone. In this way, companies remain shielded from the price pressures that normally affect products when they become commodity goods.

INDUSTRY OF THE FUTURE

A NEW DAWN FOR COMPANIES

PEOPLE

AT THE HEART OF A NEW MODEL



PASCAL DALOZ

Deputy General Manager for Corporate Development, Dassault Systèmes; Honorary Chairman, Industry of the Future Alliance

INDUSTRY IS A WORLDVIEW

The Western world's global domination has been linked to the great industrial revolution of the 19th century. It even identified itself with this industrialist world view, born out of the meeting of a belief in progress and scientific rationality. Yet, like a process that emerged from the workshops of monasteries, this vision is a rather long intellectual and material development aimed at impacting the world from inside and outside. To do so, it combines a work of representation of a vision – embodied in objects or organizations – and one of rationalization through calculation and measurement.

AN INDUSTRY OF THE IMAGINARY

The trade of a manufacturer is to invent and reinvent itself constantly. Successful industrialists will be those who create a world that does not yet exist. It is not about optimizing the present, but about conceiving new territories.

However, the true nature of digital manufacturing is generally misunderstood. Its most visible virtue is to increase productivity and competitiveness, but its real power is to unleash the imagination. People are at the heart of this model, based on the complementarity among people, machines, objects and data. Together, this complimentarity can indeed unleash the creative and entrepreneurial functions to the benefit of innovation and change management.

THE EXPERIENCE ECONOMY

The Industry of the Future is emerging within a new economy: the experience economy. Its value is no longer linked to the product, but to the multitude of customized services associated with the product, as well as the experience the user derives from its use. Take the example of aircraft manufacturers: their industry is not about making planes anymore, but about creating a "passenger experience" that impacts its entire value chain. The Industry of the Future will not be a system producing commodities, but a value chain that promotes the design and exchange of experiences, in which the value of products is complemented by online services. Data then becomes a strategic asset.

DIGITAL PLATFORMS ARE CRITICAL INFRASTRUCTURES

In this context, manufacturers must manage the digitization of their company and of its offering simultaneously. Otherwise, disintermediation by an operator offering data-driven marketplaces and value-added services becomes a risk. Experiential platforms are essential because they bring together talents, ideas, solutions and data. They enable the implementation of innovative supply strategies (interconnected modular manufacturing systems) and demand strategies (customized and connected products and services).

THE INDUSTRY OF THE FUTURE ALLIANCE

The Industry of the Future Alliance responds to this double imperative: to modernize the productive system and to support companies in their digital transformation. By putting people at the heart of its program, the Alliance aims at revitalizing the passion companies have for the future and at being the driving force behind an attractive industry that is respectful of its employees. It is leading industry transformation with the support of the public authorities.

FIND OUT MORE

More information on Dassault Systèmes website

INDUSTRY OF THE FUTURE ALLIANCE: 6 PRIORITIES FOR ACTION

1. Support companies in their transition to the industry of the future
2. Develop technological and digital solutions
3. Prepare people: coevolution, future planning and training
4. Promote, in particular, via flagship projects
5. Expand standardization initiatives, especially outside France
6. Leverage existing technology

FACTORYLAB OPENING

September 28, 2016: FactoryLab, a platform designed to speed up industrial players' integration of emerging industrial technologies, officially opens at the CEA research institute. Co-founded by Dassault Systèmes, PSA, Safran, DCNS, Actemium, CEA, Cetim and Arts et Métiers, this "project hotel" works with companies of all sizes on functional demonstrators that will shape the future of industry.

ALFI TECHNOLOGIES - A TRANSFORMATION OF THE CUSTOMER RELATIONSHIP MODEL

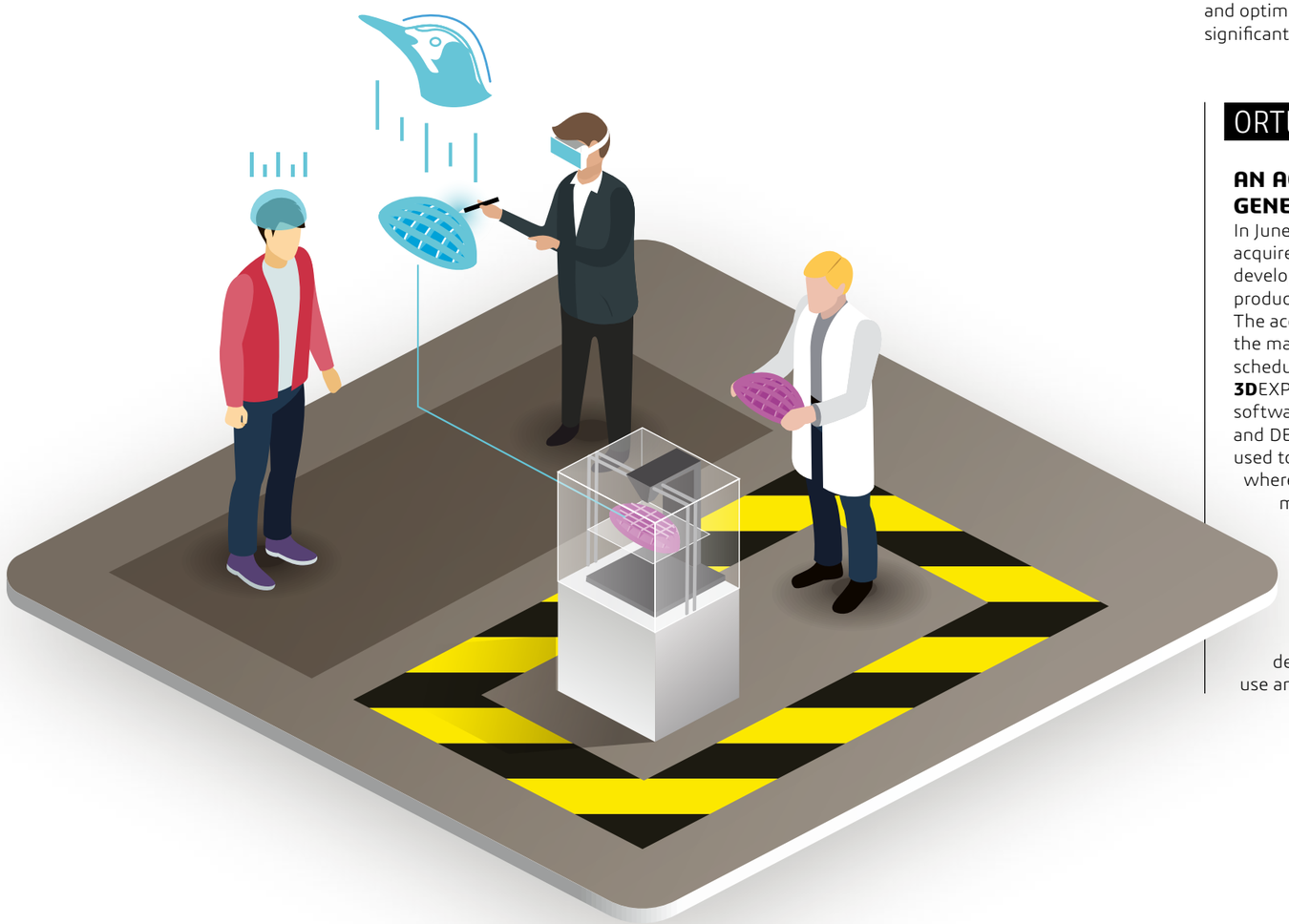
The ALFI Technologies Group, an industrial SME that manufactures equipment and production lines, has made the shift to digital under the impetus of Yann Jaubert, its CEO, who is convinced that these new technologies are a lever for the growth of French industry. Accompanied by our partner VISIATIV, the company has relied on SOLIDWORKS to implement a new dynamic. Today, ALFI responds to calls for tender with animated digital mock ups of factories, integrates new uses and offers new services to its customers. The group has reinvented its pre-sales and project development approach with its customers in order to conquer new markets.

BCG: INNOVATION CENTER FOR OPERATION

Boston Consulting Group France opened a new 1,200 m^2 pilot plant in the Paris-Saclay science and technology cluster in September 2016, in order to help its customers' transition to Industry 4.0. At the plant, the company uses two production lines designed with Dassault Systèmes' **3D**EXPERIENCE platform to conduct full-scale experiments on all the technologies that will be found in the ultraflexible, interconnected plants of the future: collaborative robots, 3D printing, augmented reality, big data, etc.

INDUSTRY OF THE FUTURE

INDUSTRY UNDERGOES A FAR-REACHING PARADIGM SHIFT



ADDITIVE MANUFACTURING BRINGS INNOVATION TO PART MANUFACTURERS

Additive manufacturing has revolutionized the design process by eliminating a wide range of constraints related to casting, stamping and machining, resulting in new types of parts and products and spectacular cost savings. Designers can ask themselves, "Ideally, what should this part look like?", and then build it using additive manufacturing.
This has led designers to conclude that some organic shapes found in nature are more efficient than those used in the past by industry. The type of generative, functional design made possible by 3D printing is set to upend manufacturing, requiring industrial companies to rethink production and process planning, as well as their approach to materials engineering. This revolution is being fueled by the speed of digital simulation and the short processing time needed to find the ideal design, by automatically generating a series of models. Placing this combination of modeling, simulation and optimization in the hands of designers eliminates longstanding hurdles, generates significant productivity gains and avoids waste harmful to the environment.

ORTEMS

AN ACQUISITION IN LATEST-GENERATION PRODUCTION

In June 2016, Dassault Systèmes acquired Ortems, a company that develops advanced planning and production scheduling (APS) solutions. The acquisition has enhanced the manufacturing planning and scheduling functions in the **3D**EXPERIENCE platform's DELMIA software. DELMIA Ortems V8 and DELMIA Ortems PlannerOne are used to manage operations in plants where a highly synchronized manufacturing information system connects virtual design with physical production. Users can automate, streamline and compare production schedules in order to meet delivery dates, manage resource use and increase profitability.

MANUFACTURING AS A SERVICE

THE DYNAMIC VALUE CHAIN

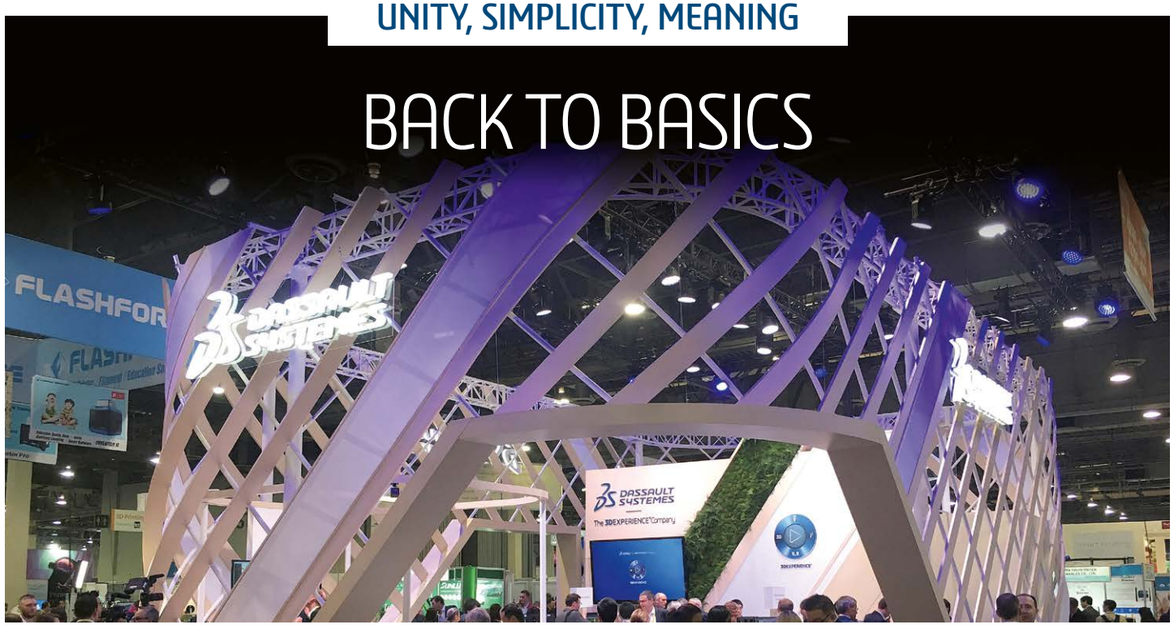
In the Manufacturing as a Service (MaaS) approach, industrial manufacturing is viewed as a service that speeds up communication between the plant and the stakeholders in the product value chain in order to optimize industrial performance. The companies that form the value chain reorganize every link – from the design phase to manufacturing and delivery – dynamically based on developments in the market. A single company of any size can belong to value chains pertaining to a broad range of products and business sectors.
In this type of highly flexible market, companies can rebuild their chain of partners and suppliers, and optimize their overall logistics operations based on needs and shifts in the market. Collaborative hubs can be developed with customers and partners to optimize operations and their execution in real time. These hubs also foster innovation through the joint definition of new products, services, assets, operations and organizational methods.

INDUSTRIAL RENEWAL

In recent years, many countries have launched national initiatives aimed at creating manufacturing industries that are more flexible, creative, sustainable and aligned with the new economy.
Dassault Systèmes is involved in each of these initiatives as a key stakeholder in the digital transition, working alongside public authorities, national industry associations, leading industrial players, SMEs and universities. Take, for example the Industrie 4.0 initiative in Germany and the Industry of the Future plan in France. Eachis relying on the power of digitalization to transform industry, but to reach two different goals resulting from each country's unique industrial landscape: automation and flexible production lines in Germany, and a systemic approach to the value chain and the human element in France. This transformation involves boosting the growth and competitiveness of SMEs; technological platforms and development (ergonomics and cobots, additive manufacturing and digital continuity, industrial internet development, shared ontology, interconnection with peer-to-peer platforms, etc.); and strategies and ecosystems related to standards and the role of humans.

UNITY, SIMPLICITY, MEANING

BACK TO BASICS



Our modern societies have created diversity, immediacy and complexity. At Dassault Systèmes, our daily goal is to use our platform to promote a renewed sense of unity that facilitates collaboration and brings our societies together to create a better future. But how is unity manifested in communication?

Vanessa Perez, Vice President Corporate Communication & Global Events

Above all, unity means returning to a simple approach based on what matters: human needs. Thought-provoking materials, elements that focus on the essentials and cultural inspiration are the key ingredients in the communication we use to express ourselves.

The eyes of the world were upon us during the 2017 International Consumer Electronics Show in Las Vegas, where everything is about technology. The challenge was to present in a simple, unique way by showing humanist solutions that spoke to people and awakened their unconscious as they sought out a reassuring environment which we provided in the form of a giant, sleek protective "nest," a luxe latticework structure giving visitors a tantalizing view of the lush "living wall" inside.

Inside, our stand showcased all our virtual reality, augmented reality technology. We stood out from our technophile neighbors by drawing inspiration through marvels of modern architecture. The exhibit embodied our dedication to the overall success of the experience and our respect for the balance between virtual and real.

When we demonstrated how the **3D**EXPERIENCE platform is helping industry, governments and citizens worldwide to imagine, develop and experience sustainable urban solutions at the World Cities Summit in Singapore, we welcomed our guests in a familiar environment: a giant penthouse with 360° city views where could meditate on cities of the future designed for and by citizens.

The care we put into the details of our pavilion – both interactive elements that encouraged visitors to join in and a cozy side more conducive to relaxation and contemplation – ensured that visitors went home with an in-depth understanding of each demonstration.

Now more than ever, unity and simplicity speak to us all in a universal language that is a source of reassurance. Now, more than ever, we must channel our efforts to create a more conscientious world. A place where it makes perfect sense to place products, nature and life in the same continuum.

FIND OUT MORE

Find out more on Dassault Systèmes YouTube channel

3DS SUMMER CAMP 2016 IN THE AGE OF EXPERIENCE

3DS SUMMER CAMP

INSPIRE FUTURE GENERATIONS

With the **3D**EXPERIENCE universes, we share a new look at the world. It is therefore natural for us to transmit this vision of the future to our children!

LiVES

Live a virtual experience in total immersion, as in real life

FABLAB

Discover the world of 3D printing and its technological and economic impact

3DEXPERIENCE LAB

Design a prototype with CATIA and print it in 3D

CODING

Learn how to encode an application

FASHIONLAB

Understand how 3D experiences revolutionize the world of fashion

HOMEBYME

Draw, arrange and visit a house in 3D

LEARNING LAB

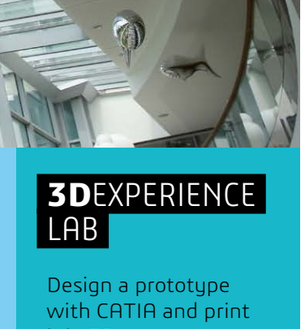
Test new ways of learning and discover the school of tomorrow

DESIGN STUDIO

Reveal creativity with the new generation tools of the designer

3D DREAM SKETCHER

Express and share imagination directly in 3D immersion



1,024
CHILDREN

741
PARENTS

33
ACTIVITIES

12
WORKSHOPS

THE WORLD IS WATCHING US

DIGITAL GOVERNANCE

3DEXPERIENCity

WORLD CITIES SUMMIT 2016

The World Cities Summit, a major event of governance and sustainable urban development, gathered more than 21,000 people from 125 different nationalities Singapore from July 10-14, 2016. This one-of-a-kind event addressed "Liveable & Sustainable Cities: Innovative Cities of Opportunity." A perfect framework for Dassault Systèmes to present the **3D**EXPERIENCity offer in action, through virtual reality environments, demonstrations of Virtual Singapore - the virtual clone of Singapore already in production and used by elected officials - as well as mechanisms for testing the future of health and social services, public services, mobility, safety and public security, facility management and environmental planning in cities. The few pages to follow gives you an overview of this complete and unique offer.

125
COUNTRIES REPRESENTED

21,238
PARTICIPANTS

FROM JUNE 30 TO JULY 30

661,345 people reached

490,206 people reached

@Dassault3DS + @3DS_Asean + @3DS_NZ
545,340 people reached

3DEXPERIENCity.com
3,043 total pages viewed

47%
OF TRAFFIC FROM SOCIAL MEDIA

ECONOMY

THE RISE OF THE EXPERIENCE ECONOMY IS SPURRING A SHIFT TOWARD NEW RETAIL STRATEGIES

One consequence of the growth of the digital economy is that cities now have turned its focus to the effects of rapid urbanization. The economy is shifting toward new retail strategies stemming from the rise of the experience economy and the growth of product-service systems, which involve sharing products rather than personal ownership. These systems are picking up momentum as the number of apps and online marketplaces continue to increase. These new consumer trends have the potential to upend the urban experience and disrupt city economies significantly. Cities will need robust technologies in order to manage these new technologies effectively, by enabling planners and companies to predict consumer patterns. A whole range of innovative products and services for urban consumers could emerge, without any negative impact on public safety or privacy.

SOLUTIONS

3DEXPERIENCity helps cities customize the services and experiences they offer and opens up new opportunities for public authorities, companies and individuals. An integrated platform analyzes new business and planning opportunities, performs simulations, and optimizes sales transactions. **3D**EXPERIENCity also offers a unique means of assessing services and new experiences designed for urban settings, as well as an innovative environment in which urban companies and cities can evolve and take part in competition on a global scale.

EDUCATION / CULTURE

A SYSTEM THAT MAKES IT EASIER TO OFFER
APPEALING, PERSONALIZED EDUCATION AND CULTURAL EXPERIENCES

Cities are magnets for innovation and experience, drawing together communities of active, engaged individuals who are eager to learn, create new knowledge, and share it with others. Learning was once relegated to the passive environment of the classroom, but now pervades all aspects of cities, which have become vast real-life classrooms. Additionally, education, once limited to a preparatory phase early in life, now continues throughout people's careers and sometimes even further. Educational opportunities provide entertainment, promote personal growth, and offer a means to become more employable and develop new skills. Education holds communities together on a fundamental level. A unified platform that combines traditional and innovative educational and cultural experiences enables businesses to tap into a well-trained, motivated workforce, build closer interpersonal relationships between residents, and promote personal development as well as new cultural experiences.

SOLUTIONS

3DEXPERIENCity makes it easier for education and training departments, cultural institutions, online universities and cultural event organizers to offer appealing, personalized cultural and education experiences. The platform develops and delivers content that improves the quality of life for residents and visitors by helping to create educational and cultural experiences and job opportunities.

E-GOVERNMENT

IMPROVING DECISION-MAKING
AND THE EXPECTED PROVISION OF SERVICES

As cities grow in size and population, they also grow in complexity. Individuals and communities seek a forum for interaction and expression that will help them play a greater role in city life. Residents also expect their municipal government to take a more responsive approach than in the past. Traditional methods of communication and interaction with residents are unable to meet current expectations of citizens, namely those of the rising generations of digital natives seeking to shape the organization and future of their urban environment in more meaningful ways. To meet the needs of businesses and residents, cities need to embrace digital technologies for collecting and managing city data in order to improve decision-making and the expected provision of services.

SOLUTIONS

3DEXPERIENCity offers a unified management tool for cities, in particular city councils, information and communications technology organizations, companies and residents. The tool helps cities operate more efficiently by enhancing the participation of companies and citizens, with increased transparency in terms of the services provided – all in a reliable, scalable and sustainable manner. Via mobile and social networks, 3DEXPERIENCity offers multi-channel access to municipal programs and services by offering a single data reference system that ensures efficient collaboration between all city stakeholders.

FACILITIES

THE CONTINUED GROWTH OF THE WORLD POPULATION CALLS FOR STRATEGIC CITY PLANNING AND MANAGEMENT

The continued growth of the world population has increased resource use, which makes strategic city planning and management a necessity, particularly in terms of how facilities, buildings and community amenities are allocated and managed. Population growth in urban environments requires new construction. At the same time, erecting and operating buildings involves processes – from heating to demolition – that account for more than a third of the world's resource use and 60% of global CO_2 emissions. It is crucial that we reduce the carbon footprint of our buildings and cities significantly by shifting to a cradle-to-grave model of building lifecycle management. Buildings, facilities and cities comprise complex networks of systems that require a different type of thinking. We need to take these complexities into account by managing them in a holistic manner, using resources more efficiently and lowering operating costs. The challenge is to bridge the gap between design and operation.

SOLUTIONS

Databases on existing facilities serve as far-reaching reference systems than can be enhanced further through calculation and analysis, enabling managers to envision, analyze, simulate, create and manage cities and facilities in virtual and real settings simultaneously. **3D**EXPERIENCity offers a comprehensive tool for efficiently designing and managing facilities, with applications for a wide range of stakeholders: building inspectors, regulatory agencies, building owners and operators, various construction sector operators, architects, design offices, planning bodies, and analysis and engineering departments. The goal is to promote the sustainable use of natural resources and develop new revenue streams, while providing greater safety and more reliable urban planning and design.

MOBILITY

A SUSTAINABLE APPROACH TO OPTIMIZING MULTIMODAL MOBILITY SERVICES AND TRIPS

Cities are reshaping their mobility policies and transportation sector players are launching new business models in reaction to rapid urbanization, increased environmental consciousness, advances in mobility technology and a desire to improve the passenger experience. These new management models view vehicles as functionalities rather than assets, as demonstrated by the growth of chauffeur and car-sharing services. However, the emergence of these new opportunities brings its own challenges. Much of the existing infrastructure has reached maximum capacity and is approaching the end of its planned lifespan. Fossil-fuel-dependent mobility technologies produce levels of pollution – CO_2 emissions and microparticles – now considered unacceptable. Solutions to address these challenges will require a holistic platform that can promote and support innovation by fostering cooperation between cities, businesses and residents.

SOLUTIONS

3DEXPERIENCity helps elected officials, municipal authorities, urban mobility managers, transportation operators and residents to optimize multimodal mobility operations and services and trips in a sustainable way. Ridership scenarios involving multiple operators improve commutes between the city outskirts and center; reduce trip times and costs; and enhance operational planning and integration, all while creating new interplay between each urban transportation stakeholder and its logical counterpart.

HEALTH AND SOCIAL SERVICES

HELPING CITIES ANALYZE, PREDICT AND PREVENT HEALTH RISKS

The density of the urban environment fosters innovation by bringing together professionals from different fields to seek out solutions to contemporary challenges. In turn, this builds momentum that drives more people to live and work in cities, where they can access a wider range of health and social programs. The city becomes "ground zero" for detecting new health crises and developing new programs that promote healthier lifestyles. Wearable sensors and portable devices, combined with analytics hosted on a robust data platform, can enable cities, businesses and residents to collect and consolidate data related to their environment and physical condition. This system capitalizes on the productivity of the dense urban environment and pinpoints all the resources best suited for healthy living, in a way that is tailored for individuals and their specific environment.

SOLUTIONS

3DEXPERIENCity helps cities develop virtual scenarios that analyze health risks, with applications for mayors, health authorities, health agencies, doctors, epidemiologists and citizens. The platform represents a complete reference system for healthcare and wellbeing services in urban settings. The solutions are patient-centric and set the conditions for healthy lifestyles and preventive care, while also providing greater responsiveness and more efficient emergency services. This leap in efficiency lowers the cost of healthcare and social services, and enables people to lead healthier lives.

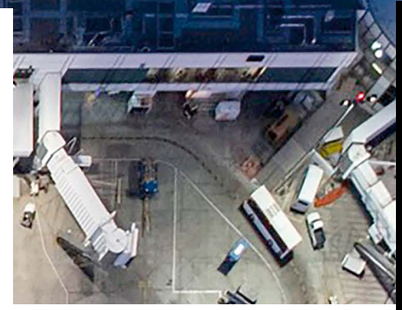
FIND OUT MORE

More information on Dassault Systèmes website

SAFETY AND PUBLIC SECURITY

ADDRESSING THE FULL RANGE OF SAFETY AND SECURITY CHALLENGES CITIES FACE TODAY

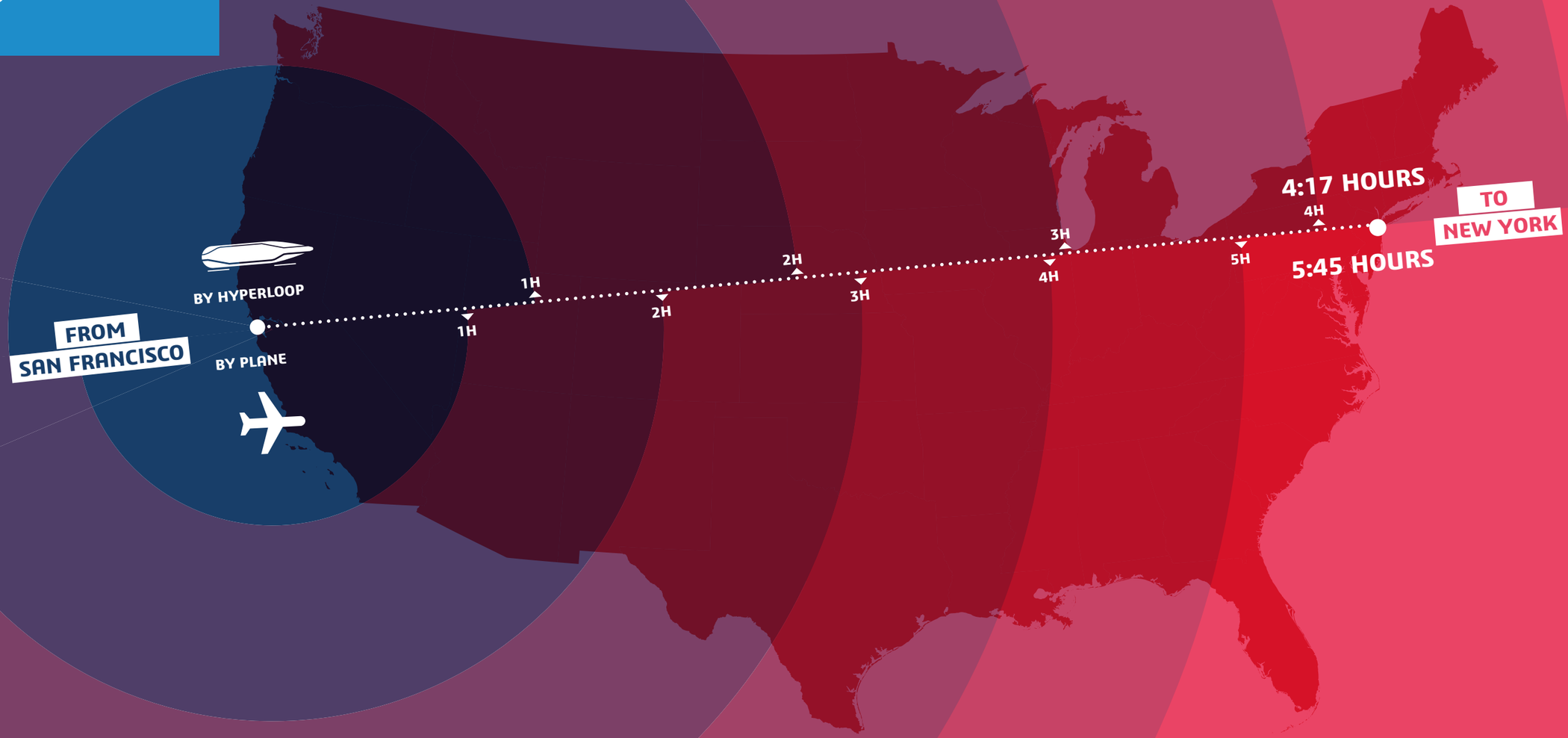
City managers are under more and more pressure as their cities continue to play an increasingly prominent role on the world stage, attracting new residents and visitors from across the globe. However, administrators need to plan for the consequences of our globalized world, which can entail risks for companies and citizens. In addition to anticipating and preventing external threats, city managers also must provide for internal order and stability, ensure the safety of businesses and residents, and prepare for potential emergency situations. Digital technologies enable municipal governments to redefine how it protects people and assets, while also detecting incidents and finding solutions more quickly. Modern cities need a common reference system that facilitates interagency cooperation in order to address the full range of safety and security challenges they face, ensuring close coordination for rapid responses to incidents and encouraging citizens to be stakeholders and partners in urban safety and security.



SOLUTIONS

The **3D**EXPERIENCity digital model lends support to municipal authorities, public and critical infrastructure, safety agencies, emergency and information services, companies and citizens. The platform digitizes all aspects of safety and security to improve planning, operations and threat response. The model sidesteps major upgrades to existing information systems to achieve rapid situation awareness. It improves interdepartmental cooperation, facilitates real-time decision-making by cross-referencing data sources, and helps plan coordinated, smooth emergency operations. The platform also helps locate, identify, interpret and monitor active threats, thus improving safety and security in both physical and virtual settings.

THE WORLD ENLIGHT-ENS US



FASTER THAN A PLANE, AS CONVENIENT AS A TRAIN

HYPERLOOP

DELFT UNIVERSITY OF TECHNOLOGY BREAKS NEW GROUND

Hyperloop is an industrial research project launched in 2013 by Elon Musk, founder of Tesla Motors and SpaceX, to develop a fifth mode of transportation. If successful, alongside boats, cars and trains, there will also be passenger-carrying pods faster than airliners that travel in a tube under very low pressure to limit air friction.

FIND OUT MORE

More information on DELFT HYPERLOOP website

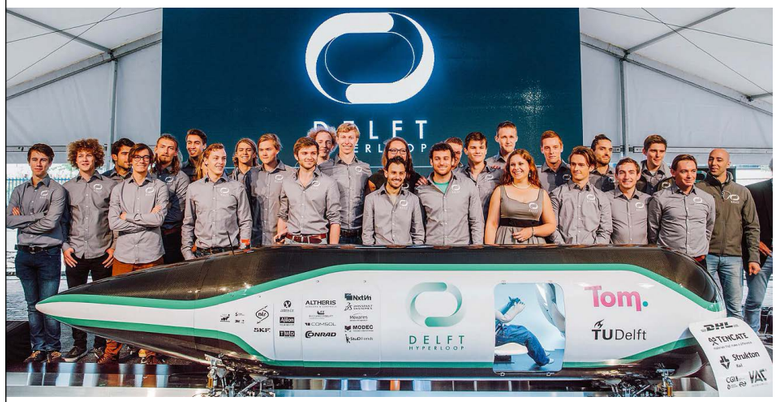
THE POTENTIAL OF HYPERLOOP

In theory, a Hyperloop system could shorten the journey from downtown Los Angeles to downtown San Francisco to 30 minutes, traveling 551 kilometers (342 miles) at more than 1,102 kph (684 mph) – faster than a plane, which can cover the same distance in 35 minutes, at 885 kph (549 mph).

OPEN SOURCE

Elon Musk is encouraging an open-source, collaborative approach to the development of Hyperloop and has refrained from filing any patents. SpaceX is focusing on a design competition for students and other organizations are working on commercial projects.

INTERVIEW WITH TIM HOUTER, CAPTAIN OF THE HYPERLOOP TEAM AT THE DELFT UNIVERSITY OF TECHNOLOGY (TU DELFT)



HOW DID THE FIRST WEEKEND OF THE HYPERLOOP COMPETITION GO?

TH: Once the series of deliverables tests was complete, 29 teams were able to run their prototype through the SpaceX test track. The organizers measured the speed, efficiency and reliability of the system. Everything went well and we ended up winning the competition.

WHAT WERE THE MAIN REASONS THAT YOU WON?

TH: We did our best to design a very scalable vehicle that could be used both on the smaller scale of the SpaceX competition and to actually carry passengers, with seats inside. We wanted the vehicle to be fast, but also as efficient, safe and reliable as possible. We integrated the induction, stabilization and safety systems from the outset.

HOW DO YOU MAINLY USE THE 3DEXPERIENCE PLATFORM?

TH: We mostly used it for the design, working with CATIA on the cloud. The whole team can work at the same time with up-to-date data. That really speeds up the entire design process – we can all work in the same environment at the same time, wherever we are. We used the different packages that CATIA offers, like composite materials and electronics.

COULD YOU TELL US A LITTLE MORE ABOUT THE POD?

TH: The Hyperloop pod looks a bit like a drop of water. The pod is a half-scale prototype that can accommodate eight half-scale passengers inside. It only weighs 149 kg (328 pounds), because the lighter you are, the more efficient you are – you have less resistance and the infrastructure costs less.

HOW DID YOU CREATE A FULL-FLEDGED, USER-CENTRIC EXPERIENCE?

TH: Our vehicle is designed to carry eight half-scale passengers, seated like real people in the future Hyperloop. We studied how to seat passengers very comfortably in a confined area without them feeling cramped. Our pod feels a bit like being in a car – there isn't very much headroom, but passengers don't really notice.

HOW DO YOU WORK ACROSS DISCIPLINES?

TH: Our team is made up of 30 students from all departments at TU Delft – all the required fields of technical expertise are represented. We designed our vehicle entirely on the cloud, which allows everyone to use the latest version of the design. It's updated in real time, so everyone can invent from what they have access to, without any conflicts between obsolete or different versions.

TIMELINE

AUGUST 2013
Alpha level: Elon Musk officially launches the Hyperloop concept by publishing the alpha version based on the work of Tesla Motors and SpaceX engineers.

JUNE 15, 2015
SpaceX announces the Hyperloop pod design competition and plans to build a 1.6-kilometer (1 mile) test track near its headquarters in Hawthorne, California, for the competitors.

JULY 2015
More than 700 teams enter the contest.

AUGUST 28, 2015
The detailed competition rules are published (and then updated in October).

NOVEMBER 2015
120 teams are short-listed including Delft Hyperloop.

JANUARY 29-30, 2016
Design Weekend at Texas A&M University, College Station. All the invited teams present their final designs. Delft 's Hyperloop wins the pod innovation prize.

AUGUST 31, 2016
Second version of the competition rules.

JANUARY 27-29, 2017
The selected pods race on the test track during Competition Weekend I. The Delft's Hyperloop team wins the Design and Construction award and receives the best overall marks, beating out competitors from Munich, Maryland, Virginia and Washington.

SUMMER 2017
Second runs on the test track during Competition Weekend II. Creation of a new team for the next 2018 competition.

SIMULATION

PREDICTING THE HUMAN EXPERIENCE OF EVERYDAY PRODUCTS

"Simulation fully complements theory and empiricism and brings them together in order to do good science."

Mark Meili,
Director of Modeling and Simulation
The Procter & Gamble Co.

Four billion times a day, around the world, P&G products touch people's lives in order to make their everyday life better. This requires us to develop products that are safe, sustainable, effective, and affordable—all at the same time.

This is a multi-disciplinary and multi-scale problem, starting with the design of products and materials at the microscopic scale, and how those products perform and interact with our consumers. At the same time, we need to also understand the manufacturing and logistics of creating and distributing these products around the world. All this requires ongoing science, discovery, and reduction of that into practice. Simulation is central to our ability to do this.

It's important to view simulation as a way to learn—not just a way to design or optimize. Simulation fully complements theory and empiricism and brings them together in order to do good science. The act of building a deterministic simulation often requires science that has not yet been done. This process of asking smarter questions leads to better understanding and ultimately better science.

Simulation led innovation doesn't necessarily mean we're going to run less experiments; rather it allows you to eliminate experiments that should not have been run in the first place, and replace those with different experiments to understand the first principals behind the behavior. Simulation lets us look broadly and understand the entire range of variables instead of just one or two, and then identify the opportunities for innovation.

Technical innovation can improve lives. Through simulation we deepen our scientific understanding of the underlying causes of product behavior, and are guided to the changes that make it perform better for our consumers, now and for generations to come.

"Make simulation an integral business practice."

Richard Boger,
SIMULIA Senior Sales Representative
Dassault Systèmes

"P&G is a thought leader when it comes to applying scientific inquiry in all levels of their enterprise to create differentiated consumer experiences. By analyzing their business, capturing that understanding in predictive models, and deploying this knowledge throughout their organization, they have developed a solid foundation for sustainable innovation. SIMULIA recognizes the visionary leadership of Procter & Gamble in the areas of science, modeling, and simulation, and we appreciate the opportunities we've had to work alongside them to make simulation an integral business practice."

ERICSSON AND THE NETWORKED SOCIETY

Since the world laid hands on the first smartphone in 1992, a series of technological breakthroughs has changed the very nature of human existence. The Internet of Things now connects objects with other objects and millions of users interact while generating and using data. Resources, knowledge and services are exchanged and shared on the cloud.

HYPERCONNECTIVITY IS REVOLUTIONIZING OUR WAY OF LIFE

THE HYPERCONNECTED WORLD IS CREATING OPPORTUNITIES TO OVERCOME HUMANITY'S BIGGEST CHALLENGES

- Improving the quality of life of fast-growing urban populations by developing traffic management, smart mobility, sustainable construction and security solutions
- Supporting the development of emerging countries via connected solutions
- Forging closer ties between partner companies through efficient networks.

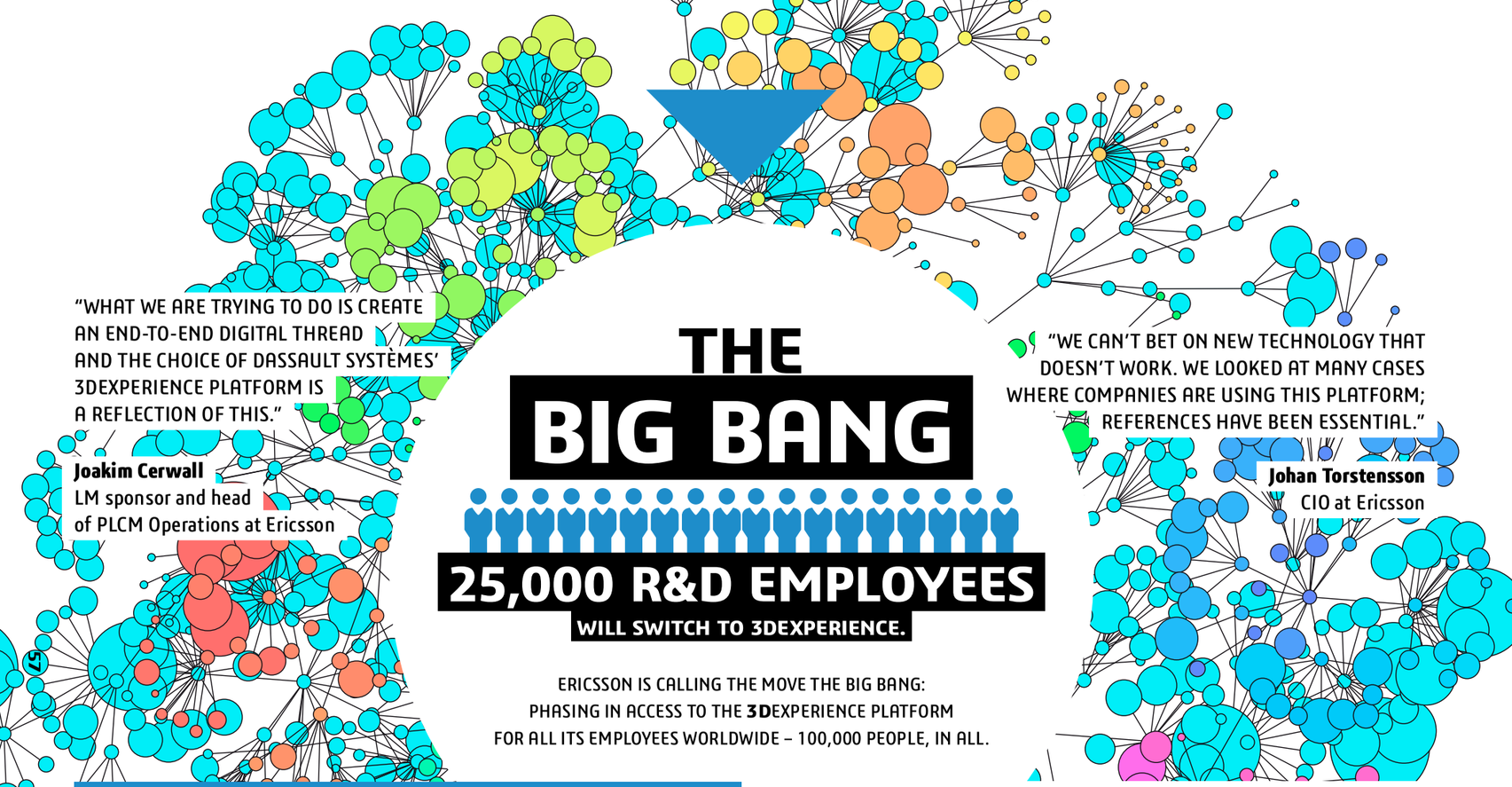
ERICSSON IS A PIONEER AND DRIVING FORCE BEHIND THE HYPERCONNECTED WORLD

New communications technology is transforming the way we interact with the world, ushering in a new society – the Network Society – before our very eyes. Vertical hierarchy is giving way to horizontal communication. The powers that be are yielding to the legitimacy of initiative and sharing. Industrial standardization is being eclipsed by custom solutions, while process- and function-based work organization is being replaced by well-oiled project-based teams that combine different skillsets.

40%
OF GLOBAL TRAFFIC PASSES THROUGH ERICSSON NETWORKS

ERICSSON SUPPORTS
2.5 BILLION
MOBILE SUBSCRIBERS

ERICSSON HOLDS
39,000
PATENTS, INCLUDING BLUETOOTH



"WHAT WE ARE TRYING TO DO IS CREATE AN END-TO-END DIGITAL THREAD AND THE CHOICE OF DASSAULT SYSTÈMES' 3DEXPERIENCE PLATFORM IS A REFLECTION OF THIS."

Joakim Cerwall
LM sponsor and head of PLCM Operations at Ericsson

THE BIG BANG

25,000 R&D EMPLOYEES
WILL SWITCH TO 3DEXPERIENCE.

ERICSSON IS CALLING THE MOVE THE BIG BANG:
PHASING IN ACCESS TO THE **3D**EXPERIENCE PLATFORM
FOR ALL ITS EMPLOYEES WORLDWIDE – 100,000 PEOPLE, IN ALL.

"WE CAN'T BET ON NEW TECHNOLOGY THAT DOESN'T WORK. WE LOOKED AT MANY CASES WHERE COMPANIES ARE USING THIS PLATFORM; REFERENCES HAVE BEEN ESSENTIAL."

Johan Torstensson
CIO at Ericsson

ERICSSON

- Reduces its costs as legacy software is more expensive to maintain and upgrade
- Gains in efficiency and data continuity since everyone works with the same tools
- Benefits from a unified, digital environment that enables easy and secure access to hardware, software and service information from anywhere and at any time
- Improves transparency, traceability, reporting and collaborative innovation

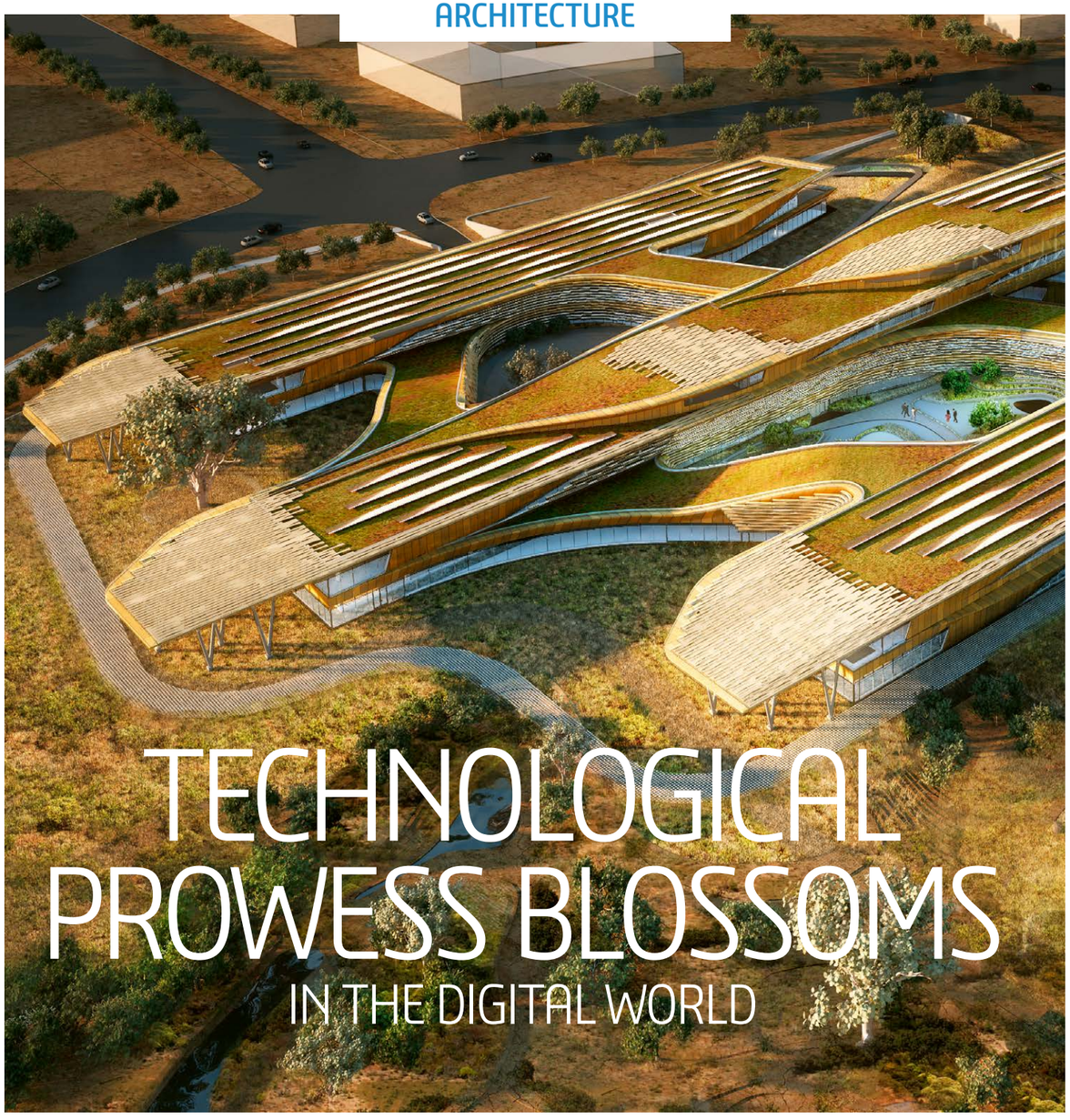
DASSAULT SYSTÈMES

- Gains a major client in the telecom industry
- Will demonstrate the power of the **3D**EXPERIENCE platform for managing ambitious, lasting changes
- Is proud to support Ericsson in its journey and serve as a partner in its digital transformation
- Helps invent new solutions that make our cities and devices smarter, manufacturing more efficient and social networks more fluid

FIND OUT MORE

More information on Dassault Systèmes website

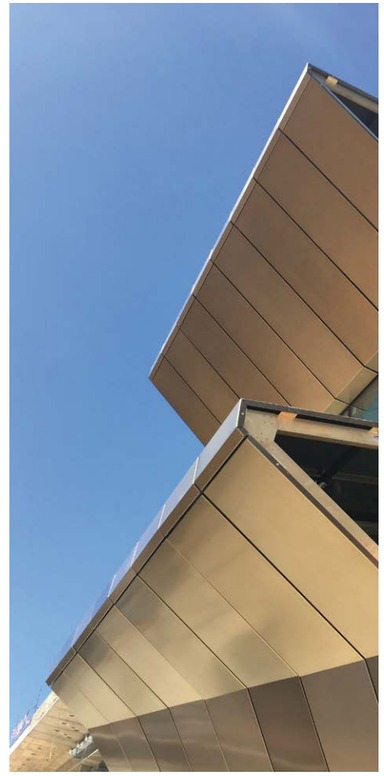
ARCHITECTURE



TECHNOLOGICAL PROWESS BLOSSOMS IN THE DIGITAL WORLD

SHoP Architects is a Manhattan-based architecture firm founded in 1996 that has completed projects across the world. The firm designs apartment buildings, offices, schools and cultural institutions, as well as urban projects on a larger scale. Here, we spotlight two iconic SHoP projects.

BOTSWANA INNOVATION HUB



"Technology and aesthetics feed off each other."

Chris Sharples
Founding Partner, SHoP Architects

"SHoP Architects is what I would call a full-service architecture firm. We aren't a conventional architecture firm because we are determined to understand execution in addition to design. Once we've grasped the design limitations and criteria, we start to think about how it could take shape in 3D. Technology has always played an important role in how we have evolved our practice, and in my opinion, technology and aesthetics have to share information and feed off each other. The **3D**EXPERIENCE platform offers both a visual model and integration with planning and environmental systems, which we can share with clients, consultants and manufacturers of various components. This ongoing relationship between design and industrial execution is vital. Models are like living organisms that continually change and grow as the design process unfolds, as the project advances and enters the fabrication and assembly phase – it even extends into the operational phase and throughout the building lifecycle. I don't think that we would be able to achieve this level of design and craft without the **3D**EXPERIENCE platform."

"The **3D**EXPERIENCE platform takes a holistic approach."

John Cerone
Director of Virtual Design & Construction, SHoP Architects

"The Botswana Innovation Hub project is a government initiative that seeks to introduce innovation and technology in a country traditionally dependent on diamond mining. The facade was designed entirely in the **3D**EXPERIENCE platform. All the parts and production information are coordinated live with real-time information. The platform allows us to have complete control over the build process in Botswana, with parts produced in South Africa. We deliver 'just in time', fabricating exactly what we need just before we ship it, so there's no waste. The **3D**EXPERIENCE platform is a completely different way to engage a project. It contextualizes the fabrication information into the project schedule, management and cost of materials and into team coordination. It's a holistic approach. Working on the cloud means that the data is live and everyone has access to it. And it's all very intuitive and sleek."

FIND OUT MORE

More information on Dassault Systèmes 3D Perspectives blog

FLOTSAM & JETSAM

A COLLABORATIVE MINDSET BREEDS SUCCESS

In 2016, SHoP received the Madrid Design District's Panerai Design Miami/ Visionary Award and was invited to create an outdoor bamboo pavilion to celebrate the event. The installation, entitled "Flotsam & Jetsam," is designed to evoke the shapes found in an ocean environment. Elements commonly associated with the beach – sand, floating toys and even a slight nighttime glow – form the fantastic foreground. The pavilion's jellyfish-inspired shape and fabrication methods are a nod to the collaborative mindset, which is increasingly vital to success in creative work.
The design team worked with two 3D fabrication firms to bring its vision to life. The first, Branch Technology, used three industrial robots and a proprietary technique called Cellular Fabrication™ (C-Fab™) to 3D-print the mesh panels. The second partner, Oak Ridge National Laboratory, used an additive manufacturing technology to print components using a biodegradable bamboo medium. The **3D**EXPERIENCE platform was used at every stage of the design process, in order to optimize the use of printed materials and create sets of instructions that could be interpreted by the production team – industrial robots, in this case. Flotsam & Jetsam celebrates the glamorous side of Miami today and what it could become, with an evocation of the coastal city in an environment created using progressive creative methods.

INTERNATIONAL DEPLOYMENT

A BIOMEDICAL RESEARCH PARTNER IN A GLOBALIZED WORLD

Digital technology is bringing innovation within our reach.
Dassault Systèmes is working with the most advanced medical research organizations across the globe to set the stage for this new paradigm.

STRATEGIC ALLIANCE WITH INSERM

Dassault Systèmes and the French National Institute of Health and Medical Research (Inserm) signed a four-year framework agreement on March 29, 2016.
The agreement will enable Inserm, Europe's largest research organization entirely devoted to human health, to speed up progress in strategic biomedical research programs in priority areas, such as aging, cancer, genomics, intestinal flora and other microbiota.
Inserm will gain access to the **3D**EXPERIENCE platform, which provides an integrated virtual environment for open collaborative research, unified laboratory management, biological and chemical modeling as well as simulation applications offered by BIOVIA.

In biomedical research, virtual worlds help health care ecosystems operate more smoothly through open scientific collaboration and research activities organized into excellence networks. These virtual worlds harness the power of modeling for representing biological complexity and developing precision medicine. Advances in personalized medicine, which tailors care to patients and their lifestyles, can be achieved through virtual experiments and calibrated clinical trials.

FIND OUT MORE

To find out more,
see the INSERM press release

NEW RESEARCH HORIZONS

Dassault Systèmes will leverage big data from Inserm's research programs to calibrate and validate scientific models that can be applied to future clinical research technologies. These models will enable the company to develop next-generation industry solutions that will use virtual trials to accelerate decision making and to establish the efficacy and safety of clinical trials earlier in the process. Combined with the ability to process big data, the introduction of modeling and simulation tools opens new research horizons. The unification of cutting-edge clinical research and the virtual world represents a springboard to the future of medicine and greater coherence between products, nature and life.

The strategic alliance will speed up the development of translational medicine, which aims to bridge the gap between fundamental medical science and actual clinical practices. In pharmaceuticals, the goal will be to establish a more direct pipeline between research discoveries and the production of drugs. One potential avenue for achieving this goal is virtual pharmacies – medicine banks that are created or consolidated in a collaborative, transparent way and managed via an open-source approach with applications in specific areas, such as the treatment of tropical diseases and rare diseases, considered "unprofitable" by the pharmaceutical industry.

USA

EXCERPT FROM BERNARD CHARLÈS

2006 SPEECH AT THE 100TH ANNIVERSARY OF THE U.S. FOOD AND DRUG ADMINISTRATION (FDA).

"As society seeks personalized health while ensuring optimum industrial security, the time has come for life sciences to at last leverage the tremendous power of the virtual world.
Digital environments are pushing the bounds of possibility to transform research, science, the pharmaceutical industry and medicine in general.
As we enter the age of the experience economy, innovation is driven by consumer and patient experience.
But a fresh approach to innovation implies collaborative projects that cut across scientific disciplines. This is one of the primary functions of innovation platforms as our **3D**EXPERIENCE platform. In addition to cross-disciplinary collaboration, our platform empowers teams to conduct in silico* 3D experiments, produce multiscale, multidisciplinary digital models, simulate healthcare scenarios and turn big data into smart data. Combined, this translates into continuous improvements in industrial processes, enhanced, customized treatments, and the development of new services from the lab to the hospital. Innovation is about imagining worlds that don't yet exist – worlds that await us in the future. Digital is about making these new worlds possible. As digital heritage is increasingly seen as a strategic competitive advantage, collaborative innovation platforms provide key tools for sustainable growth. For the Food and Drug Administration, these resources can enable it to deliver unprecedented value to the world of healthcare and science."

Bernard Charlès, keynote speech at the U.S. Food and Drug Administration's Annual Scientific Computing Days, September 2016

* A new term coined by analogy with the expressions in vivo, in vitro, in utero or in situ. Refers to silicon, a component in microchips, and indicates that research or a trial is performed using complex computer calculations or computer models.

ASIA

THREE MAJOR PARTNERSHIPS IN ASIA

Dassault Systèmes established the Living Heart project to advance the development of safe, effective cardiovascular treatments by uniting engineering, scientific and biomedical expertise. Through simulation and the creation of validated models, the project aims to provide personalized, interventional patient care, translating cutting-edge science into improved health care.
Three major medical centers have joined the community of 43 universities, 32 established companies and startups and 10 hospitals across the world. Dassault Systèmes guides the members in introducing digitalization into their diagnostic capabilities.

The National Heart Centre Singapore aims to understand blood flow dynamics in cases of complicated congenital heart disease.

The Shanghai Children's Medical Center in China is seeking to integrate virtual technologies that improve clinical applications in the treatment of congenital heart disease.

South Korea's ASAN Medical Center uses Living Heart to study heart failure, specifically the factors that influence the appearance and advance of hypertrophic cardiomyopathy (HCM).

ARCHITECTURE

COMPLEXITY, COLLABORATION AND ART

Digital 3D technologies unleash the artistic power of architecture. A unified platform galvanizes complementary teams working together on a project, from the design phase to the completion of construction, as they collaborate to write a new chapter in their history.

ZAHNER,
ARCHITECTURE AS ART

A. Zahner Company is an engineering, fabrication and construction firm that specializes in custom art and architectural systems. Zahner, based in Kansas City, Missouri, employs 190 people. Founded in 1897, the family-owned business has designed and built some of the most striking innovative architectural structures in the world and received countless awards.

"We're giving visibility to what we're thinking."

Shannon Cole,
Senior Project Engineer at Zahner

The challenge is describing to customers exactly what they are going to receive at the end of the project because it's not a standard building product. The **3D**EXPERIENCE platform helps Zahner do that in real time. They've used dashboards on this project as touch points for providing information to the customer. As they're doing design work and receiving drawings from our outside consultants, they post them as ministories. The customer has access to that, so they are informed every step of the way. Zahner is giving visibility to what it's thinking, which gives the customers a level of comfort and confidence that 2D drawings absolutely can't do. The main benefit of using one platform from concept to design to fabrication is that you can track the flow of ideas and you don't lose information. The types of projects Zahner is doing today were not possible 20 years ago.

"The future has never been so exciting."

L. William Zahner
President and CEO of Zahner

As architectural projects become more and more complex, technology helps us push the boundaries of what is possible. Zahner has been using Building Information Modeling to reduce errors through a leaner, more streamlined construction process. The biggest challenge in the construction world today is the fact that you're working within the old paradigm that an architectural project is an iterative process. When any kind of issue arises, you have to make sure that all groups exchange the right information at the right time. The **3D**EXPERIENCE platform's collaborative capabilities provided an entirely new and efficient method of communicating between Zahner and the project stakeholders. The future has never been more exciting. Zahner plans to extend the use of ENOVIA for parts management and purchasing and to adopt SIMULIA for all the structural analysis needs. One of the biggest changes in the future will be the dynamic or kinetic aspect of facades or other constructs. The platform's digital simulation features enable you to predict the way in which a structure will evolve over time. You can then integrate this information into the designs, making them more precise and less expensive to build. You can convince your clients that their projects are buildable because you can simulate construction on the digital construct before you even break ground. The possibilities are simply fantastic.

CHALLENGE

Zahner continues to take on larger and larger architectural projects that involve designing more complex geometries and require better communication between all stakeholders.

SOLUTION

Zahner implemented the **3D**EXPERIENCE platform and its Design for Fabrication on the cloud solution for the construction of the Chrysalis Amphitheater in Merriweather Park at Symphony Woods in Columbia, Maryland.

BENEFITS

The **3D**EXPERIENCE platform provided powerful design and collaboration capabilities that:
- opened up innovative geometric possibilities,
- provided an efficient means of communication between all project stakeholders.

"All stakeholders share information that is updated in real time."

Tom Zahner
Chief Operating Officer at Zahner

The **3D**EXPERIENCE platform helps in three key areas. First, there's the ability for people to do the right things at the right time. Second, there's clarity because 3D design speeds up decision-making by facilitating comprehension, regardless of what language people speak or what discipline they're from. Finally, there are no longer any problems with incompatible software solutions. Zahner decided to inaugurate the **3D**EXPERIENCE platform with the Chrysalis project, an amphitheater that we're fabricating in Columbia, Maryland. The team chose this project because of

the complexity of the parts, which requires a powerful design solution like CATIA and a more efficient method of communicating with the different stakeholders due to this complexity. With the **3D**EXPERIENCE platform, you're able to bring everybody to the site virtually, rotate it around, identify the specific area of concern and get the right people focused on it. There were several elements that were not fully designed when Zahner won the bid. The Chrysalis is a very dynamic project which requires a flexible platform to quickly and efficiently update all the stakeholders with the design and construction data. As the project matures, the team needs to process information as it comes in and make sure that every stakeholder – the owner (Inner Arbor Trust), the general contractor, suppliers, partners, and design and construction teams – can access the same information in real time.

FIND OUT MORE

More information on Dassault Systèmes website

THE WORLD INSPIRES US

Blue 4N Sapphire Planet watch
by François Quentin

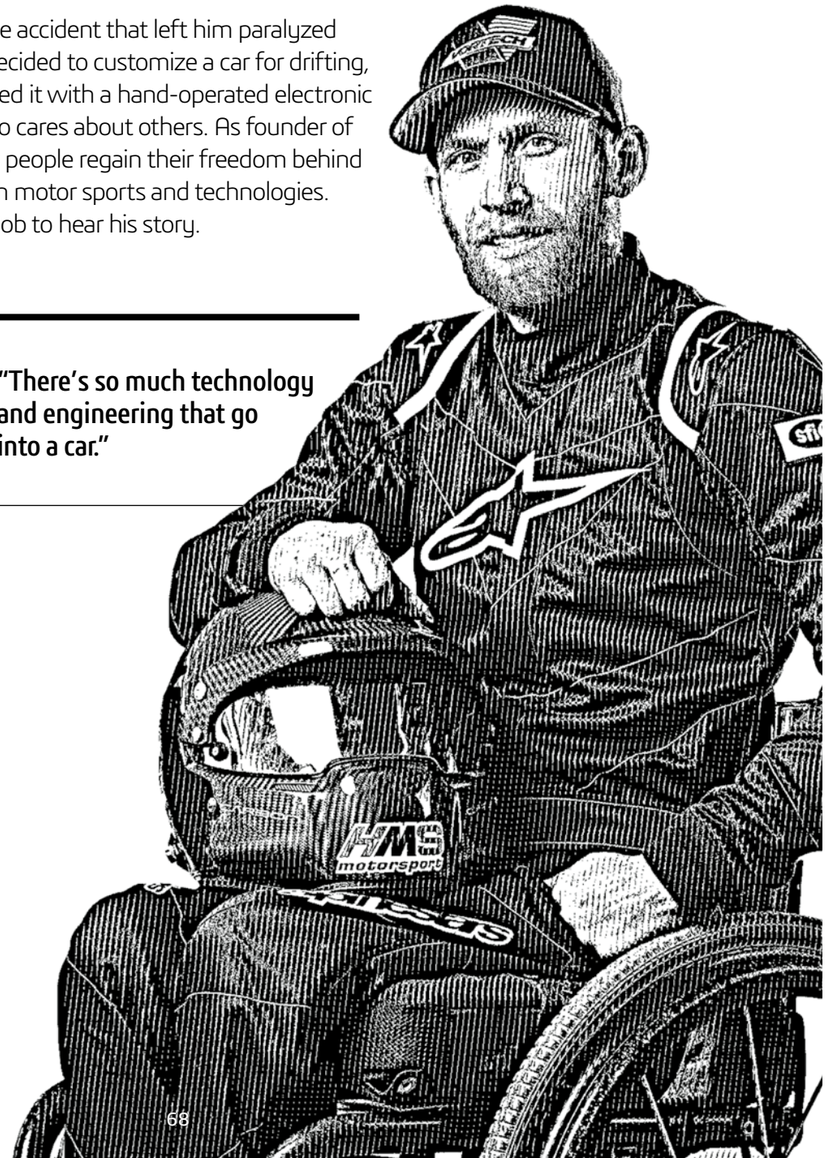
DRIFTING

ROB PARSONS, THE CHAIRSLAYER AND, SOLIDWORKS

TAKE THE BULL BY THE HORNS AND SLAY IT!

MAKING LIFE IN A WHEELCHAIR EASIER AND GIVING IT NEW MEANING

After being injured in a serious bike accident that left him paralyzed from the waist down, Rob Parsons decided to customize a car for drifting, a motorsport unlike any other. He fitted it with a hand-operated electronic steering and clutch system. Rob also cares about others. As founder of the Chairslayer Foundation, he helps people regain their freedom behind the wheel and saves lives through motor sports and technologies. We sat down with Rob to hear his story.



DRIFTING: FOUR-WHEELED SURFING AT 160 KPH (100 MPH)

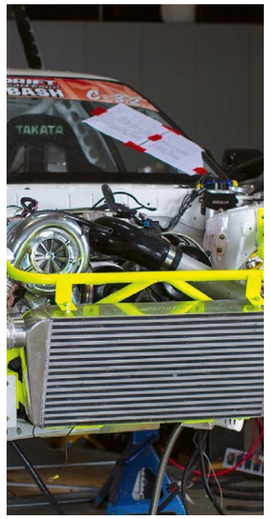
"Drifting, also known as Formula D, is a motor sport where two drivers compete against each other, maneuvering their car so that it drifts from one side of the asphalt track to the other. Judges grade the competitors on line, speed, angle and style. The sport truly is spectacular – it's exhilarating for the people who are watching and even more so for the people driving. It takes a lot of high-level control, quick thinking and quick decision-making to change direction and put the car where you want it when you're sliding around at 100-160 kph (60-100 mph). Being the driver and the mechanic of the car, I'm able to get in-depth working with my hands – there's so much technology and engineering that go into a car to make it do what it has to do to perform a specific function and be good on the track. I picked drifting to work with my hands, the exhilaration, and the fast pace of it."

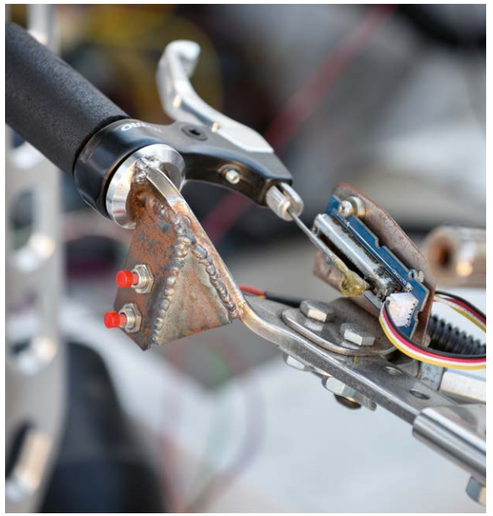
"There's so much technology and engineering that go into a car."

SOLIDWORKS AND MECHANICS

"The entire car, with respect to the tubing, the weldments, the roll cage, the clutch system, and anything that had to be made out of metal – anything I actually had to fabricate – was drawn in SOLIDWORKS first. All my sheet metal brackets, all my gussets, the full tube frame, some of the suspension arms. A lot of the parts that I needed to get machined, I created in SOLIDWORKS and sent them to laser cutters. The clutch system itself is electronically controlled. We've been working on a specific handle for the hand control that controls clutch engagement and disengagement, downshift and upshift on the electronic shifting system. We use a robotized motion control system based on a 3D model available in SOLIDWORKS. When I'm working, I despise getting in and out of the car – particularly if I left a tool out of the car and I need to get it and I'm by myself. It's extremely annoying and a real problem. When I was designing my roll cage – I remember it very vividly. I only had to get into the car once with a piece of paper, sit there, and get my widths, heights, lengths and points for where my roll cage was going to mount. And then I just got out and started drawing it on the computer. Once I drew it in SOLIDWORKS, I bent everything and it fit like a dream."

"The parts fit together like a dream."





THE CHAIRSLAYER COMMUNITY

"A Chairslayer is somebody who overcomes adversity. Somebody who takes life by the horns. It can be as simple as getting out of bed and actually doing something with your day. Creating a fully built car or whatever it may be. Just someone who is excelling at what they're doing from the seat of a wheelchair. Chairslayer isn't about the car. It can be anything. There are a lot of young guys and older people, too, in the wheelchair community. They don't know where to turn and all they need is a helping hand. They just need that little kick in the butt to take it to the next level. That's what we're trying to do. Let's get this huge community of people to create new, adaptive products for people in chairs. It doesn't have to be race cars. It can be something to make your life easier, anything to make your life more meaningful again. The best way for people to get involved is go to chairslayer.org and just send us a message. There's also a place where people can donate, but we'd love to talk to everybody first before they think of donating to us. We want to know who's helping us out and see if they can be involved in one of the events."

"A Chairslayer is someone who excels at what they're doing from the seat of a wheelchair."

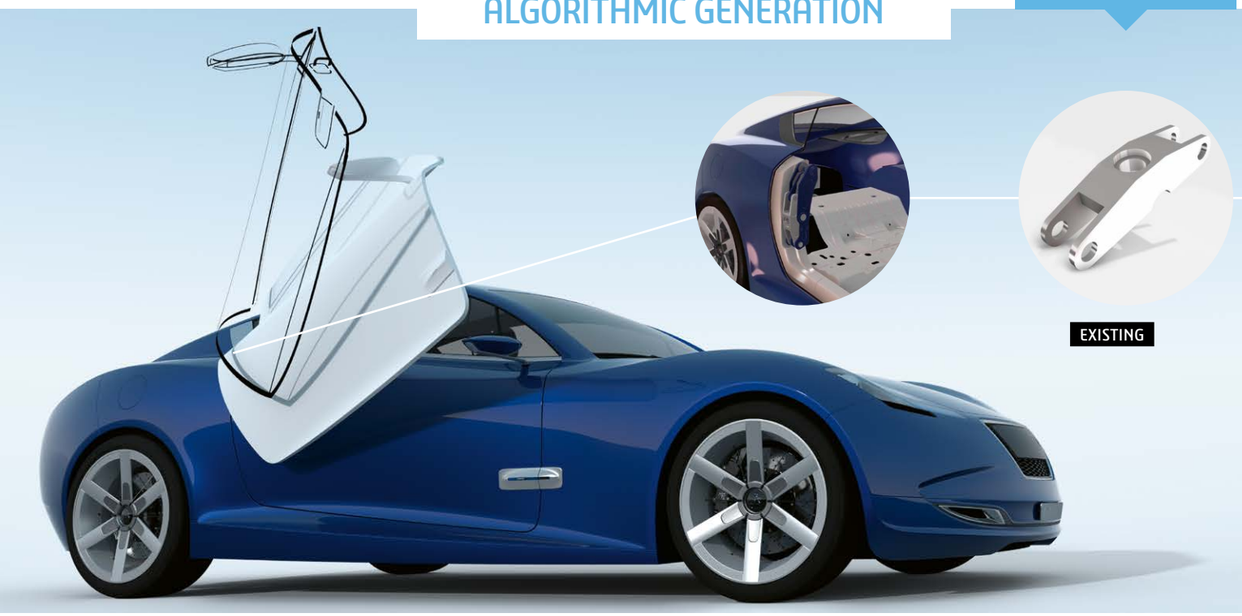
FIND OUT MORE

More information on SOLIDWORKS Community blog

790 G
Mass of the **initial** part

380 G
Mass of the **final** part

ALGORITHMIC GENERATION



EXISTING

AUTOMATIC GENERATION

OPTIMIZATION

FINALIZATION

RESULT

AUTOMOTIVE

OPTIMIZING A CONNECTING ROD FOR BUTTERFLY DOOR HINGES

The first step in connecting rod optimization is defining the work to be done and the functional areas in the virtual model. The designer then enters the weight load and connection points, setting the targets for improvement. The software automatically generates the shape and performs density checks. Before approving the shape of the new part, the van Mises method is used to ensure flexibility and bendability. The designer fine-tunes the detailed design by first tracing the sections manually and then automatically simplifying and connecting them. The final part and its integration into the system are fully optimized.

52%
REDUCED MASS

FUNCTIONAL GENERATIVE DESIGN

HOW HUMANS AND COMPUTERS JOIN TOGETHER TO CREATE OBJECTS THAT ENGINEERS CANNOT DESIGN ON THEIR OWN

Generative design is part of a broad ecosystem. It involves designing in silico (entirely virtual) elements, process definition, production and fabrication management, real-time optimization, oversight, potential problem detection, traceability and the additive manufacturing hub.

Functional generative design enters the ecosystem after the material design phase. It harnesses the full capabilities of computing power to develop innovative designs unlike those previously used in industry. Organic shapes that closely resemble natural structures are replacing the mechanical shapes used for functional industrial parts. A single part can perform several functions previously split between several parts, and assembly is streamlined to combine them into one more easily. The design also improves performance in terms of strength, flexibility and lighter weight of each part or object.

ELIMINATING MANUFACTURING CONSTRAINTS

Generative design is the automated generation of shapes based on parametric constraints and objectives. In 3D printing and additive manufacturing, there are no constraints with regard to mold stripping or air vent direction. Limitations relate to the part's function and not the manufacturing process. In functional generative design, algorithms generate proposals that take mechanical and functional constraints into account. These are then formatted to meet industrial modeling requirements. This involves determining the mechanical interfaces needed to attach the part, its interaction points, the required motions and rotations, as well as its requisite strength and flexibility when subjected to an outside force such as weight, traction or pressure. The algorithm produces the 3D form that best meets all these constraints.

The newly generated part is fairly rough or still "in the raw." Mouse in hand, an operator then adds the finishing touches – "polishing" the part by selecting a few sections to quickly produce a smoother, more regular design with no effect on algorithmic optimization. The sections are identified using a sweeping motion that cuts the part, that is then automatically reconstructed into a circular or elliptical-like shape. The new part is ready to be manufactured, with spectacular weight savings.

ALGORITHMIC SORTING

MAKING NEW FROM OLD

EXALEAD OnePart Reduce lets you imagine the future without forgetting the past

"THE LONGER YOU CAN LOOK BACK, THE FARTHER YOU CAN LOOK FORWARD."

WINSTON CHURCHILL

SEMANTIC SEARCH ENGINE

EXALEAD gathers, aligns and enriches expansive volumes of data of all kinds – heterogeneous, multisource, internal and external, structured and unstructured, simple and complex – to provide users with the information they need. EXALEAD features a semantic search engine that adds intelligence to searches, querying large volumes of data to deliver smart, relevant information in real time. The solution indexes text document files (Excel, PDF, etc.), 3D-model source files and attached data generated by SOLIDWORKS and CATIA, as well as all product lifecycle management information linked with ENOVIA.

EXALEAD OnePart organizes designs for reuse, specifications, standards, test results and data related to the design and fabrication of previously designed, produced and warehoused products. A part from an older project or a project still under development can be used for a new project. The part has already been optimized and there is no need to design or manufacture parts that already exist.

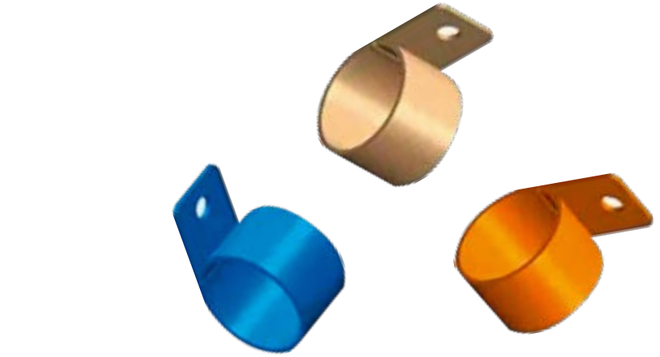
LESS COSTLY ALTERNATIVES

EXALEAD OnePart Reduce, which is integrated into the EXALEAD OnePart solution, compares a series of parts – or even an entire product – to select less costly alternatives based on the size and functions of each identified part. Using a 3D model, Reduce launches an automatic automation process and – following a search of a local proprietary database, a global database or a database shared among multiple suppliers – returns a series of replacement options along with a report displaying the best alternative for each part. The user interface highlights the part offering the most advantages in a clear, visual way.

ELIMINATE DUPLICATES

EXALEAD OnePart Reduce introduces a new way of working based on classification and deduplication, which reduces the number of legacy parts, simplifies the system and decreases inventory costs, resulting in improved cash flow on companies' balance sheets. Classification provides an overall view of all existing systems. Quality and methods engineers are able to build unique clusters of parts by assembly, project or companywide. The category structure includes partial families and subfamilies. Intuitive comparison tools specify the reference parts in each category that can be used for future projects, as well as parts to be phased out.

Deduplication is carried out once all the parts have been classified and some can be labeled "master," "alternate," or "obsolete." A specific representative part is used to disseminate information on all similar parts in the same family, simplifying searches in OnePart and on the **3D**EXPERIENCE platform. This information can easily be sent to a product data management system (PDM) and to enterprise resource planning (ERP) software in order to ensure efficient inventory management.



AVID USERS IN AEROSPACE

Aerospace industry players are a natural fit for EXALEAD OnePart Reduce. Aircraft are among the industrial products with the longest lifespan – an airliner can operate for up to 35 or 40 years, flying 40,000 hours, whereas a car rarely reaches 6,500 hours on the road (about 400,000 km or 250,000 miles). As a result, the new generations of aircraft being designed today are the descendants of those designed in the 60s and 70s. The next generations of Boeing and Airbus models, known as MAX and Neo, respectively, are based on the "classic" families that preceded them. The complexity of aircraft systems and subsystems requires leading manufacturers and suppliers to manage a vast array of parts and seek to merge versions, variants and families. This communality is also a significant source of cost savings for airlines.

ALGORITHMIC SCENOGRAPHY

USING TECHNOLOGY TO ENHANCE THE PRODUCT EXPERIENCE

AUDI

DO CARS DREAM?

Video mapping is used to project giant images onto 3D structures, such as monumental buildings – or even cars – producing a dynamic fresco of light. And the illusion takes on a whole new dimension when projected onto a moving vehicle.

It is moving? Is it stationary? Am I the one who's moving? Is this real or is it all a dream? 3DEXCITE created a stunning visual experience for the launch of the new Audi Q7. The automaker wanted to show its luxury SUV on the move. The idea was to use cutting-edge technology at the Audi Training Center in Munich to offer an awe-inspiring product experience for dealers who had traveled from across the world to learn more about it. 3DEXCITE's DELTAGEN software was used to create the scenes.

Three projection points – the ground, the background and the vehicle itself – created the visual display and thrill that Audi was seeking. 3DEXCITE partnered with Ventuz to set up the technology platform for the on-stage sequence. Dynamic and animated graphics were projected onto the Q7, bringing the car to life as it moved across the stage. There were many such highlights during the show. When the car began to move, rim projections simulated rotation and passing scenery. The body of the car changed color and a trip through an "X-ray machine" showed the seats and the comfortable interior, as well as the transmission and technical components. The projected algorithms contrasted with the overlaid light effects showing weather and other natural phenomena: lightning, an underwater scene, snow, a storm and foliage. The visual design created powerful analogies between the human body and mechanics, even suggesting that the Q7's engine was the beating heart of a living being.

INCADEA

DEALER 4.0

3DEXCITE teamed up with Incadea to create an aesthetic visual experience for DEALER 4.0, which is revolutionizing the customer journey by transforming it into a memorable experience – and increasing the number of contracts signed along the way.

Incadea is a leading provider of enterprise software solutions and services for the global automotive market, automakers and dealership networks.

The company provides effective tools, created through continuous investment and development and enhanced by feedback from its customers and partners.

NEW ADDITIONS TO THE TROPHY CASE

Audi has won its fair share of racing honors and now, thanks to the work of 3DEXCITE, the automaker can claim two new, unique awards from another area of the industry:

German Design Award – Special Mention 2017, in the Events category
Automotive Brand Contest 2016 winner in the Architecture category

Automechanika, a major auto show that was held in Frankfurt from September 13 to 17, 2016, gave the public a glimpse of DEALER 4.0. The idea behind the experience was deceptively simple. Visitors were invited to customize the vehicle's interior and exterior on a giant interactive glass wall. When they moved to the other side of the wall, a real vehicle would transform instantly before their eyes based on what they'd selected. Magic?

Not quite. Proven technology was used to create this fascinating, seamless experience. The glass touch screen made it easy for visitors to interact with the car, showcasing the smooth animation and computer-generated imagery. Powerful projectors cast the color guests had selected onto the car body on the other side of the glass, whose radiant luster provided an added supernatural dimension that completely blurred the line between virtual and real.

The marketing goal of DEALER 4.0 is to break down the linear customer journey, redesign it, and transform it into an engaging, personalized, multidimensional experience. The integrated sharing feature enabled guests to take their configuration with them on their mobile device and share it with their family, friends and other influencers. They could also continue to customize the vehicle after leaving the dealership.

Each 3DEXCITE experience is more immersive and engaging than the last, pushing the envelope by blending physical elements with virtual projections. These experiences lead potential customers through a fun, captivating journey that they will not soon forget.

FIND OUT MORE

More information on Dassault Systèmes website

ALGORITHMIC MANIPULATION

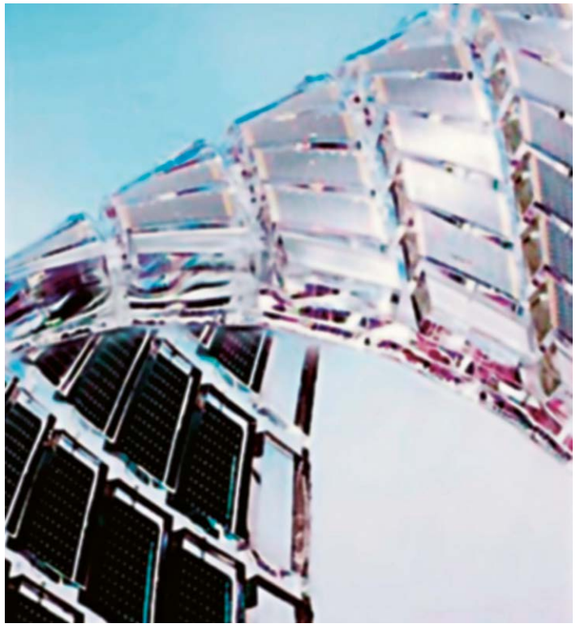
AN ELECTRONIC SECOND SKIN

Stretchable electronics are expected to make major inroads in health care, defense and sports. Multiphysical 3D simulation is the key to fostering the emergence of new functional designs in the field.

Flexible electronics have existed for more than 15 years, but stretchable electronics emerged more recently through the work of professors Yonggang Huang and John Rogers of Northwestern University. This is because of the limitations inherent in flexible objects. It is easy to wrap a piece of paper around a cylindrical object because the paper is flexible, but the paper will crumple if you wrap it around a complex shape like a sphere. The same principle applies to flexible objects. If you try to wrap a flexible printed circuit around a complex body part, it will crumple and the device will stop working. To resolve the issue, Huang and Rogers crafted a stretchable concept by cutting and modeling silicium into a wave shape that can expand and contract like an accordion.

However, the tools traditionally used in electronics design are not capable of producing stretchable electronics, so Huang developed a new design methodology using Dassault Systèmes' Abaqus simulation technology. Starting the design process with a multiphysical 3D simulation enabled the professor to select a design from a wide array of new shapes offering the perfect combination of stretchability, functionality and durability, while reducing development costs and time significantly.

"If we can make the devices flexible and stretchable, the possibilities are endless."



INSIGHTS FROM YONGGANG HUANG

PROFESSOR OF MECHANICAL ENGINEERING AND CIVIL ENVIRONMENTAL ENGINEERING AT NORTHWESTERN UNIVERSITY IN ILLINOIS

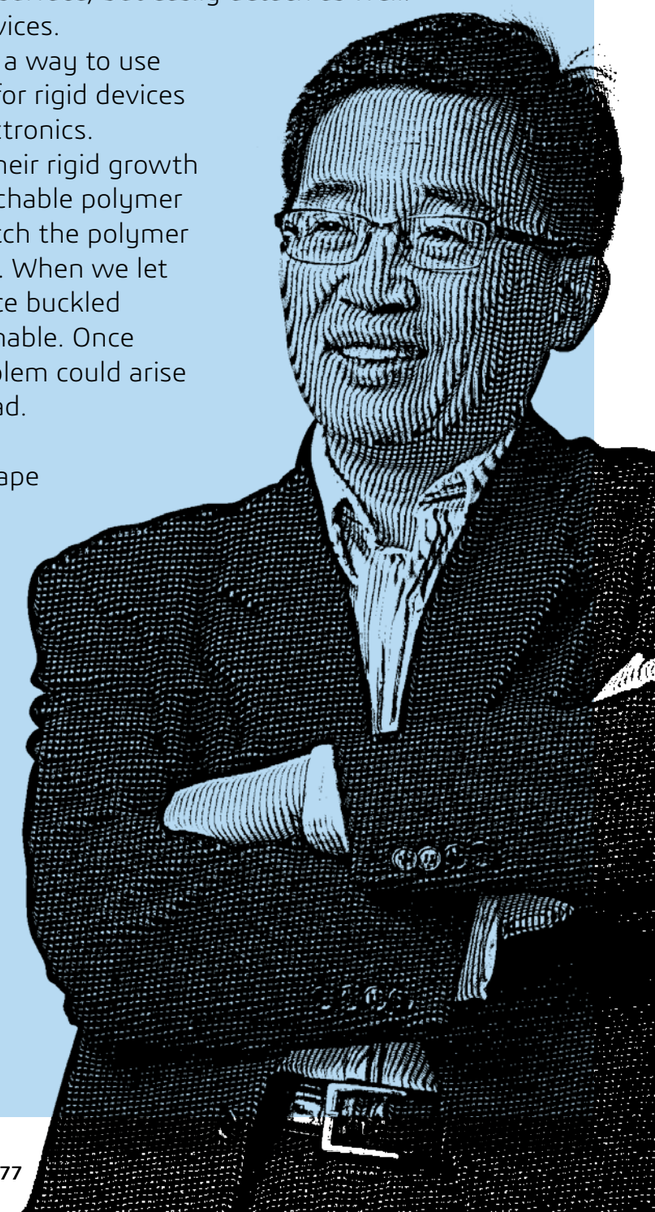
"When you develop a patch, it has to stay on your skin for several days. Some applications may use a very thin adhesive, but in other instances, such devices don't need an adhesive at all. The patch relies on van der Waals forces instead. Think of geckos. Their feet have a natural adhesion that allows them to not only stick to a surface, but easily detach as well. We try to use the same idea for our devices.

The main design challenge was finding a way to use the current 2D fabrication technology for rigid devices to make 3D curvilinear, stretchable electronics.

We transfer-printed the devices from their rigid growth substrate to a different, naturally stretchable polymer substrate. Our idea was to first prestretch the polymer substrate, then place the device on top. When we let go of the stretched substrate, the device buckled to form a 3D shape and became stretchable. Once the device is out of shape, a major problem could arise because buckling is considered to be bad.

But here, we designed it in such a way that when it buckles, the geometric shape changes but the strength inside the buckled device remains.

The mechanics design, electronics and circuits all have to go hand in hand to make sure that the device has certain functionality and at the same time won't break during the buckling process."



ALGORITHMIC IMPRESSION

XtreeE
BRINGS LARGE-SCALE PRINTING TO THE CONSTRUCTION INDUSTRY

On September 21, 2016, a 3D-printed concrete pavilion by XtreeE was erected at Dassault Sytèmes' Vélizy site. With support from the **3D**EXPERIENCE Lab, the French startup is developing additive manufacturing solutions to fabricate large parts for construction and architectural use.

AN INTERVIEW WITH PHILIPPE MOREL, PRESIDENT OF XtreeE

WHY DID YOU DECIDE TO BUILD A PAVILION?

PM: The pavilion is something of a manifesto, a way of communicating our vision for the future. It goes right to the point by showing the conceptual and technical innovations that we offer. We've already created sections of beams, structural elements and walls, but, as interesting as they are contextually, they are only partial elements.

A pavilion is a structure in its own right. It not only shows the complexity provided by additive manufacturing but also showcases what we can do in terms of creating elements of walls, frameworks, putting on the finishing touches and the like.

WHY DID YOU CHOOSE TO SHOWCASE INNOVATIVE ASPECTS OF LARGE SCALE 3D PRINTING THROUGH THE PAVILION?

PM: If there's anything XtreeE is capable of it's printing things with relatively complex geometries because we have a firm grasp of how a robot works.

As a result, we are able to produce things with greater formal complexity than what we see coming out of China, for example, where the technology produces preprinted straight walls that are installed later, without curbed surfaces or unified part sets.

Thanks to the quality of the materials we use and our partnership with LafargeHolcim, we have access to forms of formal complexity well beyond that of our competitors.

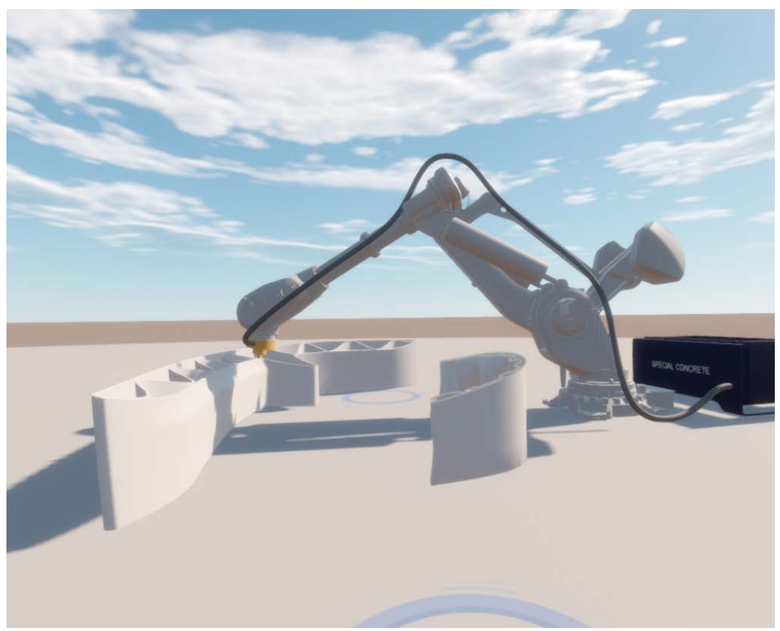
Lastly, we wanted to highlight the quality of our printing. We use very thin filaments which is something we haven't seen our competitors doing yet.

HOW DID YOU DESIGN THE SHAPE?

PM: We had clear-cut ideas but we also had to factor in fabrication constraints. We had to translate these as faithfully and accurately as possible into settings that a computer can understand as design constraints. There were a few iterations between the XtreeE and **3D**EXPERIENCE Lab teams, so we're talking about real collaborative design.

This has given the pavilion a slightly traditional feel – it's more of a technological demonstration than an architectural manifesto.

"We have access to forms of formal complexity well beyond that of our competitors."



STARTUP PARTNERSHIPS

XtreeE teams include architects, designers, engineers, materials specialists, IT researchers and roboticists. The startup partnered with LafargeHolcim from the outset and is now backed by the Dassault Systèmes **3D**EXPERIENCE Lab.

In early 2017, XtreeE signed a long-term partnership with VINCI Construction, which also acquired a stake in the startup. This alliance with the global industry leader will enable XtreeE to develop new solutions all over the globe.

Huts and other forms of vernacular housing are gradually giving way to natural, rather airy structures, such as shells, as well as more "grain-like" compacted units. Looking down at the pavilion, you can see its tightly fit organic coffee-bean design, which can only be produced through large-scale 3D printing. It demonstrates the possibilities offered by XtreeE's technology and Dassault Systèmes' solutions – including the ability to model complex surfaces within the constraints of continuous printing, simulate complete structures and generate procedural forms to ensure gradual solidity – which bear no comparison to the traditional architectural processes currently in use.

PAVILIONS AS EMERGENCY HOUSING?

The pavilion could be used as emergency or low-cost housing. Someday, we might be able to print in emerging countries using local materials (clay, soil, etc.), which is not technically feasible today. We would only have to provide the robot and the printing system (extruder and materials reservoir). House models adapted to local needs, topography and climate could be downloaded from the network. The houses could be 15, 20, 25 m^2, with the main buildings grouped or clustered to create a village.

STUDY WITH ÉCOLE BOULLE

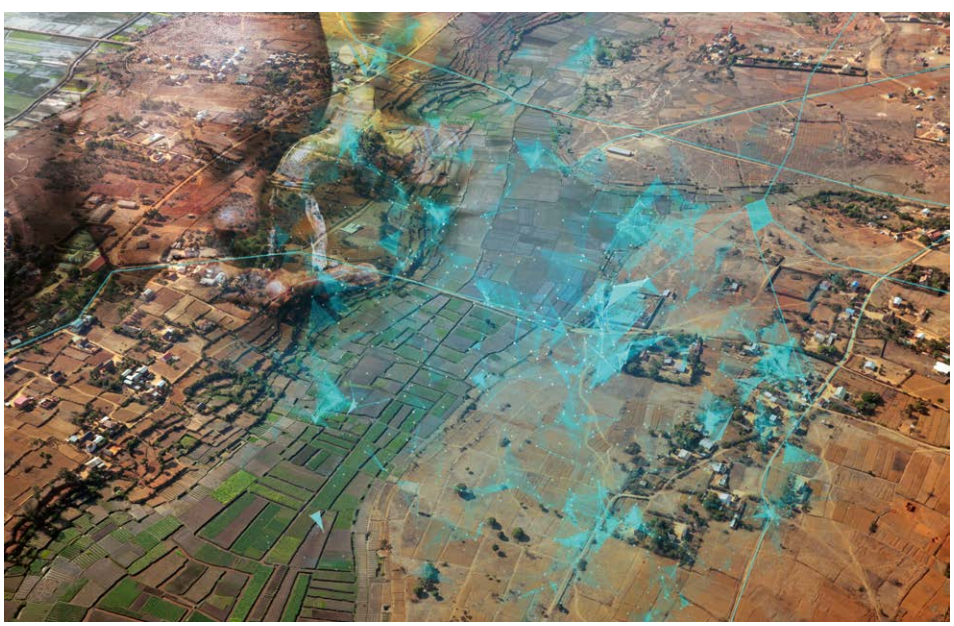
SMARTER & BETTER CITIES, FOR REAL

This study, in partnership with the product and furniture design students at Ecole Boulle, a fine and applied arts college in Paris, sought to investigate the potential for current digital tools to resolve complex issues in cities today and in the future. After identifying situations around the world, the students provided their own innovative interpretation of tools currently offered by **3D**EXPERIENCity and other Dassault Systèmes brands.
The development of services for and by citizens provides new solutions rooted in the ongoing dialogue between the digital and real worlds. Here are six of the issues they addressed and their solutions.

THE SOURCE

SACHA BULIARD AND EMMANUELLE JOBIC

The majority of urban development in Africa is informal and clustered around vital water resources, which represents a significant decision-making factor in regional development. Detection tools are key to locating ground and surface water reserves. In Africa, a continent with inequitably allocated investments and severely limited access to water, GEOVIA's virtual technologies transform physical samples into a clear reading of available resources. The ability to zone land based on water resources could open the door to a new, organized form of urbanization that improves the viability of settlements, interactions and transportation. The digital materialization of collected data could be used to achieve a sensible approach to regional development.



Dassault Systèmes' technologies – **3D**EXPERIENCity for urban planning, in particular – could help guide urbanization in an entirely new way.

Backing from aid and development organizations, with support from local NGOs and local associations, could enable these regional initiatives to thrive.

BANGKOK

URBAN OBSOLESCENCE

SOLÈNE MINJEAN AND CLÉMENT VEZON

The city is a living organism that continues to evolve and shift while also deteriorating. The natural decay of urban infrastructure could be predicted through a dating and inventory system.

3DEXPERIENCity offers a new perspective on the city, which has to be understood as a living entity where aging and renewal are healthy functions.
We aim to present accelerated models of emerging developments in cities, such as Bangkok, based on a map of temporary and lasting elements displayed in relation to dating and predicted obsolescence. Digital technology brings previously invisible changes to light. The projections could provide better control over how infrastructure lifespans and urban decay are managed, through maps and models available to residents, public authorities and urban planners.

DEHLI

THE JUGAAD EXPERIENCE

CAMILLE MENARD, ÉLODIE COQUILLAT AND KIREN MATTOO

India is a fast-developing country that suffers from inequitable access to water, which is distributed at public standpipes in the street. Limited in financial resources, the country is developing via "jugaad," a Hindi word that refers to frugal, ingenious solutions. A virtual model that digitalizes the city, water resources and resourceful practices could be used to identify water-management opportunities and innovative scenarios. **3D**EXPERIENCity could support the inventive local mindset, streamlining wastewater treatment, water supply and water recycling for users, using their own methods. For example, phyto-purification systems could be installed on India's distinctive flat roofs based on rainfall data, transforming users into rainwater collectors. This would provide an individual solution for using water from rain showers that were once problematic, while predicting household and neighborhood needs to prevent shortages.

MONTREAL

NEO-CROPS

JASMINE S. BERTHIAUME AND ESTHER BAPSALLE

Quebec only cultivates 2% of its land – most land in the region, which has 500 different soil typologies, is considered infertile due to the climate. Digital technology could be used to perform a more detailed topographic analysis and develop new agricultural solutions. The analysis would draw from satellite imaging, mapping data collected by drones and temporary or permanent sensors above and in the ground, to generate a virtual agricultural sector that could be interpreted using Dassault Systèmes software.

At the province level, this analysis could be used to pinpoint new locations for farming and devise new opportunities for sensible land use. These solutions also could help farmers with their daily work, and aid in checks and management. They also could encourage younger generations and neo-rurals to get involved, establish new forms of farming and improve natural resource management.

LISBON

TWIN CITIES

RIO DE JANEIRO

ALEXIA LIMOGES AND PAULINE JOURDAN

The "Twin Cities" project promotes large-scale cooperation between world metropolises and questions the notion of borders in the digital age. In the future, will it be possible to live in two cities at the same time? The project focuses on the dialogue between Lisbon and Rio de Janeiro, with **3D**EXPERIENCity serving as a powerful tool for expanding cooperation between the two cities. Twin Cities would emulate a network of individuals by capturing sensory data around them, sharing it with residents in the other city, and providing access to new urban experiences via virtual reality, augmented reality and holography.

Imagine gazing at an azulejo-paved street lining the beach in Copacabana or dancing to the sound of carnival in Rio de Janeiro from the banks of the Tagus. Virtual experiences would help shape the image of this new dual metropolis without negating the respective identities of the two cities.

FEELING THE CITY OF THE FUTURE

MATHILDE LEMAIRE AND FANNY PELLIER

Viewing the virtual experience in terms of "what if our city were…?" allows for a more sensory approach. We imagine **3D**EXPERIENCity as the key to unlocking an imaginary, personal world. Sensory interaction would enhance the real-world and fiction projects and people's aspirations. Digital technology would provide access to spaces for dreaming and become a strategic guidance tool for building smart cities. The scenarios that would be dreamed up in these virtual experiences could help predict future priorities. Dassault Systèmes' immersive tools would enable people to interact freely in alternative cities and experiment with this conditional future.

Our project outlines sensory experiences based on three procedural cities: Urbicande, a city where gravity defies the laws of physics; Samaris, a submerged city; and Muhka, an information-based city. The cities would enable people to delve into and investigate current issues in an unconventional way.

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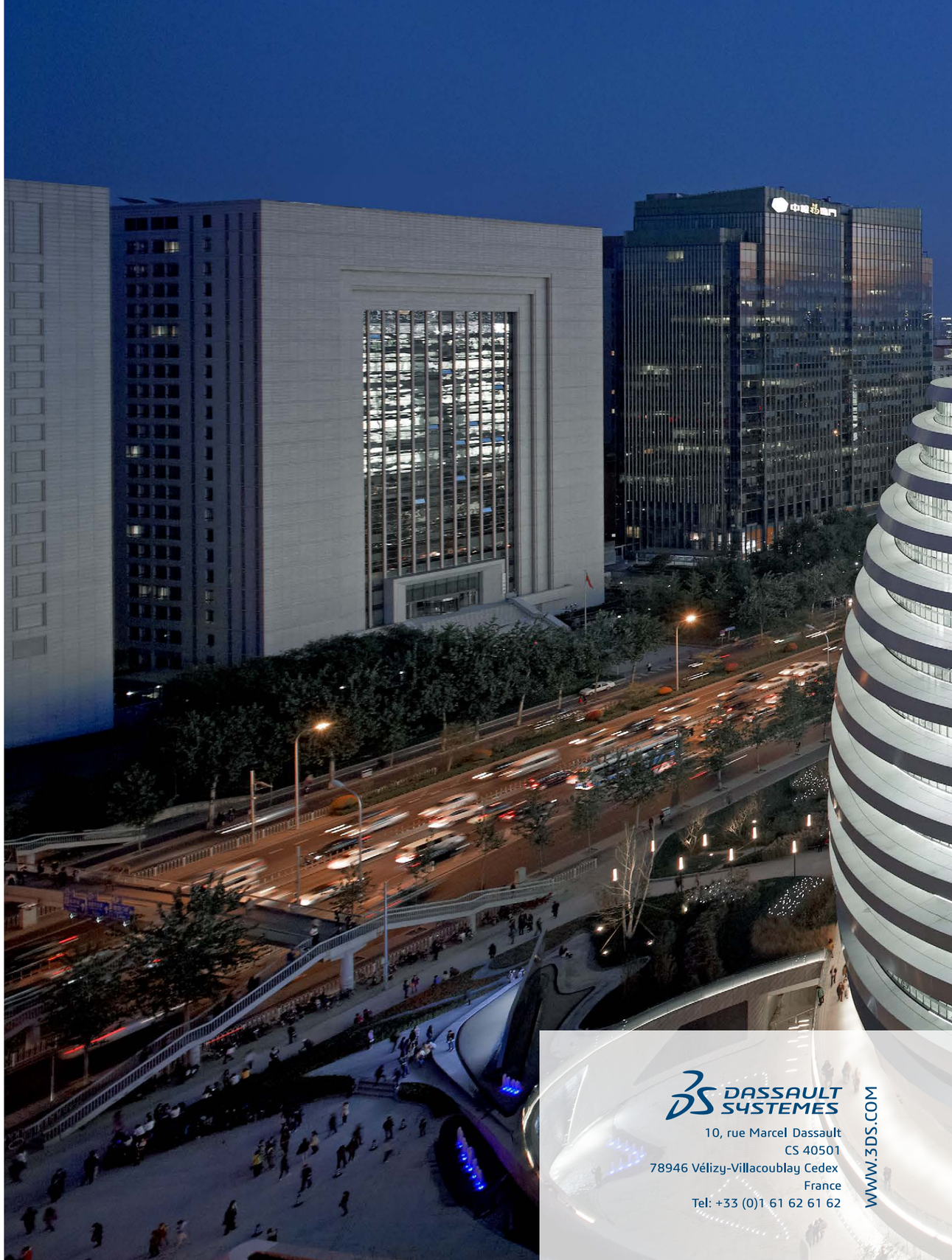

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