WE ARE THERE

2018/2019/2020
Corporate Report

DASSAULT SYSTEMES | The **3D**EXPERIENCE® Company

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Dassault Systèmes' purpose is to provide business and people with **3D**EXPERIENCE universes to imagine sustainable innovations capable of harmonizing product, nature and life.

The **3D**EXPERIENCE platform offers everyone a universe that stimulates creativity, reveals the beauty and complexity of materials, and reinvents the very notions of innovation, production and sharing. This is what we call the Industry Renaissance.

WE ARE WHERE
CITIES BECOME SUSTAINABLE,
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WE WILL BE THERE TOMORROW.

TRIBUTE
by Bernard Charlès

Serge Dassault passed away on Monday, May 28th 2018, age 93, as he was working in his office. To me, Serge Dassault was a friend, a business partner and a constant source of support. In 1987, following the death of his father Marcel Dassault, Serge Dassault took over at the helm of the holding company Groupe Industriel Marcel Dassault, main shareholder of Dassault Systèmes. He also was a member of the Dassault Systèmes Board of Directors from 2012 to 2014. To him, all that mattered was the future. He always kept his eye firmly on the future while building on his father's industrial legacy.

Serge Dassault was an enthusiastic supporter of Dassault Systèmes from the beginning. He was always very close to Charles Edelstenne, who founded our company in 1981 and who had helped Serge Dassault successfully lead the holding through the transition following his father's death. He shared our faith in science, which he believed was essential to the development of nations, and especially to France's standing in the world. An aeronautical engineer by training,he was very curious of the value that the virtual world brings to areas of industry such as health care and consumer goods.

Nicole Dassault, his wife, passed away on Tuesday, April 2nd 2018. A member of the Dassault Systèmes Board of Directors from 2011 to 2016, she was a strong supporter of our corporate ambition and especially appreciated what we do through our solutions to improve the life of everyone.

Serge Dassault believed that an innovation- and export-driven industry was the best guarantee for France's leading role on the international stage. He also was keenly aware of the crucial role played by small- and mid-sized businesses in driving the competitive performance of industry. He also was committed to training what we today call the "workforce of the future" and encouraged us in all our efforts in the academic world.

Turning to his role as a shareholder, what struck me about Serge Dassault was his focus on the long term and quality of customer service. He imparted these values to his children. His unwavering trust in Charles Edelstenne, myself and in our entire executive team, together with our strong shareholder stability, enabled us to take the bold steps that also helped shape our success. This will continue to inspire us for the sustainable future of our company.

SERGE DASSAULT

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

CHARLES EDELSTENNE
Chairman of the Board of Directors

2018 has been a remarkable year for Dassault Systèmes. We have seen strong results which support our confidence in the future. We are comforted in the strategic choices we made in 2012 when we unveiled **3D**EXPERIENCE by the trust our customers place in us whether they be major corporations, entrepreneurs or professionals. We are confident in their desire to pursue or accelerate sustainable innovation by adopting our **3D**EXPERIENCE platform and in our ability to innovate, design and deliver an unparalleled value to our customers.

Our results speak for themselves and illustrate the relevance of our strategy. In 2018 we passed the milestone of 250,000 customers with 27,000 new clients joining (not counting those belonging to companies acquired by Dassault Systèmes). **3D**EXPERIENCE adoption is accelerating, driven by our core industries and bolstered by diversification industries. Our results and confidence in the future stem from our company's core purpose, established in 2012, to offer businesses and individuals a **3D**EXPERIENCE universe to imagine sustainable innovation capable of harmonizing product, nature and life. We believe that the century ahead of us will be one of unprecedented invention and innovation, a true Industry Renaissance. In this age of innovation, we strive to deliver, not only a product or a service, but an experience. The world of experiences expands our business environment since it includes, for example, the urban environment of the future – where more than 70% of the world population will live – or medical and research practices.

Dassault Systèmes continuing expansion through acquisitions
We are constantly expanding our knowledge and know-how to bring our customers the solutions they need to reach their excellence objectives. The companies joining Dassault Systèmes come from different fields, from technological development and business operations to specific sectors. The Centric PLM acquisition has strengthened our presence in the fashion industry, luxury goods, lifestyle and retail sectors. No Magic and Argosim have expanded our offering in cyber systems and with COSMOlogic, we now offer our clients the most advanced biochemical simulation solutions. Finally, with the IQMS acquisition, the goal is to make the power of a complete solution, on the **3D**EXPERIENCE platform, available to small and medium-sized industrial enterprises, to support their requirements from design to manufacturing execution.
With SOLIDWORKS, these firms already have access to affordable, easy-to-use and robust design solution. IQMS, which will become DELMIAWORKS, will provide them a necessary complement to manufacturing enterprise resource planning.

> "Our strong results support our confidence in the future."

Major successes with customers in core and diversification industries
Two major contracts, among others, were secured in 2018. In core industries, Airbus will deploy Dassault Systèmes' **3D**EXPERIENCE platform, marking a major step forward in its digital transformation. Airbus will deploy digital design, manufacturing and services across all divisions and product lines.
In diversification industries, EDF and Dassault Systèmes signed a long-term partnership agreement for the digital transformation of EDF's nuclear engineering and its ecosystem.

Platforms: the infrastructure of the 21st century
These contracts are evidence that our vision of the 21st century economy, the Industry Renaissance, resonates strongly with our customers.
They recognize the insightfulness and the value of our vision, as well as how our **3D**EXPERIENCE platform acts as a catalyst and enabler for this transformation. Thanks to the **3D**EXPERIENCE platform, we are the partner of choice for all our clients, from the world's largest companies to small and medium-sized industrial firms spanning all industrial sectors and regions.

Strength and relevance of our purpose
Dassault Systèmes' purpose is key to confidence in our company's future. First and foremost, because it highlights the human aspect of our activity. Indeed, we believe that the leading businesses of tomorrow will be those that empower their workforce with knowledge and know-how.

Our long-term vision of "harmonizing product, nature and life" also is what enables the Company to achieve nearer-term objectives. Dassault Systèmes has been anticipating the transformations ahead, by offering customers solutions to their digital conversion needs and by delivering experiences that improve their user's life, whatever is the industrial sector.

Core and diversification industrial sectors growth driving performance
Our Core Industries, Transportation & Mobility, Aerospace & Defense and Industrial Equipment software revenue grew double-digit on **3D**EXPERIENCE adoption acceleration. Diversification Industries represented 32% of total software revenue in 2018, with strong growth in Marine & Offshore, Consumer Goods & Retail, Architecture, Engineering & Construction, Natural Resources and Financial & Business Services.

Dassault Systèmes 2018 results: strong revenue and eps growth
In constant currencies, total revenue increased 10% in 2018 to 3,488 million euros (non-IFRS), driven by license revenue growth of 11%, a 9% increase in recurring revenue, representing 70% of our total software revenue, and acquisitions. On an organic basis, total software increased 7%, with licenses and other software revenue up 9% and recurring software revenue up 6%. The operating margin was 31.8%, compared to 32% in 2017, with an improved underlying organic operating margin of about 70 basis points, partly absorbing acquisition dilution and negative currency impact. Non-IFRS EPS growth was 16% at 3.11 euros and 20% at constant currency. On a regional basis, Asia non-IFRS software revenue increased 16% with double-digit software growth across all geographies. In Europe, non-IFRS software revenue increased 8%, led by significantly higher license growth in Western Europe and strong recurring software revenue results generally. In the Americas, non-IFRS software revenue increased 7% reflecting new acquisitions, strong growth in subscription revenue and continued strengthening in Latin America. High Growth Countries non-IFRS software revenue increased 18% and represented about 18% of total software revenue.

> "We believe that the leading businesses of tomorrow will be those that empower their workforce with knowledge and know-how."

Our brand's portfolio performance has been broad-based, with double-digit growth at constant currencies for SOLIDWORKS, ENOVIA, reflecting adoption of **3D**EXPERIENCE, SIMULIA, including recent acquisitions, and DELMIA. Finally, CATIA grew 4%, in line with our expectations.

Operating cash flow expansion
Net operating cash flow increased 21% to 899 million euros in 2018, compared to 745 million euros in 2017, reflecting strong growth in net income and an improvement in working capital.

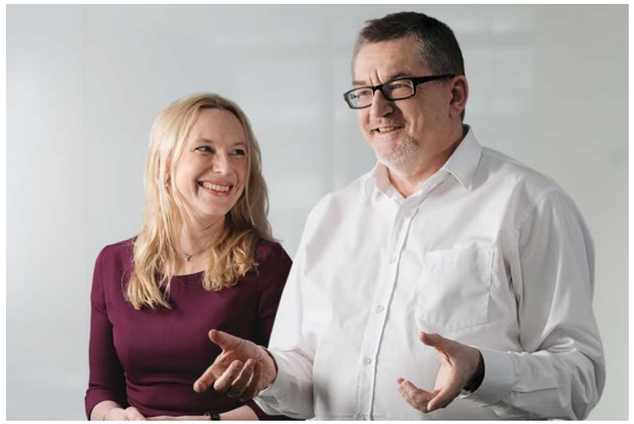
Business outlook for 2019 and 2023
The strategic drivers for sustainable growth (specifically **3D**EXPERIENCE platform strategy, industry solution approach, local focus driving geographic diversification and addressable market extension) are demonstrating good traction. We believe these drivers have put us in a good position to reach our double-digit revenue growth objective in 2019, representing the completion of our current five-year plan and the start of our 2023 plan targeting 6.00 euros non-IFRS EPS.

Dassault Systèmes, the **3D**EXPERIENCE Company, will continue to bring experiences to the world that improve life for everyone thanks to the dedication of its 17,000 employees.

GOVERNANCE

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 product, nature and life.

BERNARD CHARLÈS
Vice Chairman,
Chief Executive Officer



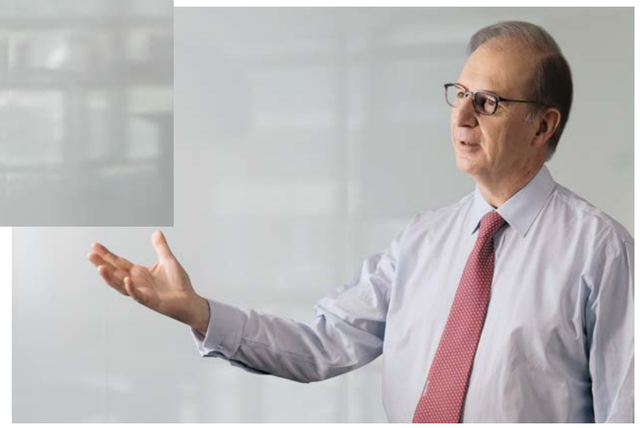
FLORENCE VERZELEN
Executive Vice President,
Industry Solutions, Field Marketing,
Global Affairs

DOMINIQUE FLORACK
President,
Research & Development

VICTOIRE DE MARGERIE
Vice President,
Corporate Marketing,
Brand and Communication

LAURENCE BARTHÈS
Executive Vice President,
Chief People and
Information Officer

THIBAULT DE TERSANT
Senior Executive Vice President,
General Secretary



PASCAL DALOZ
Executive Vice President,
Chief Financial Officer
and Corporate Strategy Officer

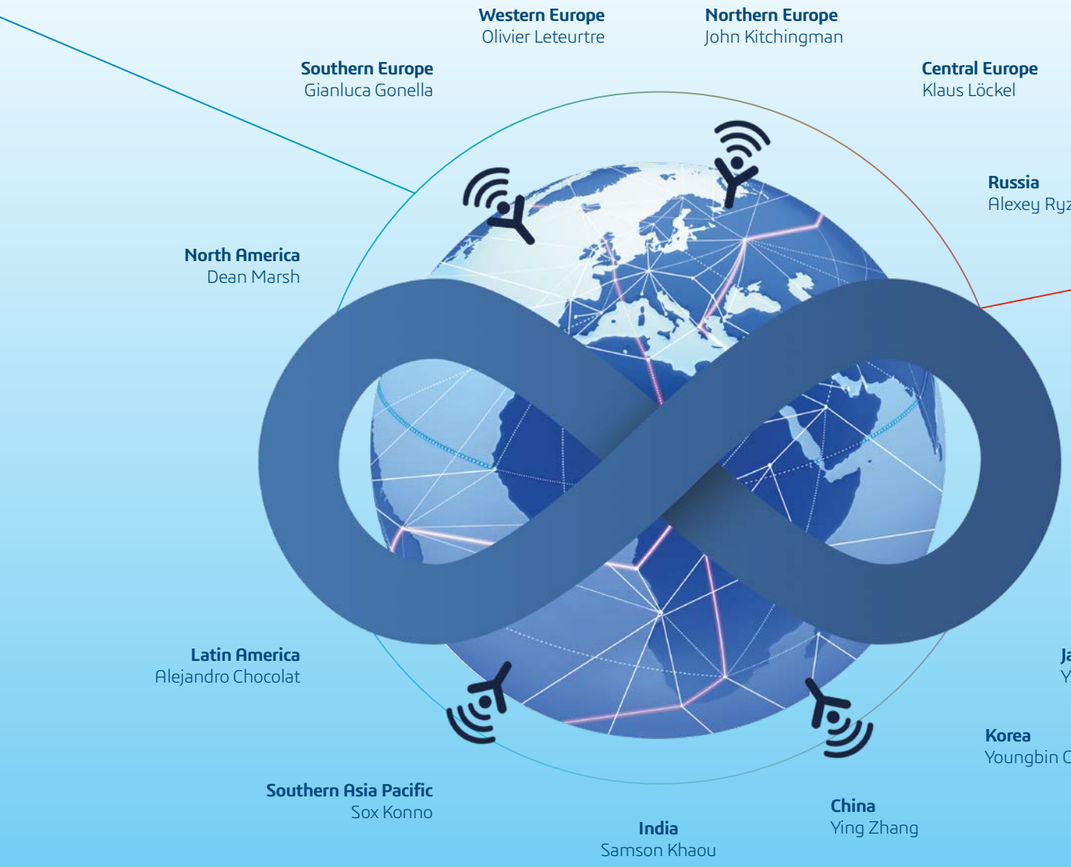
BRUNO LATCHAGUE
Senior Executive Vice President,
Brands, Indirect Channels, Americas

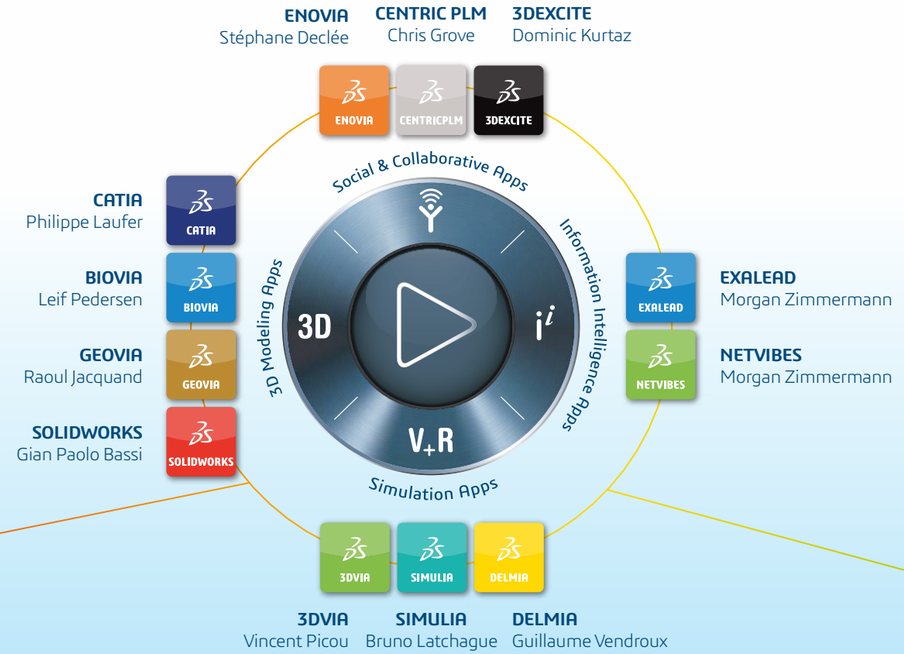
OLIVIER RIBET
Executive Vice President,
Cross-industry Initiatives,
Europe, Middle East, Africa, Russia

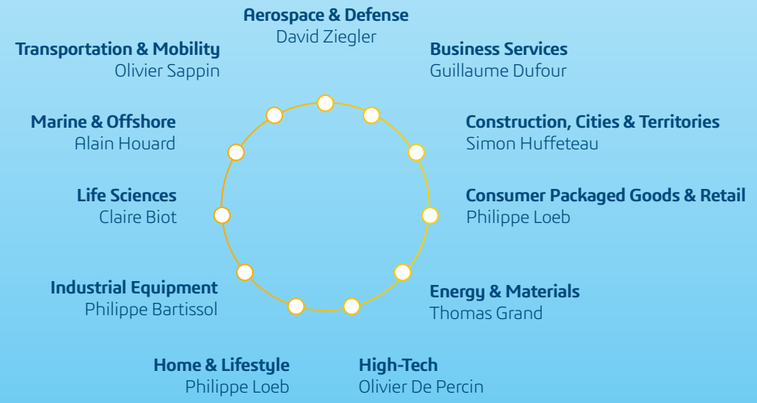
SYLVAIN LAURENT
Executive Vice President,
Business Transformation, Asia Oceania

PROFILE

With sales in over 140 countries, the Group brings value to more than 250,000 businesses of all sizes in all industries.

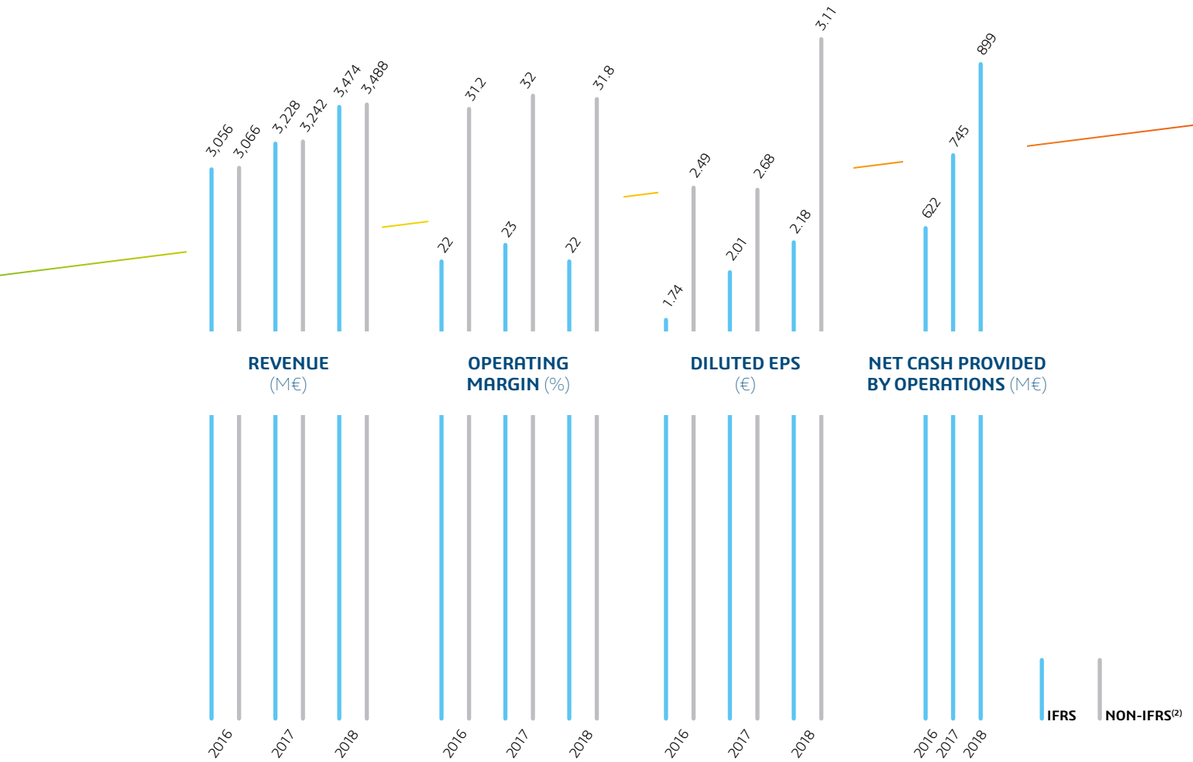




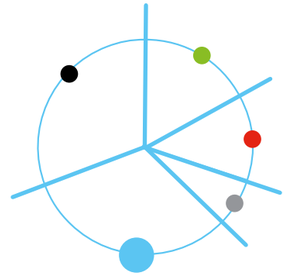


STRONG PERFORMANCE, GOALS ACHIEVED

+10% Revenue growth[1]
+11% Licenses revenue growth[1]
+20% at €3.11 Earnings per share
+21% at €899 million Net cash provided by operations

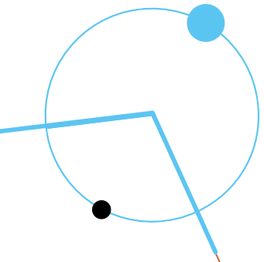


(1) Non-IFRS, revenue growth figures in constant currencies.
(2) All financial information is reported according to IFRS. In addition, the Company has provided supplemental non-IFRS financial information, which excludes the effect of adjusting the carrying value of acquired companies' deferred revenue, 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.



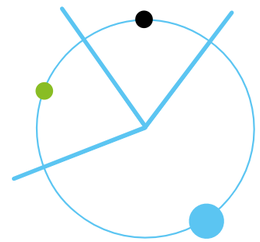
Industry diversification

- 32% Diversification industries
- 31% Transportation & Mobility
- 17% Industrial Equipments
- 13% Aerospace & Defense
- 7% Business Services



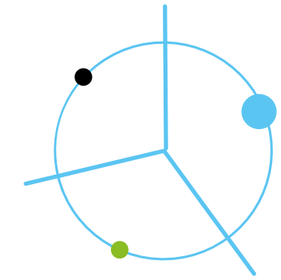
70% of recurring software revenue

- 70% Recurring Software
- 30% New Licences and Product Development



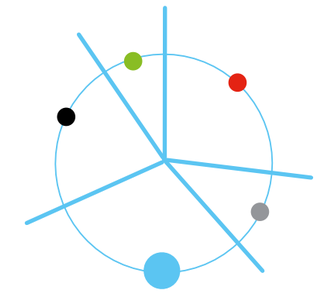
A well-distributed turnover between direct and indirect sales networks

- 59% 3DS Business transformation
- 21% 3DS Professional
- 20% 3DS Value Solutions



A gradual rebalancing between Americas and Asia

- 43% Europe
- 29% Americas
- 28% Asia



Leading brands serving our users

- 30% CATIA Software
- 22% SOLIDWORKS Software
- 10% ENOVIA Software
- 27% Other Software
- 11% Services and Other

REACHING ALL OUR 2018 OBJECTIVES, PLAN 2018-2023 ANNOUNCED

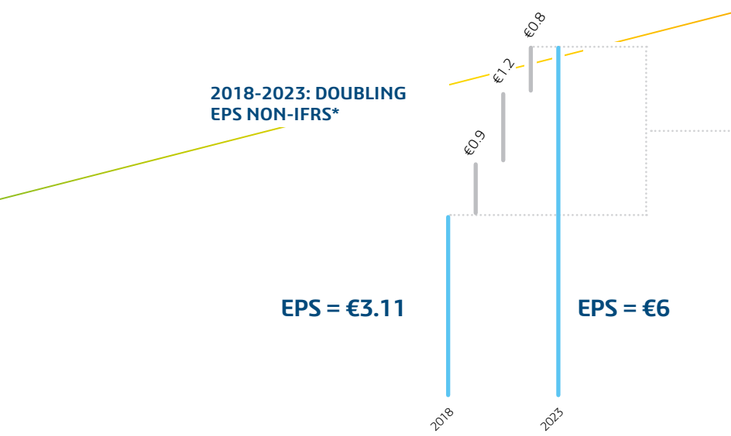
Looking at the year 2018, we delivered on all our financial objectives with total revenue and software revenue up 10%, license and other software revenue up 11%, organic operating margin expansion of 70 basis points absorbing almost all acquisition dilution, earnings per share up 16% (20% at constant currency), and cash flow from operations up 21% to 899 million euros.

For 2019, we are targeting non-IFRS total revenue growth of about 10% to 11% in constant currencies and earnings per share growth of about 7% to 9% reaching 3.35 euros to 3.40 euros. We expect further progressive improvement of our organic software revenue growth, driven by recurring revenue representing 70% of our total software.

For the 2018-2023 period, we plan to double our non-IFRS EPS, to a goal of about 6.00 euros. From a revenue perspective, key growth drivers already in action include the **3D**EXPERIENCE software cycle, our expanding global footprint bringing diversification balance by industry and geography, and new usage opportunities with the Cloud. Complementing our key growth drivers are new initiatives, including our recently introduced Marketplace and potential acquisitions aligned with our purpose. Both of these can positively animate our 2023 non-IFRS EPS objective and, more importantly, set in motion future growth drivers beyond 2023.

Pascal DALOZ
Executive Vice President,
Chief Financial Officer and
Corporate Strategy Officer

2018-2023: DOUBLING EPS NON-IFRS*



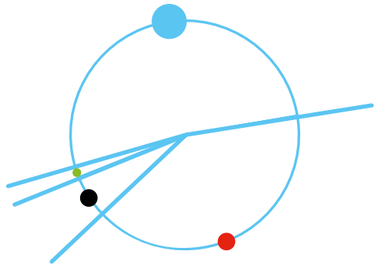
€0.8 Acquisitions & Marketplace
€1.2 **3D**EXPERIENCE Product Cycle
€0.9 Industry Diversification

ASSUMPTIONS

- Organic operating margin up to 50 basis points/year.
- Tax rate at 27%.

* non-IFRS (IFRS15)

SHAREHOLDERS' INFORMATION



Shareholder's composition

51,4% Free float
40,7% Groupe Industriel Marcel Dassault
6,0% Charles Edelstenne
1,9 % Bernard Charlès

DASSAULT SYSTÈMES STOCK DATA

Listed on NYSE, Euronext Paris and traded on the American OTC market

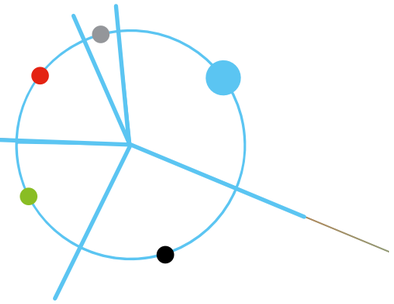
Member of CAC 40

Stock price as of 12/31/2018
€103.70 $118.00

Market capitalization
€30.3 MD $27.1 MD

Comparison of the stock performance
DASSAULT SYSTÈMES +22%
CAC 40 –11%
NASDAQ –5%

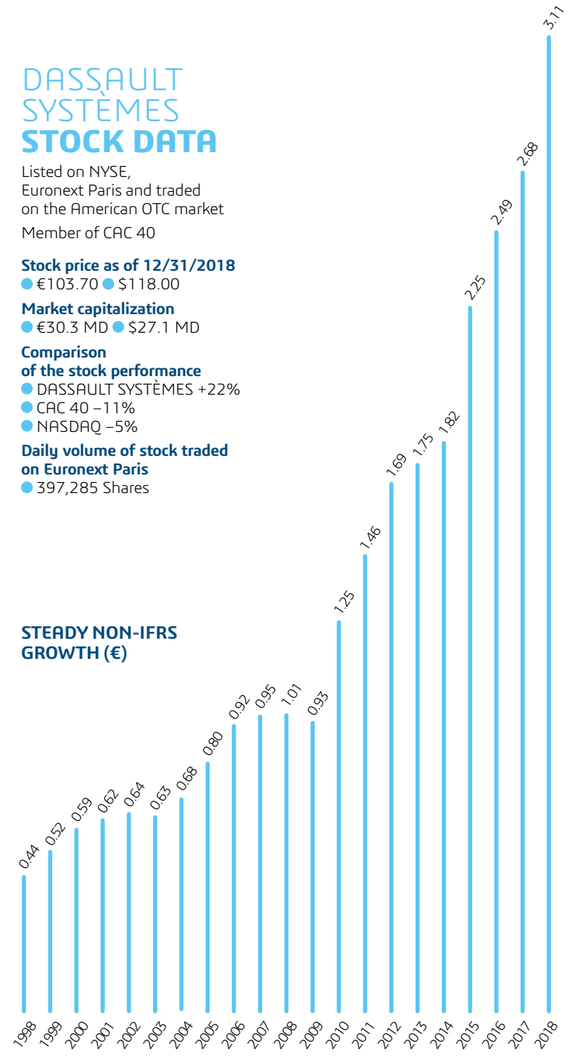
Daily volume of stock traded on Euronext Paris
397,285 Shares



Split of free float

33% North America
26% France
18% UK & Ireland
18% Continental Europe (excluding France)
5% Rest of world

STEADY NON-IFRS GROWTH (€)



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

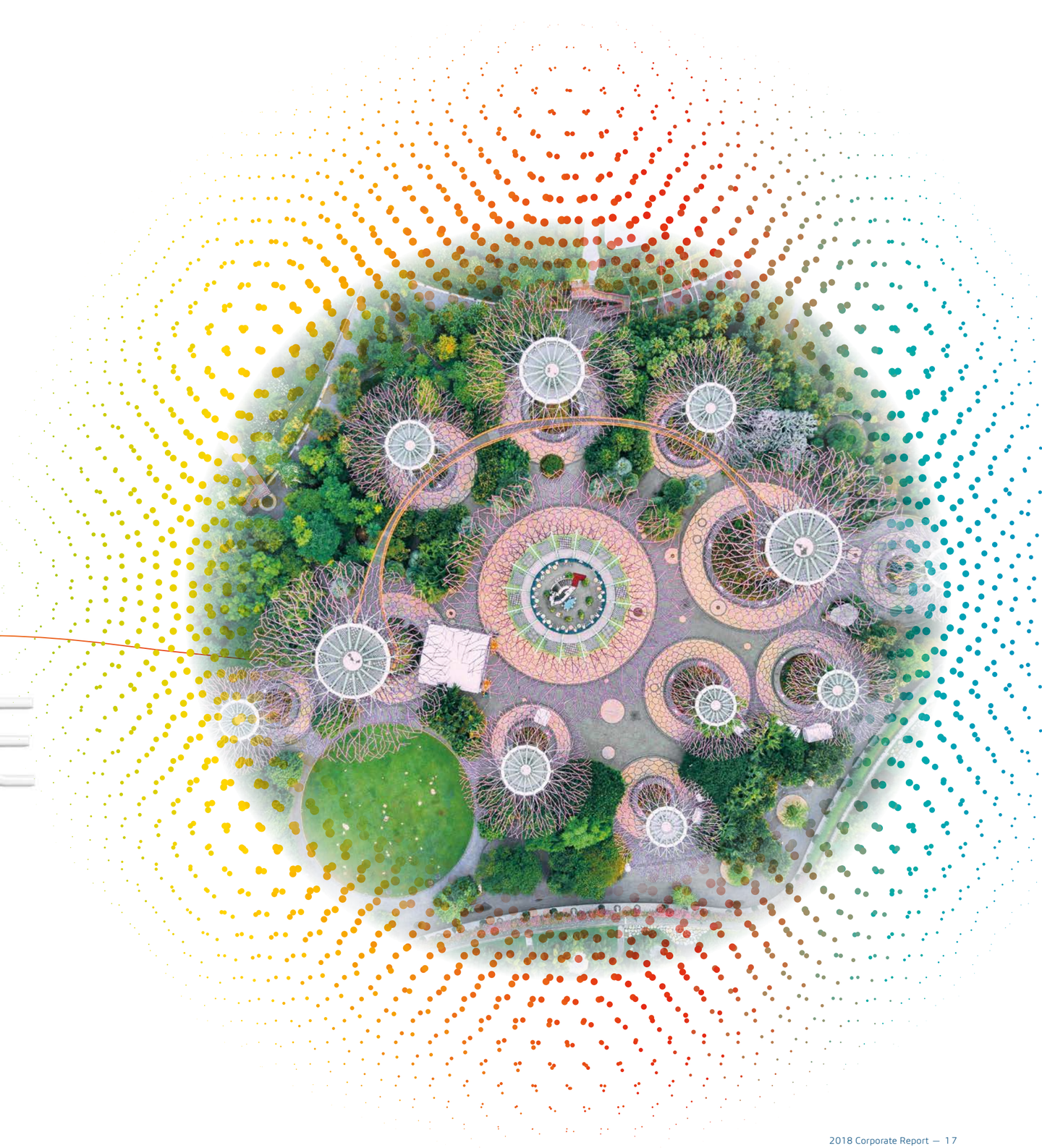
KEY 2019 SHAREHOLDERS' EVENTS

Wednesday, April 24, 2019 release of first quarter earnings
Thursday, May 23, 2019 annual shareholders meeting
Wednesday, July 24, 2019 release of second quarter earnings
Thursday, October 24, 2019 release of third quarter earnings

WE
ARE
WHERE...

In 2050, two thirds of the 9 billion people on the planet will be living in urban areas. That means we must start developing our cities intelligently now, to be inclusive and responsible, and build an ecosystem that brings together governments, citizens and businesses.

CITIES BECOME SUSTAINABLE



INVENTING A DESIRABLE FUTURE FOR CITIES

In big cities, everything – buildings, lifestyles, the environment, government, transportation networks, and its inhabitants – is structured into an ecosystem where resiliency and adaptability are essential to ensure sustainability.

Observing nature can be a source of inspiration. We can even think of nature as a giant laboratory, studying its strategies to adapt to disruption.

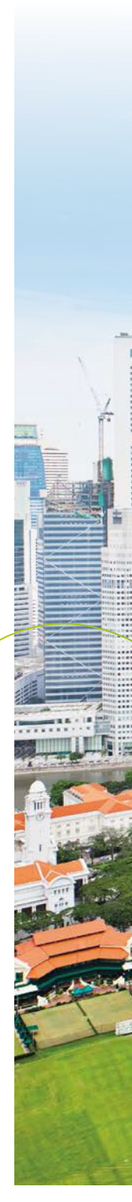
Biomimicry

Biomimicry involves understanding and emulating what nature does best in order to design innovative systems. The research teams at Dassault Systèmes use biomimicry as an innovation process to develop new approaches to urban planning through two problem-solving models: Physarum and Swarms.

Learning abilities

The first approach is derived from observing *physarum polycephalum*, a single-cell organism made up of multiple nuclei that can reach a size of several dozen centimeters. This slime mold, although brainless, is capable of learning and can solve problems, such as finding the shortest path through a maze or establishing the most efficient network. Its protoplasmic membrane forms tubes to expand and explore all possible paths before sticking with the most efficient ones to reach sources of food. This behavior has become a source of inspiration for building models to solve the shortest path problem in a graph, and is particularly relevant in designing transportation systems.
The second model, Swarms, is a socio-economic system for distributing agents in cities. The agent, representing a bee in a swarm, is an individual who builds on specific features of the urban fabric to optimize a budget allocated every month. The agent's aim is to maximize well-being by finding a balance between the amount of rent paid, home surface area, and time spent traveling to work, shopping areas and parks.

Biomimicry is a promising way forward, providing an endless source of creativity for shaping the city of the future.



The bio-inspired city

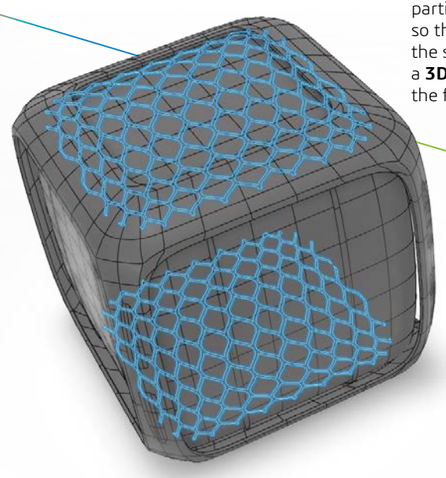
The two approaches were integrated into **3D**EXPERIENCity. The main new feature is that the research teams are getting them to work together, integrating the outcomes from one model as a starting point for the other. Aggregating data in this way considerably increases the number of potential solutions. Scientific literature generally presents applications of models designed using limited data. As a result, their findings are less coherent with the reality of industrial or urban planning issues. For example, agent models are often used and are relevant for calculating distances based on swarm behavior in birds. But when they interact with the Physarum model, they can incorporate data from a realistic transportation network. Today, these research-based biomimetic approaches do much more than just demonstrate feasibility. They can be integrated to help urban authorities in cities that already have a digital twin – such as Rennes and Singapore, which have been using the **3D**EXPERIENCE platform for several years – and, more broadly, applied to any cities with useable data. Bio-inspired cities clearly have a bright future and were a fitting topic of exploration to stimulate the creative thinking of participants at the hackathon organized during Milan Design Week in April 2018.

Tomorrow's cities will invent new forms and new uses while respecting their historical heritage.

An entire city in 3D

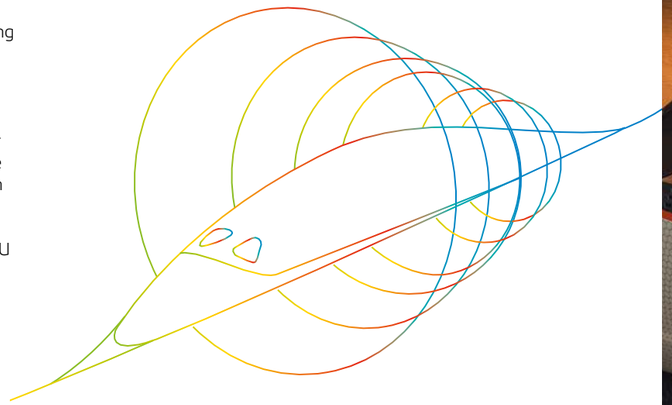
According to the traditional rules for a hackathon – a term that combines "hack" and "marathon" to refer to an intensive collaborative research event taking place over a short period – each team was tasked with designing an innovative, nature-inspired mobility concept to shape the city of 2050.

The solution had to be demonstrated using immersive 3D technology and it had to render its experiential aspect using the **3D**EXPERIENCE platform. Prior to the Design in the Age of Experience event in Milan, participants took part in a preliminary workshop so that they would be technically familiar with the system on the big day. Teams were given a **3D**EXPERIENCity model of Milan and access to the full CATIA Design software suite on the platform.



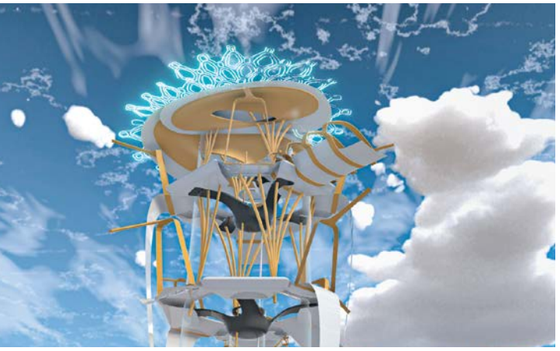
The flock-of-birds model

The judges were looking for innovative concepts, along with high-quality design and experiences, especially in terms of ergonomics. Following a hectic 24 hours, the five teams delivered some surprising solutions. The first, Wind Flower City, designed an electric energy-generation system for cars using wind power captured from trees. Another team invented a mobile transport unit, or MTU, based on a few simple design parameters, including a 360° view and the ability to move in all directions, even up and down. Three versions of the unit were designed: a Basic MTU for standing passengers; a Premium MTU with four seats; and the two-seater Business MTU. The concept presented by the winning team, Drone Flyback, put forward the idea of delivering all flows – services, goods, freight and energy – underground and leaving the surface to trees and nature. People living in the city move about through the air using jetpacks. Aerial traffic routes are shown by green lines, along which people fly about in their jetpacks like flocks of birds. The electric jetpack is charged by walking and by induction, through the soles of the user's shoes.



Flowing movements of animals

Two other awards were given. One went to the City Capsule concept, inspired by the way in which plants and flowers find solutions to get more light. Lightweight infrastructure was used to develop an urban transport network featuring capsules that can be shared to reduce traffic and soil pollution.



The second award went to the City Tube project. Modeled on the Hyperloop, the project included an entire network of interconnected stations enabling urbanites to zip through the city inside transportation pods traveling through low-pressure tubes. The concept was based on an innovative magnetic induction mechanism embedded in the ground. The capsule itself was influenced by the most energy-efficient movements the designers could find among the animal kingdom: the flowing movements of whales and sharks. The result was a solution that combines aerodynamics, aesthetics and comfort. The demonstrations were conclusive: Tomorrow's cities are likely to reintegrate the experience of nature and take inspiration from it. They will invent new forms and new uses. But between now and 2050, our cities must respect their historical heritage, drawing on certain remnants of their past. A city's heritage, often exceptional, must be cared for, wherever in the world it is located.

A better citizen experience

Conserving its heritage is one of the many concerns of the municipality of Jaipur, the capital and largest city in the Indian state of Rajasthan. Founded under the Mughal Empire at the start of

24 h
of intensive work to invent an innovative, nature-inspired mobility concept for the city of 2050.

5
awards recognizing particularly interesting proposals.

3.1 million
residents.

500,000
buildings.

12 billion
dollar GDP.

3,000 km²
(1,864 square miles)
covered by the region's
master development plan.

the 18th century, the pink city presents displays great architectural unity and holds UNESCO World Heritage status. In 2018, 1.8 million tourists visited this city of about 3.1 million residents. Jaipur has adopted the **3D**EXPERIENCE platform to connect all administrators in a single digital repository in order to plan, analyze, simulate and optimize services and infrastructure to provide residents with a better citizen experience and improve their quality of life. Jaipur is one of 100 cities being used as development models in the Smart Cities Mission, an initiative launched by the Government of India.

Involving residents

The **3D**EXPERIENCE platform will provide all city administrators with access to the city's digital twin. Currently, most of the many municipal agencies work in silos. The platform will enable all departments to work closely together to optimize planning based on analyses and simulation studies in a 3D city context.
Rapid urbanization creates many negative biases for residents and tourists alike, such as poor air quality, chaotic traffic conditions, dangerous walking environments and inadequate waste management. In addition, intense real estate development does not reflect Jaipur's heritage and cultural philosophy.
How can Jaipur be a city desired for living and visiting? Today, many projects, such as the construction of a bridge, are rejected by citizens because it will reduce vegetation. City leaders therefore want to involve residents in planning and decision-making to properly manage conflicts and objections. A 3D model is undoubtedly the best way to communicate because it can provide tangible elements for analyzing citizens' opinions, increasing renewable energies, optimally positioning video surveillance cameras and improving mobility. For example, by assessing the amount of rainwater recovered from each building, authorities can anticipate whether the volume collected is sufficient to meet residents' daily needs,or whether they will need an additional supply of public water.
The **3D**EXPERIENCE platform helps involve citizens and businesses to optimize services and ensure pleasant experiences. The cities of tomorrow will be both more sustainable and more socially responsible. The **3D**EXPERIENCE platform holds great promise to help the leadership in Jaipur involve citizens and businesses to optimize services and ensure pleasant experiences. It offers an unparalled means for helping cities like Jaipur be more sustainable and more socially responsible, and desirable for both residents and visitors.

AMAZING OPPORTUNITIES FOR THE AUTOMOTIVE INDUSTRY

Autonomous, connected electric cars that are shared or available on demand – mobility will undergo tremendous transformation over the next 10 years. Olivier Sappin, VP of Transportation & Mobility at Dassault Systèmes, offers some insight into the changes underway.

Let's be upfront. Do cars still have a future?

The question is definitely worth asking. I grew up in the French countryside where cars were, and still are, synonymous with the freedom to move about anywhere at any time. I'm a mechanical engineer. I drive a sports coupe and love cars. But I live in the suburbs of Paris, so I ride a bike to work. On some days, it's faster than driving to work. And on the weekend, public transportation is the best way to get to the center of Paris. When traveling abroad, I take planes and trains, which have the drawback of taking you from a place where you don't live to a place that's not your final destination. That's why cars, as long as they become autonomous and clean, could offer the best transportation system for the future.

Why do you refer to it as a transportation system?

Because the traditional industry silos are breaking down. Innovation in mobility is omnipresent in both four-wheel vehicles and other forms of transportation. For example, Joby is an electric vertical take-off and landing passenger aircraft designed for urban areas. EasyMile and Navya are autonomous shuttles. Airbus and Audi have partnered to develop Pop.Up, a flying car concept. Anything seems possible, and this is generating a huge wave of creativity. Traditional industry categories, like conventional consumer expectations, have become outdated.

What role do virtual worlds play in this transformation?

Collaborative platforms and virtual worlds help innovators transform their ideas into tangible concepts that can be manufactured by others. These ideas are being generated in a huge marketplace, also virtual, devoted to engineering and manufacturing. It's a place where innovators can meet the companies that will produce the vehicles they designed. The price of admission into the inner circle of carmakers has been very high for the past 100 years, due to the technical complexity and level of investment and capital required. But that hasn't always been the case. Innovators in the 19th century designed all sorts of contraptions, similar to today's startups. Now, platforms mean that the value chain is being redefined, and new players are emerging in Silicon Valley, China and Europe. Tesla symbolizes this transformation. Virtual prototyping changes everything. Aerodynamic engineering using digital technology is more accurate than physical testing performed in wind tunnels. And simulations at the nanometric scale predict exactly how materials will react.

OLIVIER SAPPIN
A mechanical engineer, Olivier Sappin worked in the CATIA Industrialization unit before moving to leadership positions in the Styling & Body team and the Global Automotive Solutions unit. In 2011, Olivier was appointed Vice President of the newly formed Transportation & Mobility Industry unit, to help manufacturers develop new mobility experiences.

How do autonomous vehicles fit in?

Simulations combining vehicle behavior, sensor modeling and traffic impact are still being developed, but cycle time is already much shorter. Millions of alternatives can be tested during the design phase: driving on wet or dry roads, during the day or at night, with or without cyclists on the road, and so forth. Autonomous cars will be here soon and will be safer than cars with humans at the wheel. And computational power will be used to design the best components by applying new performance criteria.

Does that mean optimizing the design of the various components that make up a car?

We can halve a component's mass simply by optimizing its design, which increases energy efficiency and lowers production costs. These organic-looking parts, which are too complex to mold or process, can now be produced using additive manufacturing and 3D printing. This approach will completely disrupt the automotive value chain. Intellectual property will now lie in the digital design of the car, which can be built anywhere, and customized as never before. It sounds like science fiction, but it isn't. It's the future of car-making. And it's starting now.

> The traditional industry silos are breaking down. Platforms are enabling the value chain to be redefined.
>
> **Olivier Sappin**
> VP of Transportation & Mobility, Dassault Systèmes

WE
ARE
WHERE...

Personalized medicine, encompassing genomics as well as individuals' behavior and lifestyle, is giving rise to a new approach to health care. Patients, interacting harmoniously with technology, are at the center of a collaborative network including health care professionals and manufacturers.

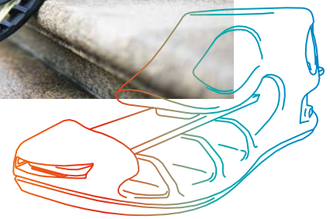
CARE BECOMES PERSONALIZED

USING VIRTUAL TECHNOLOGY
TO IMPROVE HEALTH IN THE REAL WORLD

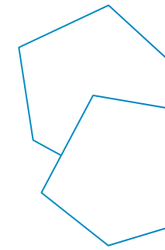
The combination of nanotechnology, biotechnology, information technology and cognitive science – known as "NBIC convergence" – is leading to new advances in the fields of molecular medicine, synthetic biology, personal genomics and service robots.

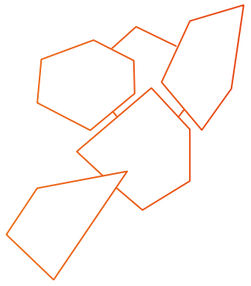
Regenerative medicine and cell therapy, fetal surgery, implants and artificial organs, next-generation prosthetics, sensors and portable medical devices, enhanced collaboration within medical teams and the creation of care networks: all of these advances represent a new way of understanding illnesses, patients and medicine in general by treating each patient in an individual way. Personalized medicine and targeted therapies make up a new approach that harnesses the power of virtual technology.

By using a digital twin of a patient, medical teams can work together, carry out surgical planning and test new therapies. New technologies are giving them new discovery methods but also new training tools, because research and teaching go hand-in-hand in the most cutting-edge disciplines. Collaborative platforms also allow dialogue between the therapists and patients themselves, opening up new avenues for patient-therapist relationships. The platforms allow patients to be better informed and help ensure greater consistency in the health care system. In this way, humans are augmented by technology, but also by other humans.



One simple measurement is all that is needed to adapt and print an enlarged model of the prosthesis very quickly.





37 to 50
million people in the world need a prosthetic device.(1)

78%
of people believe that customized prostheses will be commonplace by 2030.(2)

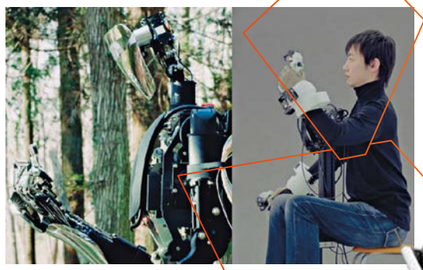
(1) Source: Mecuris
(2) Source: Frost & Sullivan

GROWING IN HARMONY WITH YOUR PROSTHESIS

Even the best treatment is worthless if it is not accepted by the patient. In the field of orthopedics, the central issue is to allow people with prostheses to lead an absolutely normal life by accepting their prosthesis. This is explained by Manuel Opitz, CEO of Mecuris, a Munich-based company specializing in the design of custom-made prostheses and orthoses designed around a 3D printing platform. This is the story of Emma, a little girl born without a left foot. When she met the Mecuris teams with her parents, she explained that she could not find a prosthesis which was adapted to her size. Mecuris then decided to use its adult prosthetic foot model which, because it is digital, is very easy to reduce in size, taking into account certain limitations such as the minimum thickness required by the materials used.
The prosthesis needs to be sized and adapted to her physiological needs, but the essential thing is for Emma to accept it. Mecuris' teams then asked her for her favourite colour and animal. Emma loves her new pink foot which is decorated with horses, and now lives like any other little girl her age. She goes to kindergarten, runs, dances and jumps in the puddles. She has much more self-confidence, and is now complimented rather than pitied for her foot, with some of her playmates asking their parents for "a pink foot like Emma." Last but not least, the prosthesis can grow with Emma: based on the digital model, all that is needed is to measure a dimension, for example the length of her foot, to adapt and print a slightly enlarged model very quickly. And as Emma's tastes are also changing, she has asked that the new version be blue.

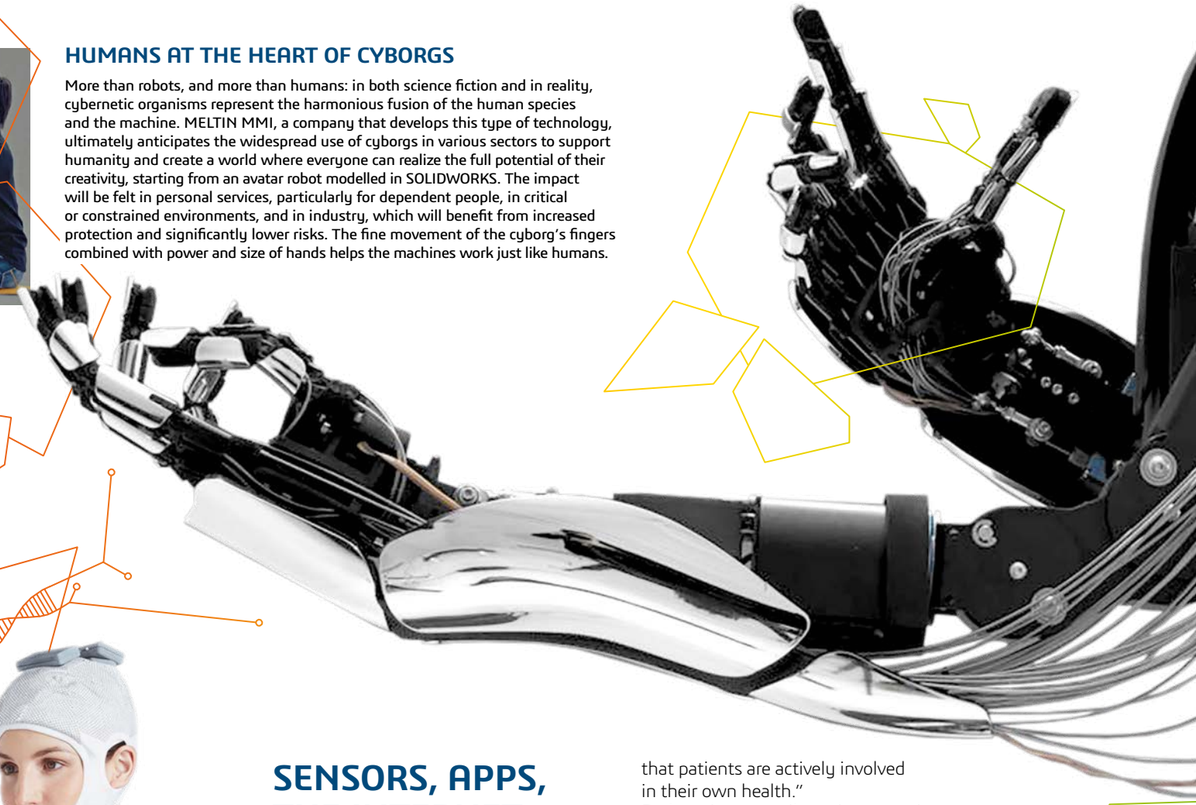
A BEATING HEART

On November 26, 2018, La Fondation Dassault Systèmes won the Corporate Social Responsibility prize in the Franco-British Business Awards. This accolade recognizes La Fondation's support for a project involving Great Ormond Street Hospital (GOSH), a children's hospital in London, and University College London (UCL). The 3D CARE (3D CArdiovascular Research and Education) project is exploring the possibilities provided by virtual reality to advance our understanding of cardiac morphology in the fetus and in newborns. In particular, it aims to create tools that make it easier to understand the complex systems that exist within each patient. An app has been developed, and both students and medical and surgical teams are using it to work on virtual **3D**EXPERIENCE twins of hearts that, in the physical world, measure only 5-15mm across. These digital models of real hearts are also used when talking to families, helping medics explain the complex structures hidden inside the body. As a result, the app helps to reduce stress among parents.



HUMANS AT THE HEART OF CYBORGS

More than robots, and more than humans: in both science fiction and in reality, cybernetic organisms represent the harmonious fusion of the human species and the machine. MELTIN MMI, a company that develops this type of technology, ultimately anticipates the widespread use of cyborgs in various sectors to support humanity and create a world where everyone can realize the full potential of their creativity, starting from an avatar robot modelled in SOLIDWORKS. The impact will be felt in personal services, particularly for dependent people, in critical or constrained environments, and in industry, which will benefit from increased protection and significantly lower risks. The fine movement of the cyborg's fingers combined with power and size of hands helps the machines work just like humans.



5<15 mm

3D CARE allows researchers to model virtual twins of hearts in newborns and fetuses that measure only 5-15 mm across.

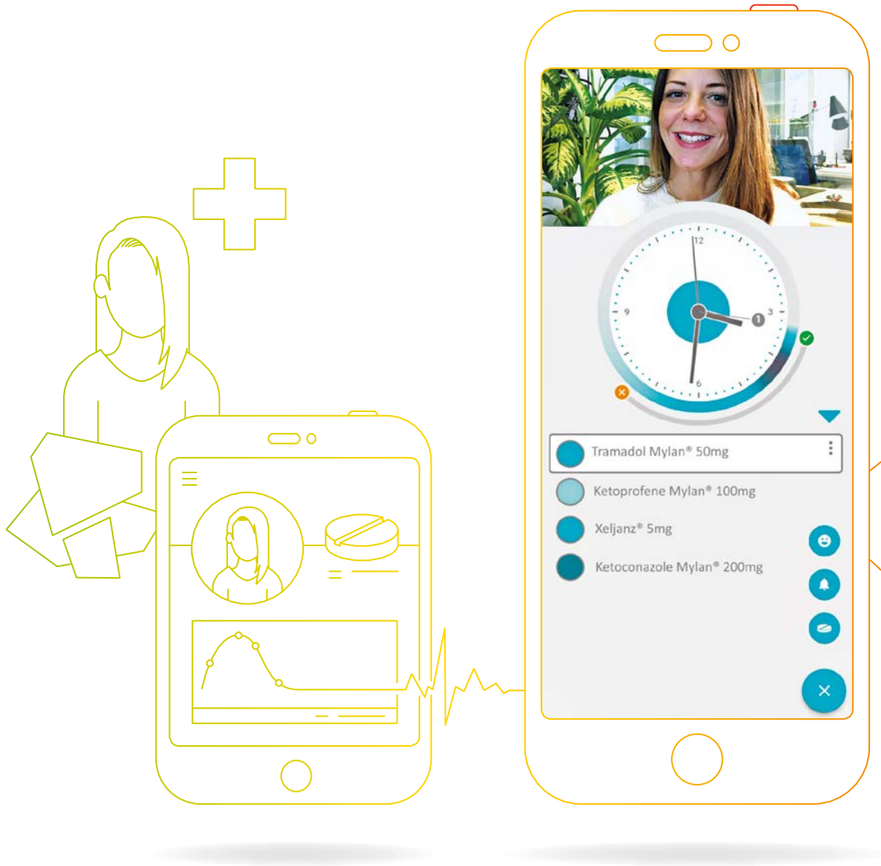
Source: Great Ormond Street Hospital

SENSORS, APPS, THE INTERNET OF THINGS AND A MEDICAL TEAM TO HELP PEOPLE LIVE BETTER

For patients with chronic illnesses, the main aim is to have the best possible quality of life while living with their disease. "This is where virtual universes, by making patients the focal point, can make all the difference," explains Marc Frouin, COO of Bioserenity and a qualified engineer, who describes himself as a designer of experiences. "Technology and computing power are important, but the key lies in the interaction between the care provider, the family and the patient, and the fact that patients are actively involved in their own health."

Patient data are adjusted constantly depending on the illness, the time of day, the time of year, the treatment regime and how closely patients adhere to it. To collect all of that information, Bioserenity puts sensors into bodysuits and other wearable items. Its first system, designed to monitor patients suffering from epilepsy, consisted of a cap and underwear. The second, used to diagnose heart problems, included a small, flexible and flat wearable computer, instead of heavier systems involving cables plugged into a fixed system, while still featuring a large number of sensors.

In the next stage of its development, Bioserenity is working with pharmaceutical companies with the aim of developing dynamic treatments by 2022. Continuous monitoring will provide doctors with a large amount of visual and quantitative information, enabling them to determine more accurately the type of treatment to prescribe, adherence, dosage and side effects.

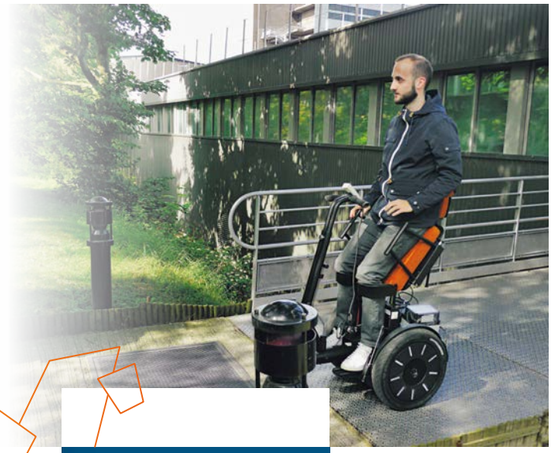


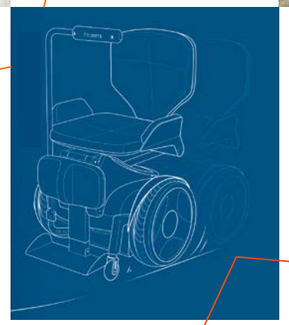
PERSONALIZED MEDICINE: A DIGITAL TWIN

How long will this medicine take to work for me? When will it reach maximum efficacy? Can I reduce my dose? How much of the active ingredient is currently in my blood? ExactCure aims to answer these questions by creating a digital twin of the patient to model the effects and interactions of drugs in the individual's body, thus helping to achieve a more personalized form of medicine.
The solution involves a mobile app that uses patented artificial intelligence models.

The digital twin has exactly the same characteristics as the patient: weight, sex, age, current treatment, etc. The avatar takes the medicine first. On the patient's smartphone screen, a clock shows when the medicine will take effect and when it will no longer be active. ExactCure, with the support of Dassault Systèmes' **3D**EXPERIENCE Lab, enables patients suffering from chronic illnesses to estimate how long their medicines will have an effect, which is vital information in helping them to lead as normal a life as possible while taking long-term medication.
"We have gone from a product-based model to a workflow and process-based model."

79 %
of people believe that wearable medical devices will have a considerable impact on the management of their health by 2030.
Source: Frost & Sullivan





GYROLIFT: A NEW EXPERIENCE OF GETTING AROUND **FOR PEOPLE WITH REDUCED MOBILITY**

Gyrolift is a mechatronics startup supported by Dassault Systèmes' **3D**EXPERIENCE Lab. Its product, also called Gyrolift, is an innovative mobility solution that incorporates a gyropod and a robotically adjustable seating system. For wheelchair users, the ability to move from sitting to standing gives them a new experience of mobility, allowing them to move around in an entirely safe way, both seated and standing up. But Gyrolift is an inclusive solution that is not just intended as a disability aid or medical device: it can be used for any mobility application that requires assistance, and offers unprecedented comfort.
Its adjustability means that users can access small spaces, and its gyroscopic technology gives it an impressive battery life and range. In addition, because it can lift users into a vertical position and has an innovative appearance, it overcomes the stigma sometimes felt by wheelchair users. It allows better social interaction, particularly by making it easier for users to remain or re-enter employment. It is also particularly well suited to repetitive, demanding work, without in any way limiting the user's agility and adaptability.
"At Gyrolift, we wanted to develop a solution that addresses the needs of people with physical disabilities and reduced independence, but one featuring a modern design that doesn't stigmatize users or pigeonhole them as disabled, and one that can meet the needs of everyone, including people without disabilities."

At Gyrolift, we wanted to develop a solution that addresses the needs of people with physical disabilities and reduced independence, but one featuring a modern design that doesn't stigmatize users or pigeonhole them as disabled, and one that can meet the needs of everyone, including people without disabilities.

DIGITAL HEALTH
AS AN EXPERIENCE

GE Healthcare's Global Design team brings together designers and researchers studying innovation, technology and social behavior. The team started out designing medical equipment but then broadened its scope to designing spaces, then patient and medical staff experiences. Interview with Marie Bachoc, Design Thinking Program Manager, GE Healthcare.

What kind of behavioral innovations are you working on?

One example would be our efforts to create a natural relationship between patients and hospitals. Patients who don't have a connection with hospitals are less likely to go there and less inclined to take a proactive approach to their health. We're looking at the processes taking place in all stages of a hospital visit, and we're trying to remove the friction that patients can encounter. The journey from home to hospital, check-in, hospital stay, discharge and return journey home are phases that can connect in a fluid way. A natural relationship also involves providing users with useful, contextualized information.

For example, virtual reality can give patients an active understanding of medical procedures, help to explain a diagnosis and tailor the way information is conveyed depending on their age, culture and where they live.

Where healthcare resources are located and how to access them are important aspects of the care pathway

Absolutely! The idea is to ensure that healthcare can be accessed everywhere. We are seeing many innovations in the fields of remote medicine and connected accessories. A few years ago, we designed an innovative and portable ultrasound solution called Vscan, and we are continuing to explore solutions to make healthcare much more mobile and accessible. To complement those initiatives, we are working on geolocation within hospitals, so that patients know exactly where they need to be and at what time. It is also important to rethink a hospital's spaces, organizing more efficient, integrated care pathways that are suited to specific complaints, so that all the necessary examinations can be completed in one day. This would reduce waiting times, including time spent waiting for results, which is generally a source ofanxiety for patients.

When we talk about the care pathway, we think about how specialists dealing with a patient work with each other...

This relates to collective intelligence and how we can use the power of communities and data. A digital twin of the patient, featuring all of his or her history and medical data, could be accessed remotely by the medical team and the various specialists at all times. We can imagine something similar for a piece of equipment. This would be a good way of knowing exactly what the status of a device is and how it could be improved. All data collected from these digital twins, all that augmented intelligence, could form the basis of predictive models and provide assistance with clinical decisions. The data can be collected from numerous sources.

79%
of people believe that diagnostic at-home applications will have a considerable impact on the management of their health by 2030.
Source: Frost & Sullivan

Marie Bachoc
Design Thinking Program Manager

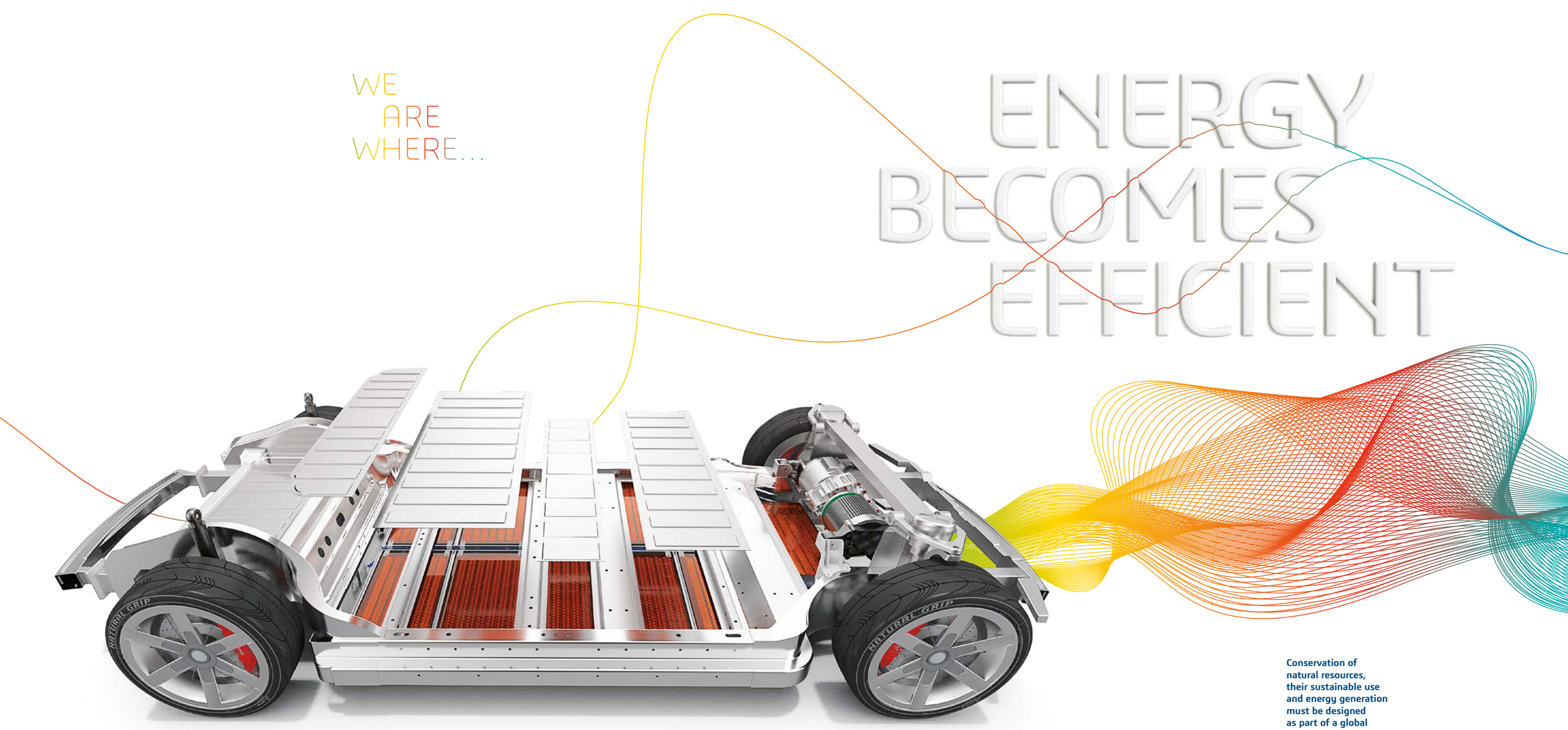
> We're looking at ways of using virtual reality to give patients a more active understanding of medical procedures.

Doesn't that raise confidentiality issues?

Of course, because personal data is highly sensitive. But by ensuring that it's anonymous, we can create a marketplace where data can be shared and transferred or even bought and sold by participants in the medical industry. We need to understand the context in which the data has been generated before we can use them, but we don't need to know who it relates to. Anonymity would therefore allow us to use this data as a source of knowledge and expertise. These are some of the promising areas in our view. Basically, we have gone from a product-based model to a workflow and process-based model. The solutions we are developing are increasingly inclusive and collaborative, because they are used by both patients and medical staff. We aren't the only ones moving in that direction, and that's good news! There are a lot of opportunities to improve the experience of patients and caregivers within hospitals.

WE
ARE
WHERE...

ENERGY BECOMES EFFICIENT



Conservation of natural resources, their sustainable use and energy generation must be designed as part of a global ecosystem. But sustainable responses need to fit into the local context and environment.

PLAYING A PIVOTAL ROLE
IN SUSTAINABLE DEVELOPMENT

A transition towards low-carbon manufacturing, the depletion of natural resources and the destruction of ecosystems mean that mining and other energy-intensive industries have a pivotal role to play in sustainable development. To bring a more unified response to these crucial issues, Dassault Systèmes now addresses the Energy, Process and Natural Resources industries through its Energy and Materials business. It provides three categories of solutions.

The first covers solutions for managing the life cycle of major infrastructure. These solutions guarantee that consistent business processes are applied when managing chemical plants, refineries and nuclear power plants. The **3D**EXPERIENCE platform ensures digital continuity through governance, engineering, construction, operation and decommissioning solutions. This was the basis of the agreement signed by EDF, Dassault Systèmes and Capgemini in June 2018 to guide EDF, France's leading electricity company, through the digital transformation of its nuclear engineering businesses. Under this 20-year partnership, the **3D**EXPERIENCE platform will help standardize, harmonize and upgrade processes and engineering methods. For example, it will design digital twins of nuclear plants, whether they are in the design, construction or operational phase.

The second area of solutions concerns the life cycle of geological assets. Dassault Systèmes provides solutions to optimize the life cycle of oil and gas fields and mines, from exploration through the various stages of operation to closure. The third area involves optimizing the life cycle of materials (alloys, composites, plastics, coatings, etc.) and chemical formulas. These solutions help customers research and develop new materials from the earliest stages, qualify and formulate them, and perfect their production processes. The **3D**EXPERIENCE platform is also essential in guaranteeing compliance and in safeguarding and passing on knowledge.

One way of achieving sustainable development is to increase the use of renewables in the energy mix. But the major drawback with wind and solar power is that they rely on the availability of wind and sunlight, over which we have no control. As the proportion of renewable energy gradually increases, energy storage will be the key to developing dependable ways of ensuring a continuous power supply. Meanwhile, electric vehicles will be developed on a massive scale. By offering users attractive pricing deals, electricity grid operators will take some of the power in their batteries during peak load periods and store it, or use it to manage peak demand. This is undoubtedly where the real electric energy revolution will take place. And innovative, sustainable and affordable materials will get us there.

Efficient motorization for electric vehicles

The future of sustainable mobility depends largely on the development of electric vehicles. What technology should be used for their motorization? There are three main options: fuel cells, internal combustion engines coupled to electric generators and power from battery accumulators. For Dr. Menahem Anderman, founder of Total Battery Consulting, "Lithium-ion batteries have always been the technology of choice for battery electric vehicles (BEVs). Their high energy density, durability and acceptable operating temperature range make the solution very appealing." The range of these is the key. The most efficient vehicles now approach a range of 500 km (311 miles). The challenge is to expand that distance so BEVs are no longer restricted to urban metropolitan areas – increasing

> "Producing renewable electricity, and using the batteries of millions of electric vehicles to store and release it, will soon be entirely commonplace."
>
> **Thomas Grand**
> Vice President,
> Energy and Materials,
> Dassault Systèmes

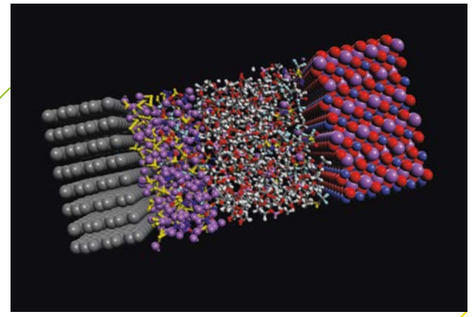
the range while reducing charging time, because no one wants to stop for an hour to recharge their battery, even if they're driving 1,000km. Improvements in batteries must take into account multiple variables: lower costs, increased volumetric energy density, improvements in charge acceptance rate – while respecting lifetime constraints, ease of manufacture and safety, and ecological requirements from extraction through to recycling. The study of new materials is one way of aligning these constraints. In a lithium-ion battery, the electrodes contain an active material such as graphite or a mixed metal oxide, combined with a polymeric binder, and the electrolyte is a complex formulation of organic and organometallic materials. In the course of charging and discharging the battery, many reactions occur, leading to a change in the underlying chemistry of the battery, which can eventually lead to failure.

Reducing prototype costs

One way to improve energy density and safety is to replace the organic liquid electrolyte and polymer separator with a non-combustible solid electrolyte. Different approaches are in development: polycrystalline metal oxides and sulfides, glass-based metal oxides, polymer electrolytes, gel electrolytes, as well as combinations of two or more of these options. "Batteries are complex material systems," explains Anderman. "Modeling and simulation can be very useful in discovering new material options and reducing the time and cost of physical prototyping. This is where Dassault Systèmes, through its BIOVIA brand, may have a role to play."

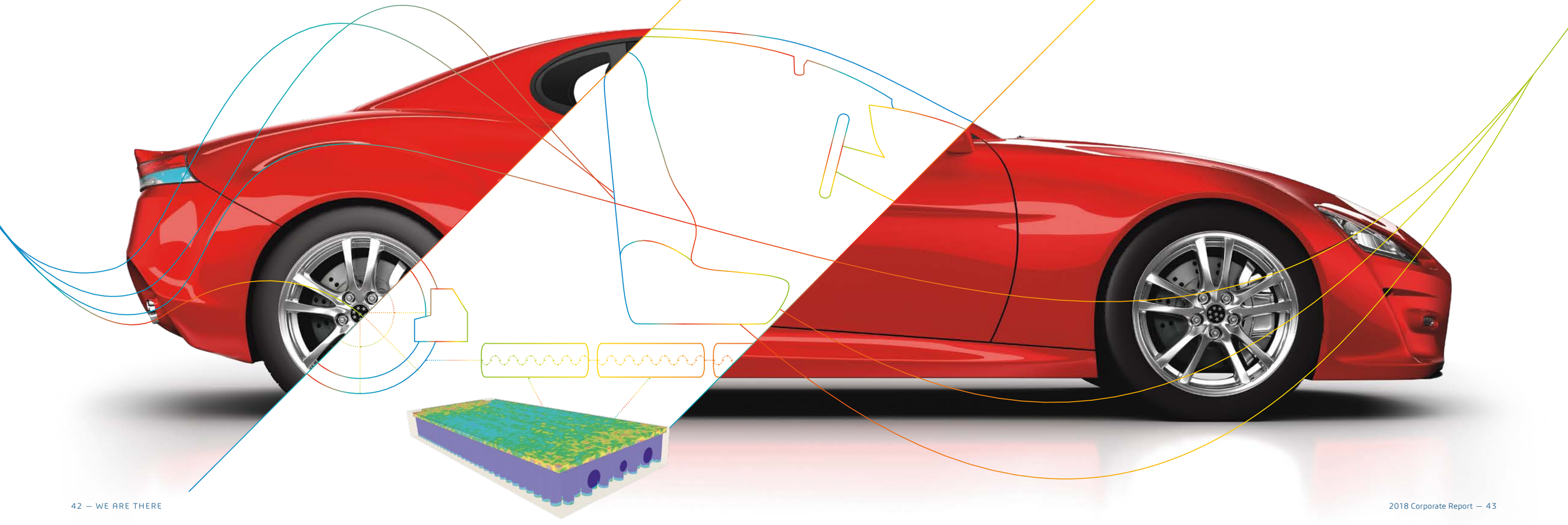
BIOVIA Materials Studio is an integrated suite of tools that helps researchers understand the properties and behavior of materials at nanoscale. Special additives are included, for example, to modify the properties of an electrolyte. Molecular dynamics are applied to model the diffusion of lithium ions in different formulations, which can be directly related to the conductivity of an electrolyte. Electrolyte simulations also allow understanding of why conductivity changes

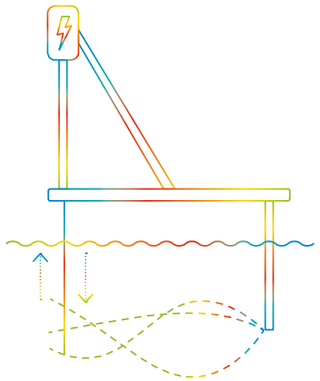
BIOVIA modeling capabilities facilitate material exploration and accelerate innovation.



depending on the formulation. Examination of the precise movement of lithium ions reveals the impact of the local environment on diffusivity, which facilitates the definition of design rules for the development of new additives. The modeling tools provided in BIOVIA Materials Studio, therefore, enable engineers to explore a vast range of potential materials, understand their behavior and select the best option. The use of these tools, based on traditional simulations, but also on quantum mechanics, accelerates the development of the next generation of batteries needed for the success of future electric vehicles.

The development of new materials goes beyond the limits of lithium-ion technology. To recharge a battery first requires production of electricity. Sustainably producing such energy is a major challenge. The seas and oceans play an increasingly important role in renewable energies. Although the first wind turbines were installed on land, it is at sea that wind turbines can reach their full potential, as offshore winds are stronger and steadier than on land. Originally located in shallow waters, wind farms are increasingly being moved further offshore. Hydro turbines are less mature





in terms of technology, and use the power of permanent or tidal currents to harness an equally renewable, but more predictable, energy source.
In addition, CATIA and SIMULIA solutions complement the molecular aspect of battery engineering to ensure digital continuity, not only in terms of researching new materials but also researching all systems – from propulsion to the entire range of mobility logistics, including the vehicles themselves.

Harnessing the power of tidal currents

French startup EEL Energy develops next-generation tidal machine prototypes that could revolutionize the way alternative energy is produced. The company is aptly named: designed without a turbine or propellers, the machines feature a fiberglass or polymer membrane that, like an eel, undulate under the water with the tidal current. Several models are under development in different shapes or adapted to a specific aquatic environment. In the marine version, the power generators are located on the membrane. The river version has a mast that triggers a generator outside the water. Compared with other sources of renewable energy such as wind and solar power, this solution offers greater predictability.
EEL Energy is developing and testing its river prototypes in the reservoirs of the Ifremer oceanographic research institute, and its tidal prototypes off the coast of Brest in northwestern France, with the support of Dassault Systèmes. Digital simulation is used to avoid errors, reduce testing costs and optimize design. The membrane is submerged virtually to measure performance, practicality and profitability before it is physically produced. Thousands of variations of virtual prototypes can be tested on a computer in the time it would take to build just one physical prototype.

Respecting the ecosystem

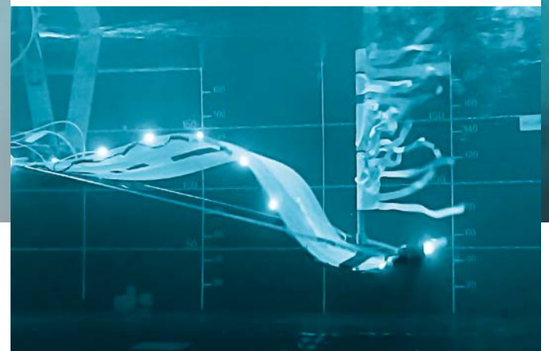
Different models of membranes are available, ranging in size from 0.8 m for test prototypes to 1.6 m and 2.6 m for small 2-3 kW retail models, and up to 5 m for a 30 kW version developed and tested in late 2018. A 10 m, 100 kW model is being developed for 2020, and after that, possibly a 16 m, 500 kW machine.
Admittedly, this is far below the power output of traditional energy generation methods, but the membrane is not meant to compete with tidal turbines, which need stronger and faster currents to operate. However, the solution is perfectly suited to places with weaker currents. Another advantage of EEL Energy's models is that they respect ecosystems. As they are underwater, there is no visual pollution. Also, tidal turbines take up a lot of space, like a dam, and have the same drawbacks. The membrane, in contrast, does not interfere with the movement of underwater life. "During one of our ocean trials, a dolphin came to play with the membrane," Franck Sylvain says. "The system is very gentle and not aggressive."
To promote new forms of renewable energy, the production of which is by nature irregular and unpredictable, we need to have better control over its distribution. Stationary batteries can play a key role in stabilizing grid generation and energy distribution. Storing and releasing power as needed, these batteries balance out peaks in supply and demand.

Reinventing the industry

The mining industry is at the opposite end of the spectrum from the public's perception of a gentle business that respects ecosystems. But mining is necessary, especially in the transition towards a low-carbon economy.
The electric vehicle revolution cannot take place without the extraction of mineral resources, starting with lithium, widely used in today's batteries. Through digital technology, this longstanding industry is reinventing itself, changing its image and how society views it.

Franck Sylvain
CEO of EEL Energy

> Tidal currents have been studied for centuries. We know when and how much clean energy we can produce, and the energy is predictable. That's not the case with solar power at night or when it's cloudy, or with wind power when it's nice out and there's no wind!

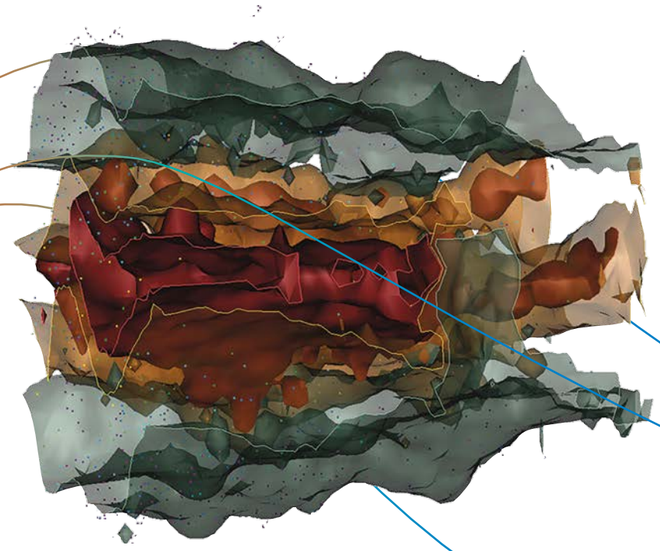


Seeing the unseen

Digital twins can be applied to many business sectors; in mining, it can be used to test, plan and optimize the full range of operations. But the parameters in mining are very different to those in other industries. Within a factory, millions of units of the same product can be manufactured, rolling out processes established when production begins. However, mining involves much more uncertainty. It is not always possible to know what will come out of the earth. The GEOVIA suite by Dassault Systèmes addresses the challenges arising in each new project. Mineral content differs not only from one mine to another, but also within a given mine. Operators have to learn, and change their plans and models, in real time. On top of that, once the resource is extracted, it cannot be put back. GEOVIA must make predictions and assumptions to provide an accurate idea of what will be extracted, which means it has to see what is currently unseen.

Changing the script in real time

The platform first creates a geospatial scene. GEOVIA draws on earth sciences, such as geology, importing point clouds developed using data collected from aerial or underground drones to produce a 3D model of underground reality as faithfully as possible, like a future film set. The initial footage shows which path to take to extract the resource from the earth and bring it up to the surface. Naturally, reality has its own rules, and the script sometimes needs to be adjusted. The **3D**EXPERIENCE platform brings together the set designers, the scriptwriters and the actors, by factoring in unpredictable data such as terrain-related constraints, mechanical failures and human error.

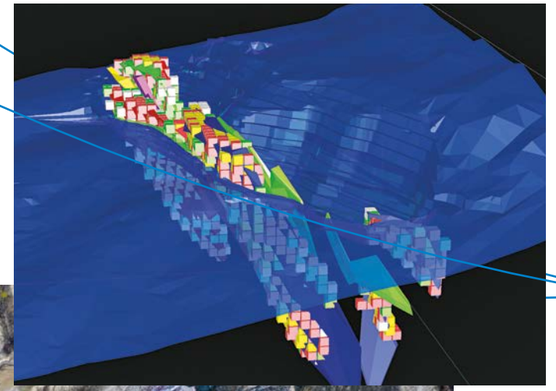


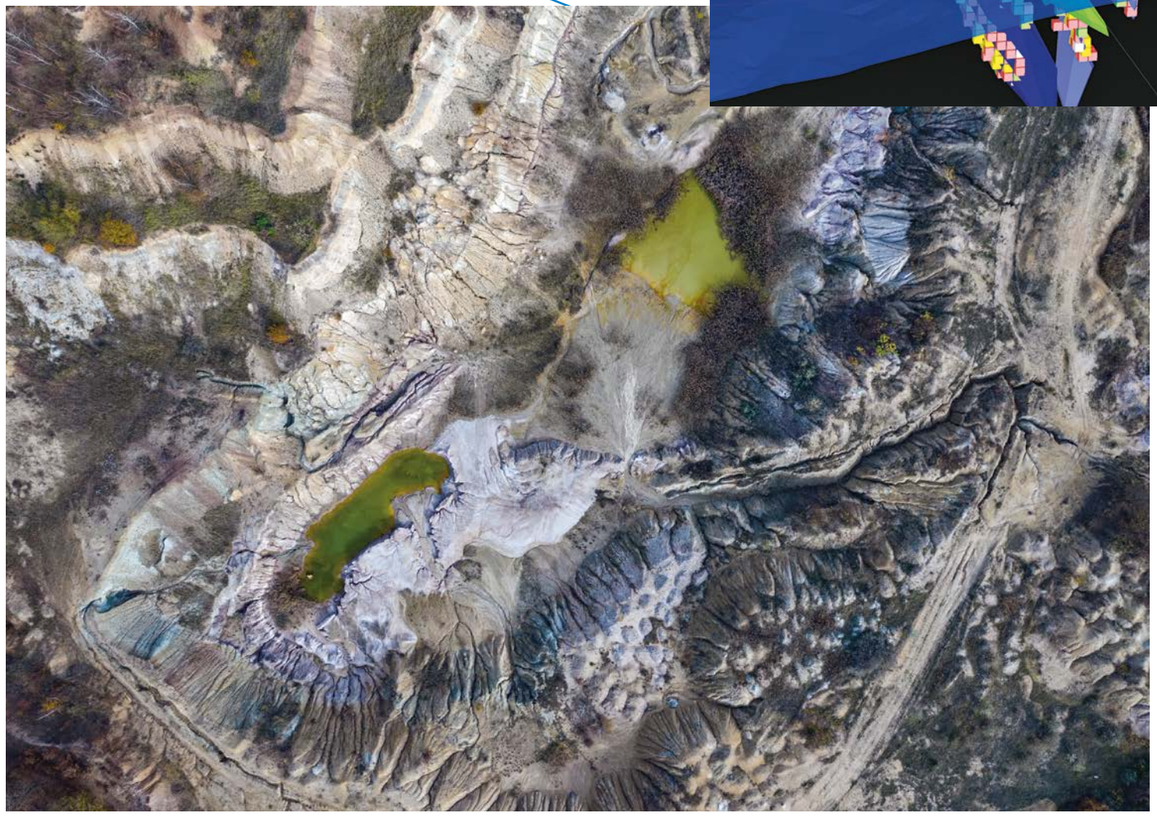
Digital continuity creates an iterative loop between those planning the work and those carrying it out, or between the scriptwriting team and production crew. But the script does not end once the resource is extracted. This is when the second act, telling the story of how the resource is processed at the surface, begins. Many more steps are involved in converting the raw ore into a substance that can be processed into a marketable product.

Sustainable mines

Creating a virtual universe, in a mine or elsewhere, facilitates sustainable development. The communities in which mining companies work can be taken into account and factored into their operations by assessing safety parameters and finding solutions to make the extraction process less invasive and less destructive. Parallels can be drawn with new techniques used in abdominal surgery. Surgeons used to make an incision, create a wide opening, perform cuts, piece things back together, close and sew up. But these days, they control a robot and endoscope with a joystick, and do not necessarily even need to be in the operating room. This provides a good analogy for mining operations. Digitalization and mathematical algorithms, governed by the rules of geology, curtail the amount of drilling necessary to identify the resource. As such, the mine's environmental footprint is considerably reduced. Artificial intelligence also can be brought into the mix to interpret data from the visual survey of the rock surface. This avoids use of explosives to blast into the rock, ferrying samples to the lab and waiting several weeks for the geochemical report to come back. Technology is faster and more accurate. Neither does it depend on subjective human judgment, thereby circumventing cognitive bias. It brings together science, nature and people.

When working in a mine, so many unforeseen events can occur that the initial plan has to be updated in real time while factoring in the impact on all stakeholders. GEOVIA makes that continuous iterative experience possible.



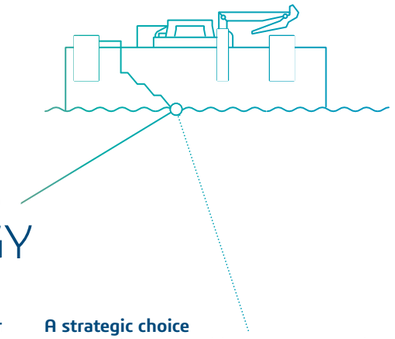


WE
ARE
WHERE...

BOUNDARIES FADE

Digital transformation is creating a new business model that is more robust, more agile and capable of reinventing itself. Teams are using virtual platforms and spaces, collaborating and coming together both inside and outside the company. In the experience economy, subjects and objects interact as a community.

THE SEA: A BOUNDLESS SOURCE OF RENEWABLE ENERGY

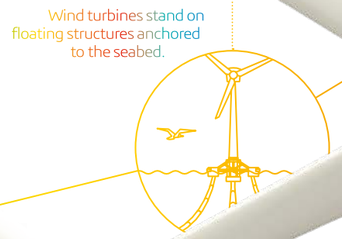


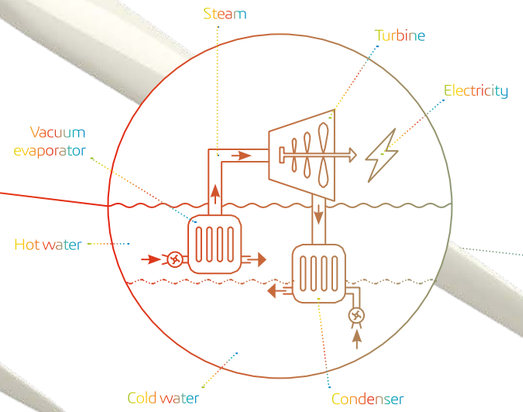
The marine industry is changing rapidly and is paying greater attention to alternative energy sources. Naval Energies is using the 3DEXPERIENCE platform to develop new offshore wind turbines and ways of recovering energy from deep sea water.

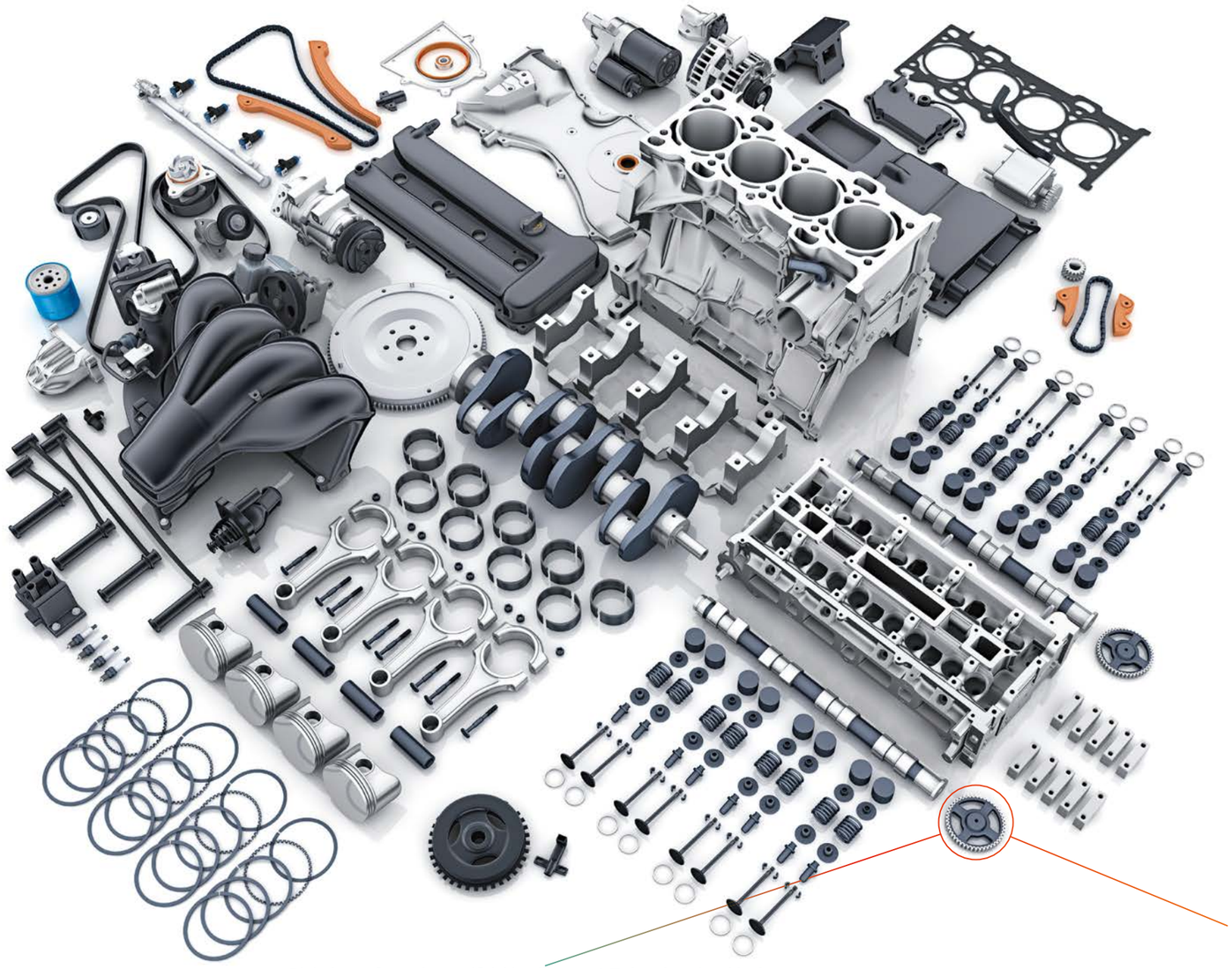
Naval Energies, which is majority-owned by Naval Group, is a leading player in marine renewable energies. It is developing systems that generate electricity from two different sources: offshore wind and ocean thermal energy conversion. Floating offshore wind farms capture energy from the wind in parts of the sea that cannot be seen from the shore, using a floating structure fixed to the sea bed by an anchoring system. The second source is deep sea water, which is brought to the surface as part of a method called Ocean Thermal Energy Conversion or OTEC. OTEC plants harness the characteristics of deep sea water for multiple applications: power generation, SWAC (Sea Water Air Conditioning), desalination, industrial cooling, ORC (Organic Rankine Cycle) and fish farming. In both of these segments, Naval Energies handles the entire product lifecycle – design, construction, installation and maintenance – and covers the whole value chain, both at sea and on land.

A strategic choice

"The sea is a renewable energy source that can help meet the needs of the world's growing population, while ensuring zero carbon emissions during the operational phase," explains Laurent Schneider-Maunoury, CEO of Naval Energies. "The **3D**EXPERIENCE platform was a strategic choice, allowing us to speed up the development of our technological solutions. Cloud-based technology has enabled us to deploy the platform and adjust the way we use it, from the design process to manufacturing and operations." Naval Energies will use the platform's Designed For Sea and On Time To Sea solutions, along with SIMULIA for structural calculations and DELMIA for marine operations. The **3D**EXPERIENCE platform will be used for program management, engineering and analysis with respect to semi-submersible floats, anchoring systems, subsea cables and connection solutions for offshore wind farms. It provides a fully secure structure within which Naval Energies can work with its network of partners, reuse and share existing expertise and reduce program development time and cost.







Digital transformation, artificial intelligence, IoT, deep learning, big data… these concepts provide opportunities for manufacturers to reinvent the way they think and operate. Laurent Bertaud, head of Strategy, Sourcing & Standardization Intelligence at Dassault Systèmes' subsidiary NETVIBES-EXALEAD, and Morgan Zimmermann, CEO of NETVIBES-EXALEAD, spoke to us about these major developments.

IDENTIFYING NEW PERFORMANCE DRIVERS THROUGH A COMBINATION OF AI AND 3D TECHNOLOGY

Interview with Laurent Bertaud, head of Strategy, Sourcing & Standardization Intelligence at NETVIBES-EXALEAD, Dassault Systèmes.

When you talk about artificial intelligence within a company's purchasing function, what do you mean?

Against a background of increasing complexity, we believe that it is crucial for the purchasing department's strategic position that it should have a say on design and engineering matters as early as possible. This involves machine learning algorithms, which are central to engineering operations, but guided by the purchasing department. The algorithms make it possible for the two functions to talk to each other, opening up new ways of enhancing performance and reducing costs.

How can a purchasing department make use of AI, in practical terms?

In the aerospace sector, AI is used to cross-reference engineering and purchasing information about existing components between different programs and production sites. It helps the purchasing department to define context-specific standards, check that they are applied properly, and optimize sourcing on a global scale. The resulting cost savings free up resources for innovation, which is vital for manufacturers.

Does the purchasing department have its own control interface?

Buyers have their own dashboard, which acts as an interface with the engineering department. Combining AI with the 3D signature of components allows purchasing staff to have a better understanding of the engineering department's requirements, analyze existing orders and identify potential cost savings and other areas for improvement.

What results are your customers achieving?

One Tier 1 supplier of aerospace subsystems estimates that it has achieved annual savings of 15 million euros (US$16.83 million)., and an industrial machinery manufacturer puts its savings at 65 million euros (US$72.9 million) per year. This shows that there is untapped potential to optimize performance compared with standard technologies. However, the sourcing and standardization phases are very hard to automate, unlike billing, for example. Manufacturers may say that they have adopted policies to improve sourcing and have tried-and-tested standardization rules, but mostly these involve manual processing on a spreadsheet. They remain dependent on the quality of data entered into an array of different systems.

So where should they start?

They need to start by connecting their engineering and financial systems globally, using 3D recognition as a universal language, and offer a simple collaboration solution. The **3D**EXPERIENCE platform and its business analytics functionality, along with the Marketplace PartSupply service, make this possible. With those capabilities, the purchasing department can strike the right balance between sales, finance and engineering. In two or three years' time, it will be standard practice for purchasing departments to use advanced analytics applications. Now is the time to adopt this technology, in order to get a competitive edge.

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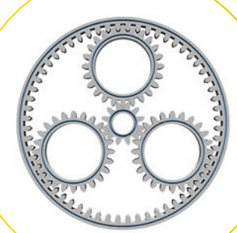
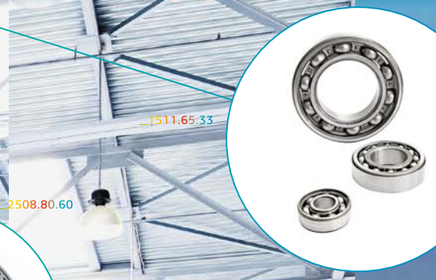




Learning from data through analytics, Interview with Morgan Zimmermann, CEO of NETVIBES-EXALEAD, Dassault Systèmes.

The "factory of the future" is a fashionable expression at the moment. What is your interpretation of it?
The factory of the future encompasses a number of buzzwords – internet, industrial, IoT, digital twin, etc. – all connected to digital transformation. Using new technologies, we can capture much more data than before.
Many companies talk about digital twins, by which they mean that they can take data from the real world and create a representation of a physical object, which could be a machine, a production line or a whole factory. Analytics and advance prediction functions then allow them to anticipate problems. However, that approach is seriously limited, because it only uses real-world data as the learning input. Without any reference base for projections, it is very hard to correlate, segregate, interpret and contextualize the data.
This is why we decided that real-world data should not be projected onto a representation of the object (a "dead" image), but onto a complete virtual model, which can be fully configured and simulated, and this is what we call the **3D**EXPERIENCE TWIN.

By reconnecting the virtual and the real worlds, we can generate infinite possibilities. For example, this allows companies to devise "What if?" scenarios and create new data for AI algorithms by simulating extreme usage conditions that are rarely, if ever, encountered in the real world.

How can data be used to support collaboration?
Twenty years ago, Dassault Systèmes made the first digital mock-up of the Boeing 777, and that became the catalyst for multi-discipline collaboration. Today, all business processes are digitalized. From program resource allocation to cost management and logistics, everything within these systems is digital.
Accordingly, analytics and artificial intelligence are providing opportunities to enhance performance and collaboration. They allow all staff members to understand how their decisions affect the company's performance (program price, production costs, logistics), and so they ensure that everyone involved in performance enhancement complies with the company's priorities.

How do you see the future of manufacturing?
Over time, manufacturing has moved from local optimization, at the factory level, to holistic optimization involving integrated operations. But the real challenge is to overhaul what we call the "Value Network." In the new ecosystems, everyone will be able to rethink entirely their contribution to the overall value chain and establish new business models. This will result in greater agility, infinite development opportunities and new ways of increasing competitiveness.
So I'm very optimistic about the future of the manufacturing sector and the companies that work in it.

JOURNEY TO
THE STRATOSPHERE

Bloostar is a revolutionary launch vehicle developed by Zero 2 Infinity to deploy lightweight satellites into low Earth orbit. The launcher will be used to build and replenish satellite constellations in an environmentally friendly and cost-effective way. After a stratospheric balloon lifts Bloostar to a height of 25 km (15.5 miles) of altitude, its rocket engines ignite and carry Bloostar to its final destination.

Established space industry leaders and new entrants, including Blue Origin and SpaceX, put satellites into orbit by launching rockets from the ground or launch them from airborne airplanes from where they are then launched. Zero 2 Infinity completely disrupts this traditional approach by dividing the ascent into two phases: first, a high-altitude balloon takes the Bloostar launcher into near space through the densest parts of the atmosphere, above 97% of the mass of air. When Bloostar reaches a near-vacuum altitude at 25 km (15.5 miles) of altitude, its rocket engines ignite and place its payload into an orbit as high as 1,000 km (621.4 miles) above the Earth's surface.

The system is sustainable because it is reusable, no pollutants are emitted into the atmosphere during the balloon's ascent phase, and a non-toxic propellant is used during the next phase. Compared to a traditional launcher, it requires fewer materials and less energy during manufacturing and operation, using simpler engines and less infrastructure to deliver a smoother launch for its cargo, all geared toward delivering a high-performance solution, particularly for the emerging microsatellite market. From providing global connectivity, to better understanding the Earth's climate, the world will greatly benefit from such new, smaller satellites.

Through Bloostar, Zero 2 Infinity aims to lower the cost of access to space and respond to changing needs in this high-growth market. Bloostar is the first launcher fully designed to take advantage the quasi-vacuum environment of near space. Zero 2 Infinity has already ignited scaled rockets in near space and a series of tests are paving the way for a first orbital trial launch, expected in 2021.

600 km (372.8 miles)
Low Earth orbit

Firing of the launcher

40 km (24.8 miles)
Upper limit of the balloon's range

30 km (18.6 miles)
Upper limit of the atmosphere

10 km (6.2 miles)
Altitude of commercial flights

7,000
small satellites should be launched within the next 10 years – **six times more** than in the past decade
Source: Euroconsult 2018

THE MICROSATELLITES MARKET TAKES OFF

The miniaturization of technology has disrupted the satellite market. Many microsatellites are designed to provide data related to Earth observation, smart city management, security and weather or emergency situations. Others are used in telecommunications or connectivity services. These satellites weigh 10-250 kg (22-551 pounds), and must be precisely positioned in orbit in order to be integrated in a constellation.

BENEFITS OF THE 3DEXPERIENCE PLATFORM

Zero 2 Infinity joined the **3D**EXPERIENCE Lab program and is using SOLIDWORKS, CATIA and SIMULIA for design and simulation. Bloostar's design fits within a large ecosystem of partners, suppliers and innovators from the space industry and beyond.

BLOOSTAR'S MAIN ADVANTAGES

Green: It is the most environmentally friendly launcher ever designed. Emissions take place outside the bulk of the atmosphere and are mainly water and carbon dioxide.

Cost: Replacing a conventional launcher with a high-altitude balloon during the atmospheric stage of the launch significantly reduces development complexity. 3D-printed parts, advanced materials and reusability are at the core of the launcher's design.

Freedom: Bloostar can accommodate larger surfaces (antennae, solar panels, radiators) than other ground-launched rockets because there are no significant aerodynamic constraints or strong vibrations.

WE
ARE
WHERE...

EXPERIENCE BECOMES REAL

Standardization is extinct. Mass personalization – the ability to design adaptable products at a competitive price – is becoming an essential way for companies to stand out. Value is no longer a function of the product itself but of how the product simplifies and improves life.

PUTTING THE INDIVIDUAL AT THE CENTER OF THE CUSTOMER EXPERIENCE

In June 2018, Dassault Systèmes acquired a majority stake in software firm Centric PLM. We spoke to Philippe Loeb, Vice-President, Home & Lifestyle, Consumer Packaged Goods & Retail Industries at Dassault Systèmes, about this new addition to the Group.

Why is the acquisition of Centric PLM important for Dassault Systèmes?

Centric PLM is a US firm focusing on providing ready-to-use solutions for companies in the fashion and retail industries. Its software allows information to flow smoothly between fashion companies and their suppliers. That's crucial in this industry; you have very little time to bring large quantities of products to market, so you need to be able to communicate rapidly and effectively. Centric PLM allows a company to develop collections more quickly and make fewer mistakes. Companies are launching more and more collections each year; this is a fundamental trend in the market. Fast fashion has consigned the traditional model, based on two or four collections per year, to the past the new pace of development means that companies must follow consumer trends, whereas in the past they were the ones suggesting or even setting the trends. Now, consumers make the decisions and the fashion icons they follow could be anyone on Instagram. To keep up, companies need to speed up their processes, and Centric PLM is the right solution to help them achieve that. That's why Centric PLM joined our group.

How does this fit with Dassault Systèmes' Home & Lifestyle business?

All consumer-driven industries are seeing a similar shift to the one taking place in fashion. Consumers want personalized experiences, so companies are offering more products with shorter life spans. They need to offer more customer experiences while ensuring consistency, which creates a new type of complexity. We're seeing this in fashion but also in home furnishings and sport, and all B2C markets will be affected, including food and consumer electronics. To manage the wide array of products and experiences on offer, companies need next-generation, easy-to-use solutions, which is what Centric PLM has developed. Its approach fits well with Dassault Systèmes' **3D**EXPERIENCE strategy.

Is that why Dassault Systemes changed the name of its Consumer Goods segment to Home & Lifestyle?

We came to the conclusion that since consumers are creating trends, major brands need to adopt a consumer-centric approach to accelerate innovation. We're no longer dealing with a model where the marketing department seeks to understand trends, which designers turn into products that are pushed toward the consumer at the end of the chain. In a consumer-centric model, companies need a new philosophy for developing products and new solutions that allow them to interact continuously with consumers. We can go further with customization, product selection assistance and connected dialogue. That's why we've relaunched our consumer goods and retail segment under a simpler name. Home & Lifestyle covers the home, lifestyle and fashion space, as well as mass consumer goods and retail, with the aim of helping companies stay in constant touch with consumers.

Have your customers already reached that level of maturity?

I think the vast majority of our B2C customers are already there. They've been using digital technology to maintain a dialogue with consumers for years and understand that consumers are also citizens who think about the way they consume and the impact caused by the products they buy. Our most advanced customers understand that we can help them, while others are still asking questions. But they all know that it's not just about communicating effectively any more; they also need to transform their businesses.

CENTRIC SOFTWARE

Centric PLM is the market-leading producer of PLM (product lifecycle management) software solutions for the fashion, retail, footwear, luxury goods, outdoor leisure and mass consumer goods industries. The company has a strong presence in the United States, France, Italy, China and Japan and is growing quickly in South Korea, India and Turkey.

THE FUTURE OF RETAIL
IS CUSTOMIZED

Since 2016, Dassault Systèmes' FashionLab incubator has been working with the Innovation Lab of ECCO to develop the first data-driven, customized shoe experience. Virtual technologies open up possibilities for extending personalization and customization to other sectors of commerce.

"*Any customer can have a car painted any color that he wants, so long as it is black,*" Henry Ford famously said in 1908 when he launched the Model T, the world's first mass-produced car. For more than a century, personalization and mass production seemed incompatible. Everything has changed, and "mass customization" is no longer an oxymoron. In collaboration with Dassault Systèmes, Danish shoe manufacturer ECCO has created an exclusive data-driven shoe-customization service called QUANT-U (quantified you). The first consumer trials occurred simultaneously at Le Bon Marché in Paris and at the Isetan department store in Tokyo early in 2019, providing consumers a glimpse into the future of retail.

Data-driven design

The shoes marketed by ECCO were presented as part of the *Geek mais Chic, le shopping du troisième millénaire* (Geek but Chic: Third millennia shopping) exhibition, an event dedicated to digital innovation and technological sensory experiments, organized in partnership with leading international brands in the luxury sector. QUANT-U was integrated with the **3D**EXPERIENCE platform to create an automated, data-driven design customization service that is deployed on the cloud and capable of generating infinite 3D models.

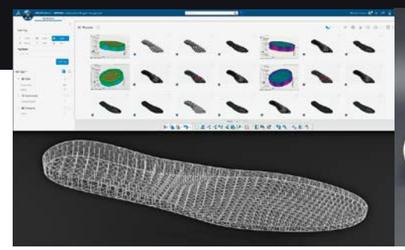
Customization is based on the 3D printing of customized midsole inserts. The midsole is a key functional component of a shoe that determines its comfort and performance. Midsoles are printed in high quality silicone using a process that allows the material to perform exceptionally well, giving 3D comfort through optimization of cushioning, stability, fit and performance of footwear.
These soles are manufactured on demand, beginning with the real-time capturing of an individual's foot contours and walking data. A learning algorithm analyzes each foot's data to develop its digital twin using the **3D**EXPERIENCE platform. Automatic learning and structural simulations generate a customized digital configuration. The structure and performance of each unique midsole is tested before it is approved and optimized for localized 3D printing, offering the consumer a unique experience of comfort and individualized performance.
This experience continues from an in-store to digital experience through the QUANT-U consumer portal. Here consumers will soon have access to their bio-mechanical data and the ability to reorder customized footwear online, without the need to recapture their data.

In 2030

81%
of consumers believe they will be using digital technologies in stores.

80%
of consumers expect to be using personalized products.

Source : Frost & Sullivan



NEVER MIND THE BOTTLE…

In October 2018 in Paris, a three-day hackathon took place to create sustainable cosmetic products. The projects encompassed the container, the content and the distribution model, bringing together customer and product, subject and object within carefully curated experiences.

The LVMH-sponsored Cosmetic Valley hackathon, which took place as part of the Cosmetic-360 trade fair in Paris from October 15-18, 2018, had the aim of bringing together students and scientists with marketing, 3D design and media specialists to come up with innovations in the body care sector. Eight teams with a total of 47 people took part. All teams used the **3D**EXPERIENCE CLOUD platform, including NETVIBES to identify social trends and CATIA Design to develop ideas for their products, design them and prepare them for production. At the end of the project, the containers they designed were 3D printed, giving physical form to the teams' ideas.

Connected bottles

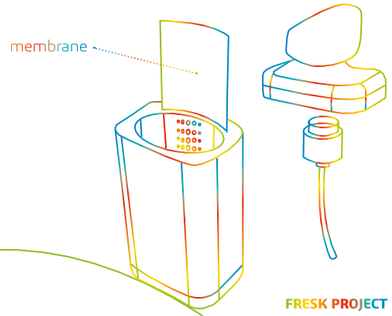
The winning project, entitled JUNE, was devised by a startup called Petites Essentielles and was no fluke. The team held 700 meetings, visited 200 pharmacies and consulted approximately 100 experts. Its findings show that 90% of people want more natural ways of meeting their health and beauty needs and would like to make greater use of aromatherapy and essential oils. The problem is that people don't know enough about the oils' therapeutic properties to be able use them in an entirely safe way. June's solution is "a new cosmetics experience" based on accurate analysis that takes into account each person's preferences and medical history, resulting in a personalized, ready-to-use product that is delivered to customer's door. Central to the concept is the JUNE connected bottle, made from glass and recycled aluminum, which provides a personalized analysis through a microbalance and a computer chip, combined with a mobile app. The bottle sends notifications to users about the daily amount of product they can use.

The bottle's design is heavily inspired by nature. Its shape is inspired by the flower of the magic dogwood, a plant that symbolized protection for the Cherokee people, a Native American tribe that thrived in portions of what is now the United States.

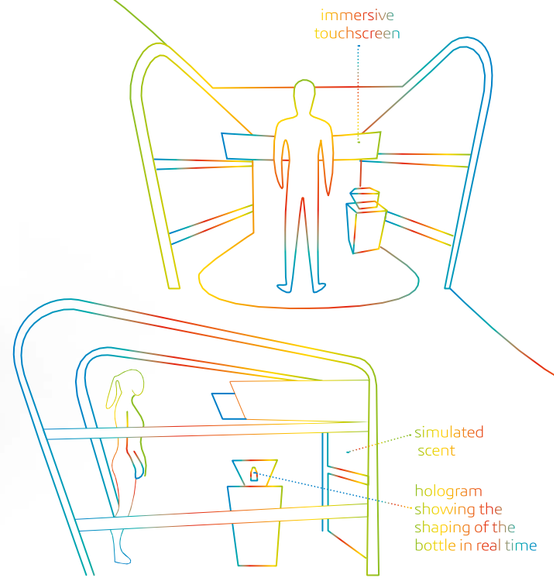
Like a fine wine

The Fresk project won the jury's special award for its living fragrance concept. Fresk seeks to reflect each user's personality, complexity and authenticity through fragrance. A 3D-printed membrane consisting of natural fibers allows the fragrance to mature over time, like a fine wine. The bottles are displayed in store in cabinets made of wood and recycled materials, which can be easily dismantled. When visiting the store, users complete a digital questionnaire, stating their habits, tastes, opinions and values. A simulated scent suited to their personality is then produced. Finally, they are presented with a set of digital images from nature, which they use to select the shape of their reusable bottle. The bottle is then 3D-printed with two possible finishes (walnut or granite). With all due respect to Musset, who famously said "never mind the bottle, as long as you're intoxicated," the former is now just as important as the latter.

JUNE PROJECT



FRESK PROJECT



MAGIC DOGWOOD
(cornus florida urbiniana):
this plant is highly prized for its large leaves and especially its white bracts – modified leaves in the shape of a flower – that clasp together to create a shape reminiscent of a Chinese lantern.

FROM LIFECYCLE
TO THE CYCLE OF LIFE

Designing the mobility of the future means adopting a sustainable approach that takes into account the whole product lifecycle. It also means putting people at the heart of vehicle design, to provide new experiences and reinvent the way people use vehicles. During Dassault Systèmes' Design for Life conferences – part of Milan Design Week 2018 – the heads of design at two of the world's leading carmakers explained their approach. Excerpts from their talks are presented here.

THE RISE OF ECOMATERIALS
Kenaf (*Hibiscus cannabinus*) – also known as Deccan hemp, Guinea hemp and Java jute – is a fast-growing plant. Like flax and hemp, the intrinsic qualities of its fibers and its positive carbon footprint mean that designers are making increasing use of it in the fields of architecture and furnishings.

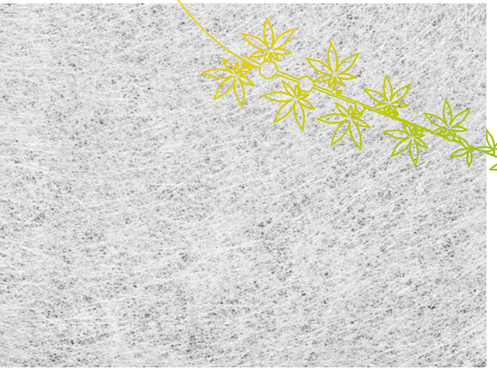
Adopting a holistic view of the product

"When we talk about design, customers tend to think only about the aspects they can see. But when sustainability comes into play, we also need to take into account the hidden aspects of design. What processes are involved in making the product? Wha materials are used? It's not just about designing a car; we need to adopt a holistic view of the product. We started to do this for the first time with the BMW i3, an electric city car. We worked on the materials used, the logistics chain, the production method and end-of-life processing, calculating the carbon footprint at each stage of the product lifecycle. In our recycling center, where we recover materials and put them back into the circular economy, we are seeing that electric mobility is creating new challenges. This is why end-of-life processing needs to be factored in right from the design stage. We don't just need to think about how a car is dismantled, but also how the various materials are interconnected. The whole design process needs to be rethought, a major cultural change that must be driven by the company's head management.

Embracing disruption

How can we improve a product's carbon footprint? First, by reducing; if we don't manufacture it, it has no carbon footprint, which also explains the appeal of using recycled materials. Reducing weight is also attractive for two reasons. If we use less material in the manufacturing process and also during the vehicle's life, fuel and electricity consumption is reduced because there is less mass to move. However, to really change the paradigm, we have to embrace disruption and not just improve what we already have. If we want to design something radically new, it's much easier to start from a blank slate. So for the i3's dashboard we used kenaf, a plant that belongs to the jute family, and this considerably reduced the car's carbon footprint. That decision was the result of a collaborative, iterative approach involving our design, supply chain management and lifecycle analysis departments."

Daniela Bohlinger
Head of Sustainability in Design, BMW Group



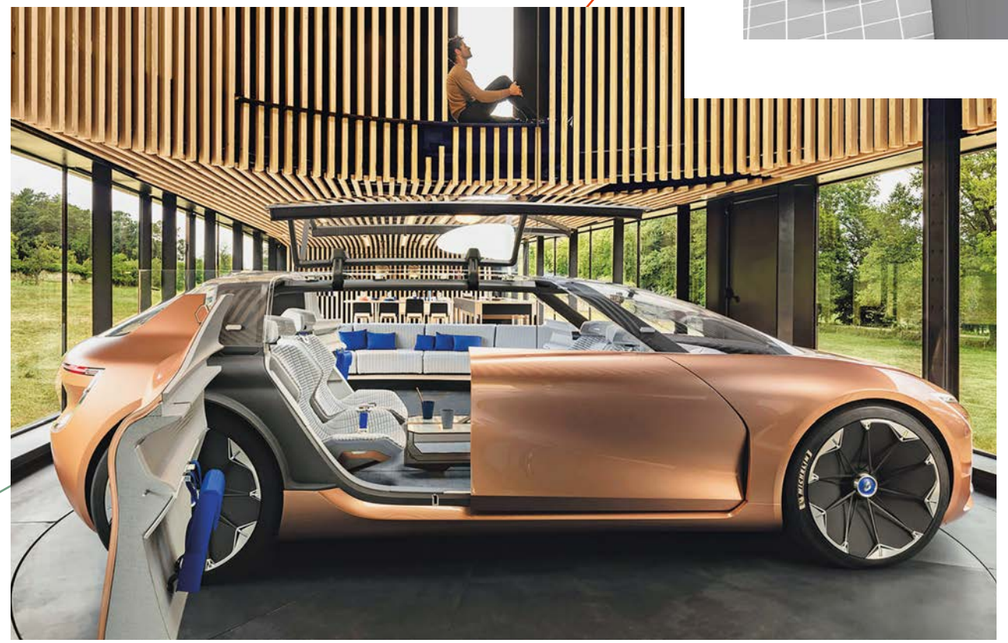
A more autonomous, electric and connected world

The design strategy is very important because it conveys a company's brand values, what the company really wants to be. At Renault, people are at the heart of our vehicle design and we aim to ensure that the types of vehicles we produce connect with the changing needs of drivers. This is what we call the cycle of life.
Two of our concept cars demonstrate this approach. The first, Symbioz, reflects an integrated approach to personal mobility in which the car is part of your ecosystem, just like your home, your smartphone and all the other objects around you. The car connects and shares information, but also can exchange energy to recharge itself or other devices. Symbioz takes us into a more autonomous, electric and connected world. It also revolutionizes the way a car is used. You can choose either to drive the car or be driven. If you switch to fully autonomous mode, the steering wheel moves back and you can use the screen to watch a film. The car becomes a sort of lounge on wheels, almost an extension of your home!

Connected to the city

The second concept car is designed as a service. It requires no driver, has no steering wheel or pedals, and you can arrange to be picked up via your smartphone at any time. This is uncharted territory. Is a driverless car still a car? Is it a piece of architecture? Or is it a part of the city on four wheels?
The vehicle is based on an electric platform, on which several variations are possible. It is autonomous, using LiDAR, radar and sensor technology to ensure a constant connection with its environment. Because it is self-driving, it opens up mobility for the greatest number of people, and it has been ergonomically designed to make it easy for anyone to use. For example, you don't need to bend down to enter the car; you enter from the front. Inside, the environment is highly social. There's no need for screens because passengers have their smartphones, but the car is transparent and melts into the city. It's possible to imagine this vehicle becoming as iconic as the London black cab or the New York yellow taxi.
We don't pretend that we have all the answers when it comes to the mobility of the future: these concept cars are an opportunity to foster debate, to experiment, and even to make some mistakes. This open, free and bold approach to the mobility of the future is intended to broaden the scope of what is possible, and to help us design a better way of living.

Laurens van den Acker
Senior Vice President,
Corporate Design, Renault



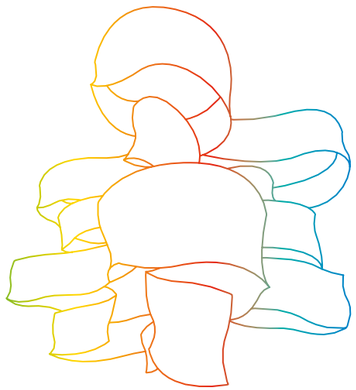
IDEAS IN 3D

CATIA Natural Sketch Virtual Reality allows designers and engineers to design directly in 3D and interact with their ideas in a virtual reality environment.

CATIA, the iconic CAD software package that was the starting point for Dassault Systèmes around 40 years ago, is constantly being reinvented. With Natural Sketch VR, it now enables designers in the automotive, aerospace and consumer goods sectors to create 3D sketches with the help of virtual reality.
Natural Sketch VR is a very simple design package: brushes can be customized according to thickness and opacity, and designers work with a palette of predefined colors and a color wheel.
3D sketches and drawings created in Natural Sketch VR can then be reused in CATIA.
Natural Sketch VR opens up new ways for designers to unleash their creativity.
It gives those unfamiliar with CAD packages an easy way to express their ideas in an immersive environment. It provides a space where designers can freely create 3D sketches, increasing their productivity.
Natural Sketch VR is also a new collaboration tool, a space where design teams can think, develop common solutions and make decisions together.

WE
ARE
WHERE...

MATERIALS TAKE NEW FORM



The experience economy is a new approach to seeing the world, learning, designing, inventing, producing and doing business: It's a way of putting people back at the center of the ecosystem where art, industry and technology interact.

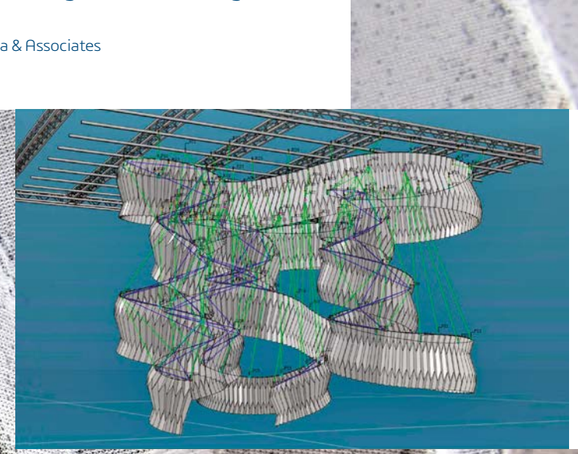
WHEN ART PURIFIES THE AIR

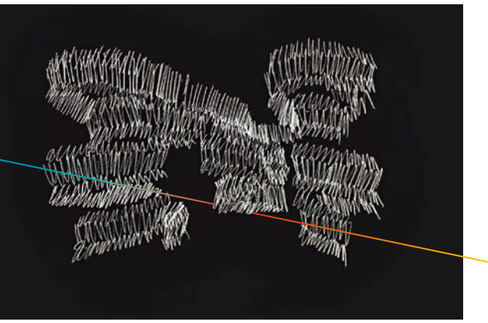
Kengo Kuma, whose architectural works grace more than 20 countries and which regularly receive prestigious awards, presented Breath/ng at the Milan Design Week 2018. The impressive textile sculpture can absorb the polluting emissions of 90,000 cars per year. The architect thus continues to reinvent post-industrial spaces using innovative materials to better correspond to their cultural and natural environments.

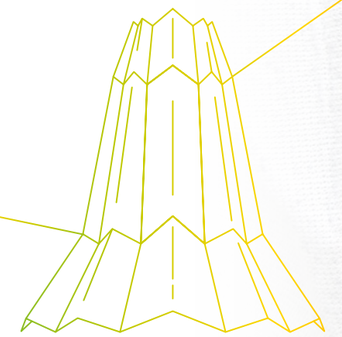
Unveiled during Milan Design Week 2018, Breath/ng is impressive. This origami-style suspended structure consists of 120 hand-folded panels, constructed with an air-purifying textile that captures pollutants, cleans fine particles and generates cleaner air. The project thus proposes a creative architectural response to the growing societal and environmental concerns surrounding pollution, by employing design to achieve a positive impact.

Japanese folding

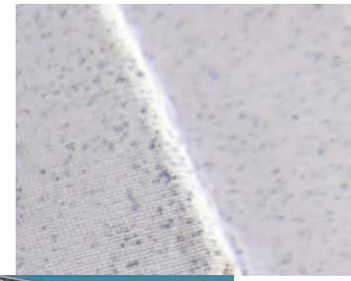
At the heart of this project is the use of a textile material, developed by the Italian start-up Anemotech, which is structured in three layers. It contains a nucleus activated by a molecule that separates and absorbs large quantities of toxic pollutants, including nitrogen oxides and sulphur oxides, present in the surrounding environment. One of the major challenges of the project by Kengo Kuma & Associates was to create an internal structure that would allow the chosen fabric to adopt a precise shape, like a skin. The solution chosen by Kengo Kuma, one which pays true tribute to the craft, is origami. By reproducing the principles of this Japanese folding art, the architects succeeded in effectively structuring the material. In addition, this choice significantly increases the surface area of the textile used, thus significantly absorbing pollution. This choice of folding is therefore interesting for two reasons, in that allows both the creation of a real aerial sculpture and greater efficiency of the installation.







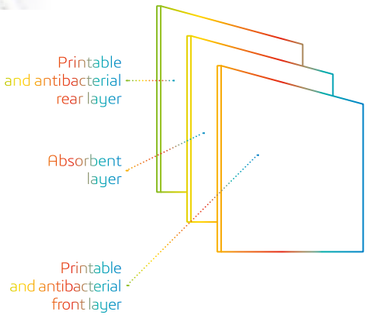
> The search for new materials has always been central to my creative approach. My conviction today is that our generation is looking for something softer, which implies the choice of natural materials. But this is not enough. We also need the contribution of digital technology to go further. CATIA allows us to add a sustainable dimension to this softness and Breath/ng is, in my opinion, a good example of the direction in which architecture should go. It is by no means a decorative installation, but a structure that is extremely useful to society.
>
> **Kengo Kuma**
> Architect, founder of Kengo Kuma & Associates



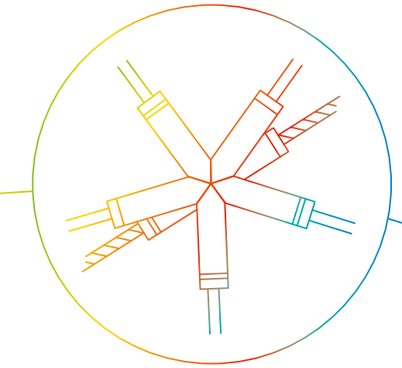
175 square
meters of textile

46 joints
printed in 3D
to form the structure

6 meters
high



Unique shape
The final, stunning dimensions of Breath/ng probably would not have been possible without the use of the **3D**EXPERIENCE platform. Kengo Kuma & Associates used the CATIA solution to prepare and calculate the height and position of the folds. By the architect's own admission, the complexity of the final shape was such that only powerful CAD software could perform this type of calculation, simulate the resistance of the whole and, thus, transform the idea into a concrete realization of this extraordinary project. The 3D experience complements the work of the structural engineers who were called upon to create this unique sculpture. They chose to combine this folding mechanism with carbon fiber to reinforce the solidity of the whole. The result is as much a work of art as a technical installation.



KENGO KUMA
Kengo Kuma & Associates is a Japanese architecture firm founded by Kengo Kuma in 1990. With offices in Tokyo, China and Paris, it is developing a new approach to architecture in a post-industrial society. The architectural structures designed by the firm can be found in more than 20 countries and have won a number of prestigious awards. The firm designs structures that blend into their cultural and natural environment, and it is constantly researching new materials.

WHEN CREATORS PROPOSE **A BETTER** AND MORE SUSTAINABLE FUTURE

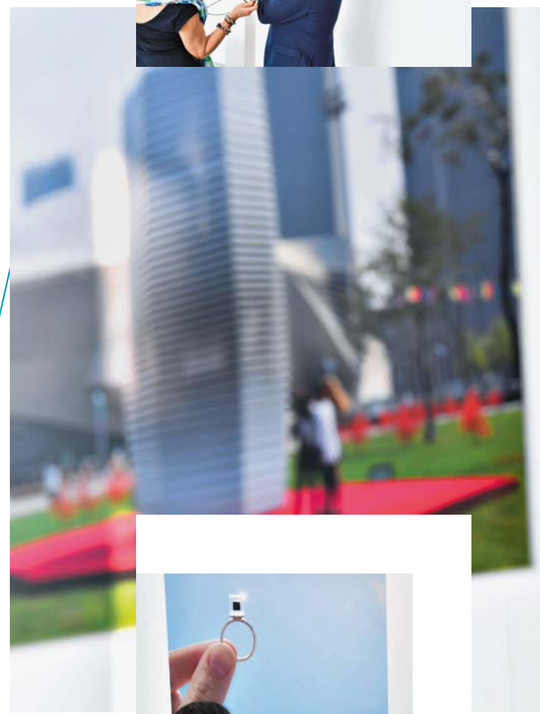
During Milan's Design Week from April 17-22, 2018, as part of the "Design in the Age of Experience" event, Dassault Systèmes teamed up with specialized designers, architects and artists to kindle creative approaches to combating climate change and air pollution.

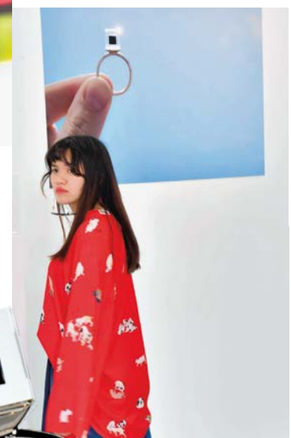
ANAB JAIN
is a designer, futurist, filmmaker, teacher and lecturer. She also is co-founder and director of Superflux, a studio that strives to ensure that her design practice is responsive to the challenges and opportunities of the 21st century.

WESLEY GOATLEY
is a data artist whose work examines the politics and hidden power of data and network technologies.

Atmospheric disturbances

For this immersive experiment, Anab Jain and the Superflux team, together with Wesley Goatley, used mobile sensors to collect data on air pollution during a walk in Milan. Measurements of carbon monoxide, nitrogen dioxide and microparticles were mapped as sounds and images, which increase or decrease in size and volume as pollution data changes, visually revealing the peaks and patterns of air quality in the city. Air quality is thus translated into tangible representations, facilitating awareness, the first step toward implementing change.





DAAN ROOSEGAARDE
is a Dutch artist, inventor, architect and entrepreneur who designs projects that integrate technology into urban environments.

'Smog Free' Project

The "Smog Free" project is a series of urban innovations designed by Dutch artist and innovator Daan Roosegaarde, along with his team of designers and engineers, to reduce pollution and provide the inspiring experience of improved air quality. It includes the Smog Free Tower, Smog Free Jewelry and Smog Free Bicycle concepts.
The Smog Free Tower uses patented positive ionization technology to produce smog-free air in public spaces. The Smog Free Tower purifies 30,000 cubic meters (1 million cubic feet) of air per hour and uses no more electricity than a water boiler (1,170 watts). Smog Free Jewelry is made from the smog particles that the tower collects, which are compressed and encapsulated in a resin case.
Each ring corresponds to 1,000 cubic meters (35,000 cubic feet) of purified air. It symbolizes and conceptualizes a concentrate of magnified pollution.

GENERATIVE DESIGN, INSPIRED BY THE LIVING WORLD

Applying the concept of morphogenesis to generative design stretches the boundaries of design automation, looking to nature to come up with new forms and guide new expertise.

Generative design has moved into a new phase. CATIA Generative Design already uses automated shape design in modeling industrial components, drawing on pre-defined parameters that meet mechanical requirements and fit smoothly with other components. This automated process produces a totally unique, lightweight three-dimensional shape that offers extremely high performance and can only be made using 3D printing. And morphogenesis takes the generative capabilities even further.

Optimizing mass locally

Morphogenesis is the process by which living tissue and organs take shape. The Morphogenesis approach is inspired by two types of structure observed in nature: lattice and trabecular (featuring small rods). One of the major advantages of the lattice structure is its strength. It produces a material that is very even and can support external force while retaining its tensile capacity. Trabecular structures are used to optimize mass locally, as the rods are aligned in the direction of force and stress. That is not the case with lattices, which feature a repeating pattern.

Almost countless options

The key strength of this new generative design technique is in its tremendous agility and the creative power of the mathematics on which it is built. Designers can adjust the overall shape very simply, influence the appearance of the model locally (solid, lattice, trabecular, etc.), let their imagination run free and test any number of possibilities. That is the ultimate paradox of generative design. As it does not produce standard shapes, it opens up an impressive array of potential solutions.

By combining generative modeling with a bio-inspired approach, Morphogenesis melds the designer's creativity and expertise with the almost countless options made possible by lattice and trabecular patterns. A vast array of solutions is brought within reach, free from any of rules of convention to reintegrate the human element into the design process.

A LATTICE STRUCTURE (opposite) is a three-dimensional mesh-like network consisting of a repeating pattern of interconnected lines with spaces between them, forming a basic geometric shape in space.

A TRABECULAR STRUCTURE (above) generally refers to porous bone tissue. Trabeculae are rods and plates of bone matter that structure the marrow cavities in spongy tissue.

DEEPENING OUR UNDERSTANDING
OF THE WORLD

The SIMULIA software suite helps scientific and technical communities reveal the world in which we live through realistic simulation of products, nature and life.

SIMULIA's simulation applications allow designers and engineers to accelerate the process of evaluating the performance, reliability and safety of materials and products very early in the design and development process, often reducing and even eliminating the need for physical prototypes. Not only is simulation used in the development of a broad range of products, including cell phones, cars, planes, shoes, medical devices and wind turbines, simulation applications also are used by scientists to analyze the potential of earthquakes, evaluate the potential for extracting oil deposits and to study the behavior of the human body. Realistic, digital simulation reveals things that, historically, could not be seen or measured. It helps predict impacts that have not yet happened. Simulation is the key to a deeper understanding of the world.

Realistic behavior
Dassault Systèmes provides robust and proven end-to-end industrial processes based on digital models built with multi-scale, multidisciplinary and connected simulation applications. SIMULIA's capabilities predict the realistic behavior of electromagnetism, fluids, materials, structures and vibro-acoustics. As an integral part of the **3D**EXPERIENCE platform, SIMULIA applications facilitate innovation at all stages of the product life cycle to help customers achieve their sustainability objectives. Research and development departments can reduce physical testing phases, increase product quality and bring products to market faster by using virtual worlds, which are always available for digital testing.

Tristan Donley
Senior Technical Manager,
SIMULIA North America
Center of Excellence

"The recent acquisition of PowerFLOW into the SIMULA brand of Dassault Systèmes has created an exciting time for us and our customers. Now, customers who only used PowerFLOW in the past are able to experience the added value of combining structural, fluid and electromagnetic technologies within model-based, end-to-end industry solutions. The integration of robust multiphysics simulation on the **3D**EXPERIENCE platform improves efficiencies and fosters collaboration among different design and engineering teams, which ultimately helps them accelerate the delivery of innovative products to their customers."

"Dassault Systèmes' digital healthcare solutions show that SIMULIA's simulation capabilities are now available to a much broader audience and span the entire innovation cycle. CIMdata believes Dassault Systèmes is a leader in providing simulation to the digital healthcare industry.

Their SIMULIA brand's simulation capabilities, combined with the **3D**EXPERIENCE platform, provide a good foundation for enabling digital twin capabilities. With its comprehensive simulation capabilities in multiscale and multiphysics, Dassault Systèmes' SIMULIA brand has the foundational elements to execute such predictive simulation and support the enablement of the digital twin—the **3D**EXPERIENCE Twin."

Source : CIMdata Commentary "Dassault Systèmes' SIMULIA Analyst Event 2018: New Highlights in Simulating Product, Nature and Life" from May 2, 2018

SUSTAINABLE DESIGN:
TRADITIONAL IS THE NEW MODERN

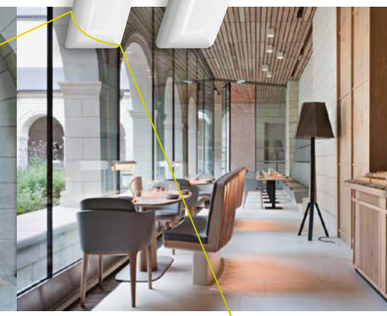
In their quest for more sustainable ways of doing things, some designers are reconnecting with secular traditions while exploiting the vast possibilities offered by simulation and virtual technology. Could data be a material that is just as authentic as wood, linen or leather? We spoke to designer Patrick Jouin.

Design is a discipline that is now aiming to achieve greater sustainability. How do you factor this into your work?
Our design work on the interior of the Abbaye de Fontevraud is a good illustration, I think. This abbey is one of Europe's largest monastery complexes, built in the 12th century in the Loire Valley region of France and consisting of four separate monasteries. It became a hospital, then a prison, and is now a cultural center and hotel. You can feel a sense of history in each stone, and our work obviously needed to take that into account. We gave new uses to the various parts of the complex – for example, the chapel is now a bar – and responded creatively to its constraints, using the energy of the place and its special ambience. The walls are made of solid stone, which gets very cold in winter, and when you talk there's an echo. So we hung large pieces of fabric to provide sound insulation and block the echoes, and we installed underfloor heating. The floor was virtually the only thing we could touch in this architectural jewel. There is also a system of table-top heaters that provide warmth to people up close, like the fireboxes used centuries ago.

PATRICK JOUIN
Patrick Jouin is a French designer. His creations often feature a minimalist style, combining the traditional and the modern. His design work encompasses objects, interiors and staging. His works feature in the collections of MoMA and the Pompidou Center, and he designs prestigious spaces all over the world.

Designers are increasingly making use of short distribution channels; what is your approach in this area?
We decided to work with tradespeople living within 50 kilometers (31 miles) of the abbey. For example, we were originally planning to buy the same tableware used in the hotel, but one day while traveling to the abbey I saw a potter's sign, so the restaurant manager and I went to see him. We talked to the potter, got to know each other, and we explained to him the type of cuisine that the restaurant would be offering and how the dishes would be prepared. So, just like in the time of the monks, the tableware will be shaped, turned, fired and colored almost on site, and I'm very happy about that because the potter is an exceptional colorist. Short distribution channels are good for the carbon footprint, but also being integrated into the local economy is very beneficial from the social point of view.

Has sustainability changed the way you work?
My style is often described as stripped-back, and my work combines traditional and modern elements, using authentic materials like leather, wood and linen. I definitely like natural objects and my style is a serious one. But around 10 years ago, as an interior designer, I was focused on the creative aspect of the work: environmental issues were not a central concern and the way I worked was very different. I'm now thinking more about how I do things and adopting new attitudes. I think that's giving my work a new dimension that's fueling my creativity and my approach to the various components of each project. Previously, I may not have gone to visit that potter; I would have done my design work and sent my plans to various people, who would have turned them into tangible objects. It's worth highlighting that, for centuries, the abbey was at the heart of the region's economy, and it fostered a whole ecosystem of agricultural and craft activities. All that had disappeared, so in some ways I'm reconnecting with that history.



> Factoring environmental and social concerns into my practice fuels my creativity.
>
> **Patrick Jouin**
> Interior architect and designer

How do you recreate that link with the surrounding area?
The soap we use in the hotel is made locally. The beds and all the linen and fabrics we use come from factories in the region. It wasn't easy to achieve, but I'm convinced that it gives an extra dimension to the project, giving it greater meaning and depth. That's because Fontevraud is also a gathering place, a space for dreams and contemplation, not just from a Christian point of view as it was for centuries, but in a more universal, humanistic way. In France, as in Italy, we are fortunate to have such an exceptional architectural heritage. It's vital that we find new purposes for these buildings, which could fall into ruin in a century or two if we do nothing. The question is how to manage the transformation and ensure that we preserve that heritage while adapting buildings to new uses. This is clearly what we're trying to do.

WE WILL BE THERE TOMORROW

The most resilient, sustainable and innovative companies and societies will be those that can harness collective intelligence and share resources and data to foster talent capable of meeting the challenges of the future.

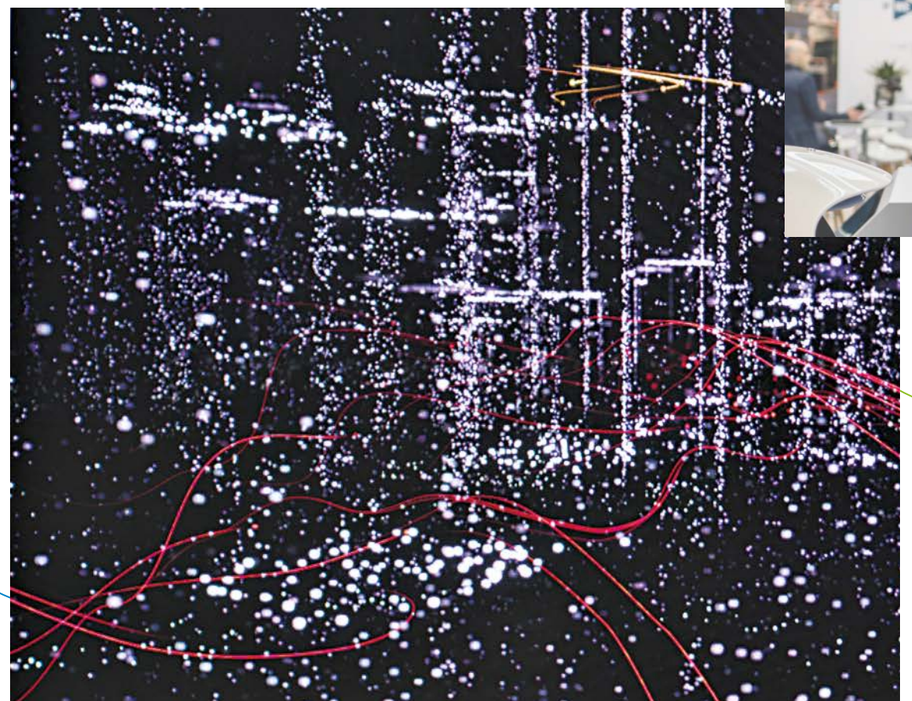
CONSUMER ELECTRONICS SHOW
EXPERIENCING THE FUTURE

Accelerated urbanization, changing demographics, environmental concerns, and cognitive and connected technologies are transforming the way we live, work, travel and consume. These shifts are creating new markets and new opportunities for businesses, consumers and citizens.

We are living in a time of unprecedented change. Expectations and usages in areas ranging from mobility to healthcare to retail are quickly moving in new directions, towards greater flexibility and increased customization. Dassault Systèmes was at the Consumer Electronics Show in Las Vegas from January 8-11, 2019 to present accelerated, disruptive projects through the **3D**EXPERIENCE platform, and to show how virtual worlds enable people to enjoy personalized experiences every day. Cities of the future will have to adapt to the changing needs of their inhabitants by offering new mobility, consumer and life experiences, and new ways of interacting with their environment.

Visitors to Dassault Systèmes' stands were given the opportunity to test a personal assistant and video projector, learn about customized footwear, fly in an air taxi in a virtual reality pod, and discover an electric two-wheeler designed for last-mile delivery service. Participants could also take part in an interactive experience based on the results of a forward-looking study that explored consumers' expectations for healthcare, home mobility and consumer technology in 2030. Each interaction generated a creative outcome that reconfigured city design in real time. Figures were also provided from Frost & Sullivan's *Experiencing City Life in 2030: Trends & Perspectives* report, which built on the expertise and experience of Dassault Systèmes. Users selected a topic and answered a survey question how they foresee major trends in urban life. The impact of their response was then displayed in the virtual city, along with the responses from the study.

Also during CES, the **3D**EXPERIENCE Lab presented the Startup Accelerator program at the Paris Region stand in Eureka Park, the space dedicated to startups, featuring three Lab participants: Gyrolift, ExactCure and Zero 2 Infinity.

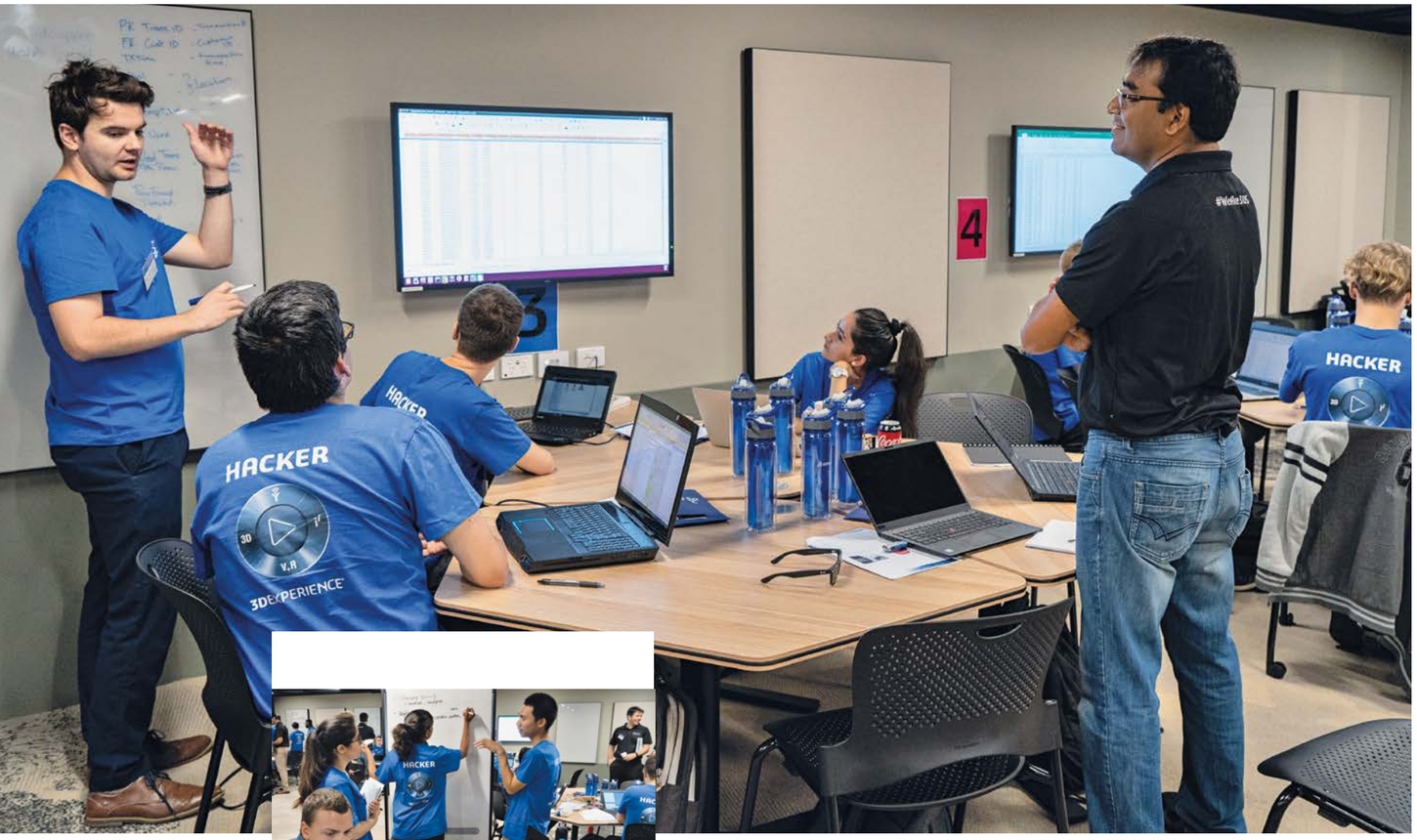


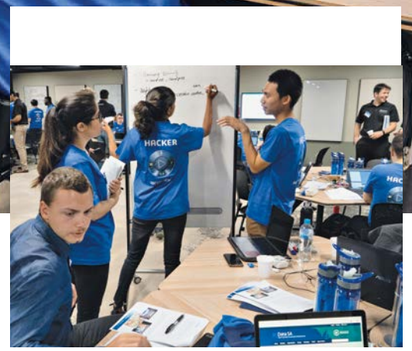
77%
of 25-34 year olds expect to share their vehicle.

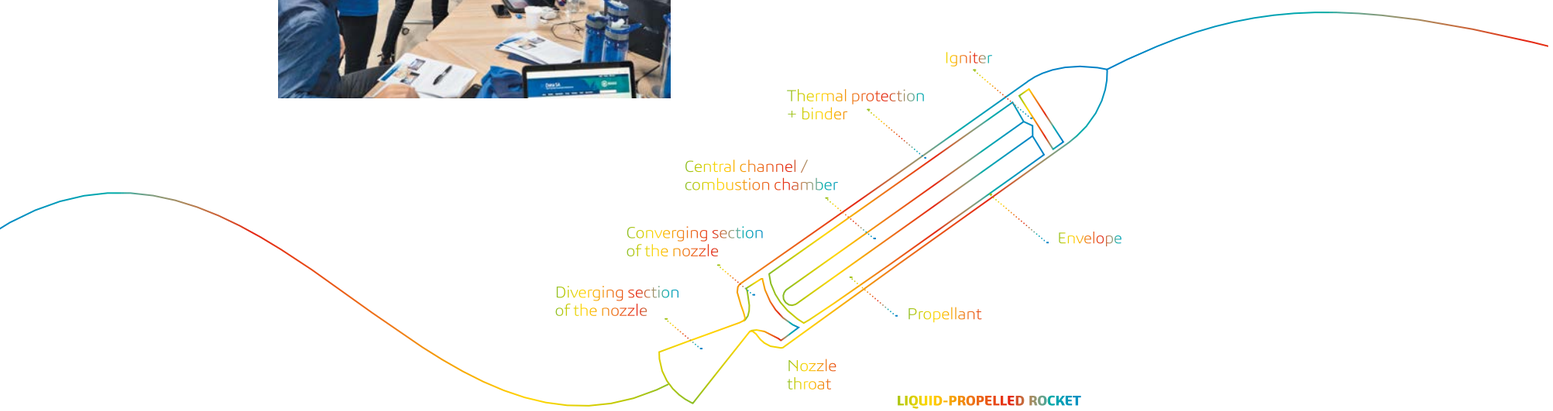
71%
of consumers expect to use fully electric vehicles, and more than half expect to use autonomous vehicles.

79%
of people think that personalized preventative care based on genomics will impact their health.

23%
of consumers think that it is very likely that they will shop only online; the majority think they will still visit physical stores as well.







LIQUID-PROPELLED ROCKET

DEVELOPING TOMORROW'S TALENT

Bringing together research, teaching, business and the public sector to create a solid base of knowledge and expertise is a crucial part of developing what will be the lifeblood of tomorrow. It's how we will be able to meet the challenges faced by a planet that is short on sustainable solutions.

Stars in the eyes of young American scientists

In the United States, a prize of more than $1 million awaits the team of STEM students that wins the Base 11 Space Challenge. The challenge is to design, build and launch a liquid-propelled rocket to an altitude of 100 km (62 miles) by December 30, 2021. The challenge is a real opportunity to showcase STEM (science, technology, engineering and mathematics) skills. With the aim of fostering talent and generating interest in space-related careers, Space Challenge encourages universities to build up their rocket-related programs, and gives students the chance to learn through access to critical resources and world-renowned experts. The teams taking part in the challenge are gaining practical experience in engineering, prototyping, testing, failure analysis and data management, but also teamwork, collaboration and innovation. Dassault Systèmes is partnering with Base 11 by providing its 3D design and simulation solutions, and is giving all student team members the chance to gain SOLIDWORKS and CATIA certification free of charge.

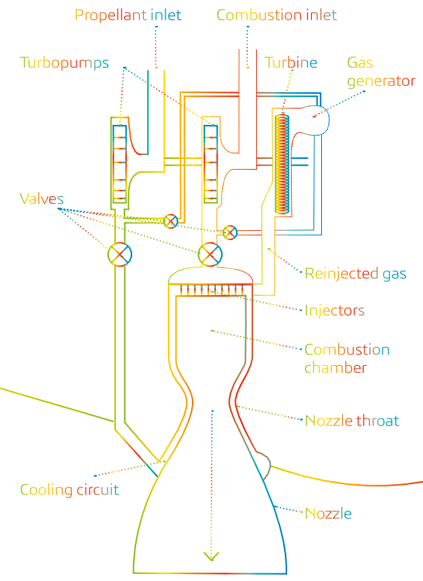
A new campus for education and vocational training

Marseille-based engineer Henri Fabre invented the seaplane, which flew for the first time over the Étang de Berre lake in 1910. So it's fitting that the Henri Fabre education and vocational training campus ("*Campus des Métiers et des Qualifications*" or CMQ) should be built on the banks of that lake in Marignane, France. This hub of secondary and higher education and vocational training establishments, supported by employers and an array of public-sector partners, is also the site of a startup incubator and provides advice to local SMEs on the technologies involved in the industry of the future. Dassault Systèmes, by providing solutions from its **3D**EXPERIENCE platform, is naturally taking part in the project, alongside Airbus Helicopters – also headquartered in Marignane – and EDF.

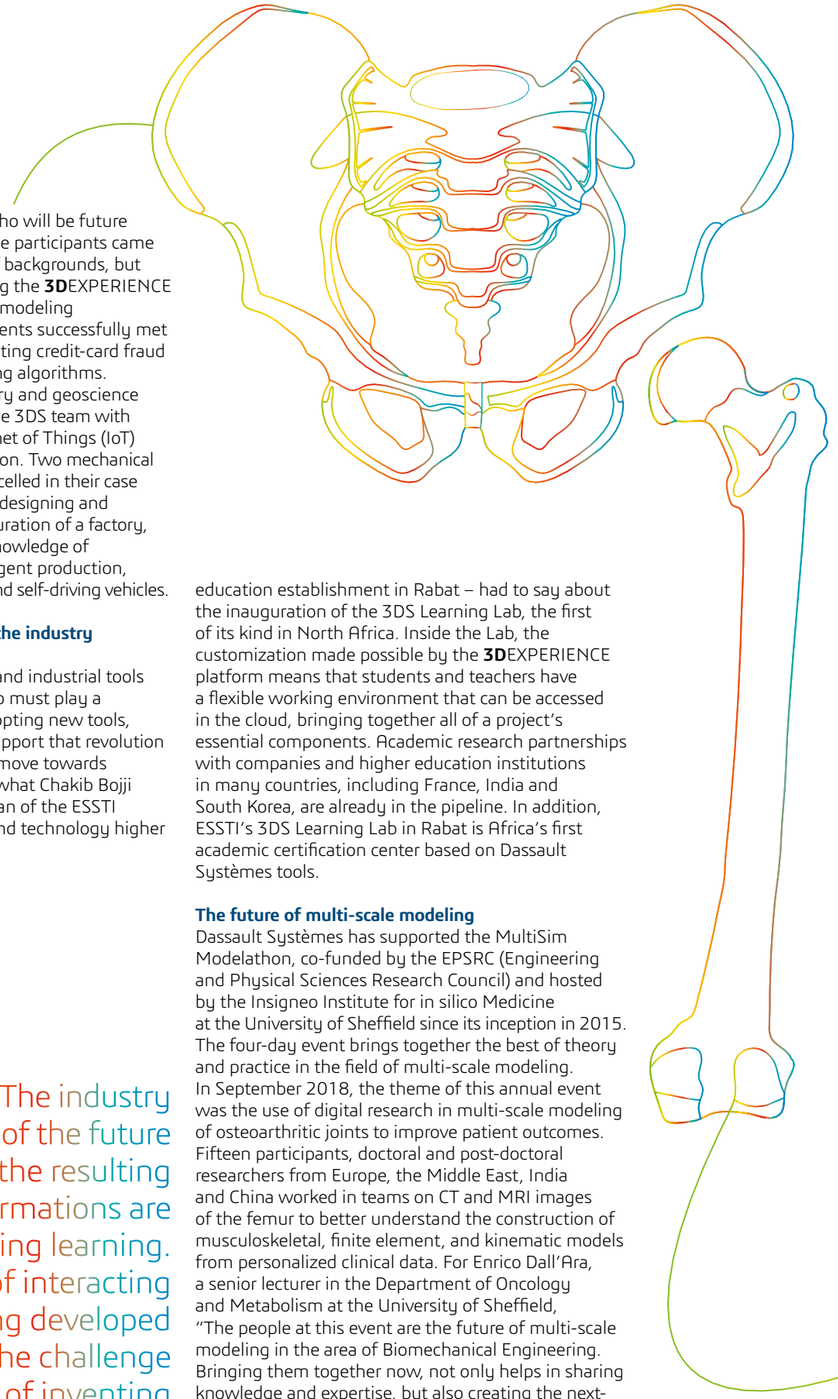
The Henri-Fabre TEAM (Technologies & Expertise in Advanced Manufacturing) unit is the industrial part of this economic development project. It oversees a shared innovation hub dedicated to the industries of the future. It is a technology accelerator that, together with its partners, provides manufacturing companies with an array of services, helping them to innovate and diversify, and training employees and students.

Identifying future innovators

Forty graduates took part in the 3DS Hackathon over the weekend of September 8 and 9, 2018 at the University of Western Australia. It was the first hackathon organized by Dassault Systèmes (3DS) in Australia, and its aim was to identify



LIQUID PROPULSION



young IT graduates who will be future innovation leaders. The participants came from a wide variety of backgrounds, but worked in teams, using the **3D**EXPERIENCE platform's generative modeling applications. The students successfully met the challenge of detecting credit-card fraud using machine-learning algorithms. Mechatronic, chemistry and geoscience students impressed the 3DS team with their skills in the Internet of Things (IoT) and machine integration. Two mechanical engineering groups excelled in their case study, which involved designing and optimizing the configuration of a factory, showing impressive knowledge of manufacturing, intelligent production, robotics, 3D printing and self-driving vehicles.

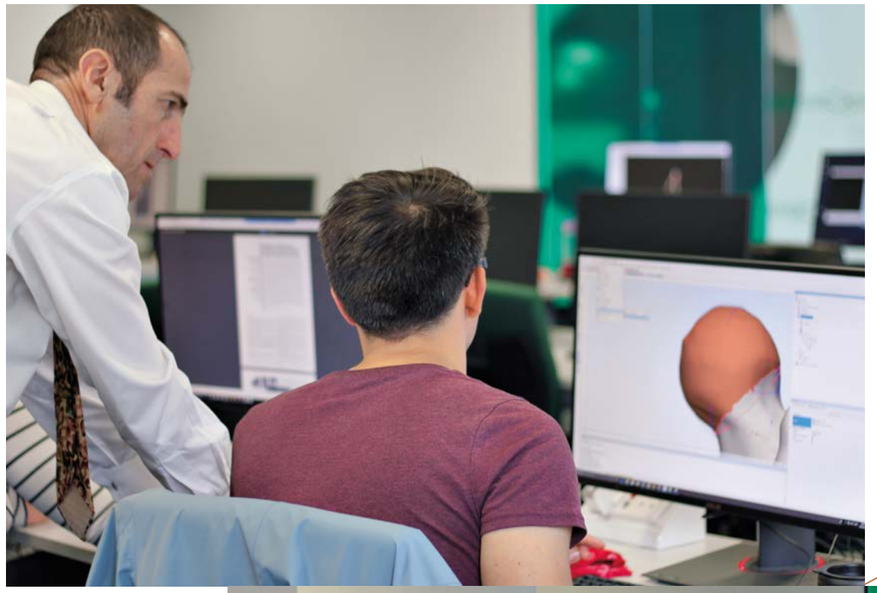
Morocco: pioneering the industry of the future

"The world, industry and industrial tools are changing. Morocco must play a pioneering role by adopting new tools, and ESSTI wants to support that revolution and help the country move towards Industry 4.0." This is what Chakib Bojji – founder and chairman of the ESSTI engineering science and technology higher education establishment in Rabat – had to say about the inauguration of the 3DS Learning Lab, the first of its kind in North Africa. Inside the Lab, the customization made possible by the **3D**EXPERIENCE platform means that students and teachers have a flexible working environment that can be accessed in the cloud, bringing together all of a project's essential components. Academic research partnerships with companies and higher education institutions in many countries, including France, India and South Korea, are already in the pipeline. In addition, ESSTI's 3DS Learning Lab in Rabat is Africa's first academic certification center based on Dassault Systèmes tools.

The future of multi-scale modeling

Dassault Systèmes has supported the MultiSim Modelathon, co-funded by the EPSRC (Engineering and Physical Sciences Research Council) and hosted by the Insigneo Institute for in silico Medicine at the University of Sheffield since its inception in 2015. The four-day event brings together the best of theory and practice in the field of multi-scale modeling. In September 2018, the theme of this annual event was the use of digital research in multi-scale modeling of osteoarthritic joints to improve patient outcomes. Fifteen participants, doctoral and post-doctoral researchers from Europe, the Middle East, India and China worked in teams on CT and MRI images of the femur to better understand the construction of musculoskeletal, finite element, and kinematic models from personalized clinical data. For Enrico Dall'Ara, a senior lecturer in the Department of Oncology and Metabolism at the University of Sheffield, "The people at this event are the future of multi-scale modeling in the area of Biomechanical Engineering. Bringing them together now, not only helps in sharing knowledge and expertise, but also creating the next-generation professionals that will drive our industry and research forward in the future."

The industry of the future and the resulting transformations are revolutionizing learning. New ways of interacting are being developed to meet the challenge of inventing a sustainable future.



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15
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PUSHING BACK THE BOUNDARIES OF KNOWLEDGE TO BENEFIT THE WHOLE OF INDIAN SOCIETY

La Fondation Dassault Systèmes is a charitable foundation established in 2015 in Europe and expanded into the United States in 2016. In November 2017, it set up an Indian arm focusing on training and research in the fields of agriculture, health care, renewable energies and cities. La Fondation's work showcases ways in which we're transforming how people learn and discover.

Better education means a better future. La Fondation supports various initiatives that are transforming Indian society: new educational approaches using learning methods based on innovative 3D teaching content, efforts to improve engineering skills and innovation in universities, and projects to promote an entrepreneurial culture among students. Dassault Systèmes staff play an active role in these initiatives by volunteering their skills, which this is one of the key advantages of La Fondation in India.

It targets four areas: agriculture, health care, renewable energies and the environment, and cities and infrastructure. It has started 15 projects since it was created, and we focus on three of them below.

Aakruti: a product design competition

With 1,120 teams taking part from 218 universities in 24 different Indian states, the scale of the Aakruti competition organized by La Fondation reflects that of the sub-continent. Aakruti is a Sanskrit word meaning shape, and the themes of the competition were improving the rural economy and protecting the environment. Fifty Dassault Systèmes volunteers were involved in the project.

Each team had to produce 3D designs of innovative products intended to address socially important subjects. The jury, consisting of experts from industry, academia and startup incubators, were highly impressed by the students' designs. Each project also had to include a "do it yourself" manual, providing detailed instructions to village craftspeople about how to make the product.

Knowledge on Wheels: mobile training

India has a target of doubling the incomes of small farmers, who represent the vast majority of Indian farms, by 2022. To support them in an environmentally friendly and economically sustainable way, La Fondation helped Centurion University, which has high-level expertise in agriculture, to launch the Knowledge on Wheels program on January 15, 2019. Its aim is to train small farmers how to use new production techniques and agrotechnology. To make it easier for the program to reach thousands of isolated villages, a van was fitted with a training system making use of virtual reality. The training program includes creating a digital farm, modeling and optimizing work done by agricultural machinery, and designing plowing routes. It also features modules on organic agriculture, precision irrigation and anaerobic rice-growing.

Developing solar power skills

La Fondation is helping to set up a center for research and skills development in the field of solar power, working with Nagesh Karajagi Orchid College of Engineering, a technology institute that is part of Solapur University. The institute has a laboratory that teaches solar engineering and develops prototypes. As well as research facilities, the center will offer courses to help students find work as engineers and technicians. The aim is to help young people develop skills in the solar industry, particularly in design, production, operation, maintenance and testing. The goal is to train 60 engineers and technicians per year. La Fondation has also supported the development of Solarium, a solar-powered vehicle designed and developed by engineering students at the Pimpri Chinchwad College of Engineering in Pune.

15 projects
supported by La Fondation Dassault Systèmes in India.

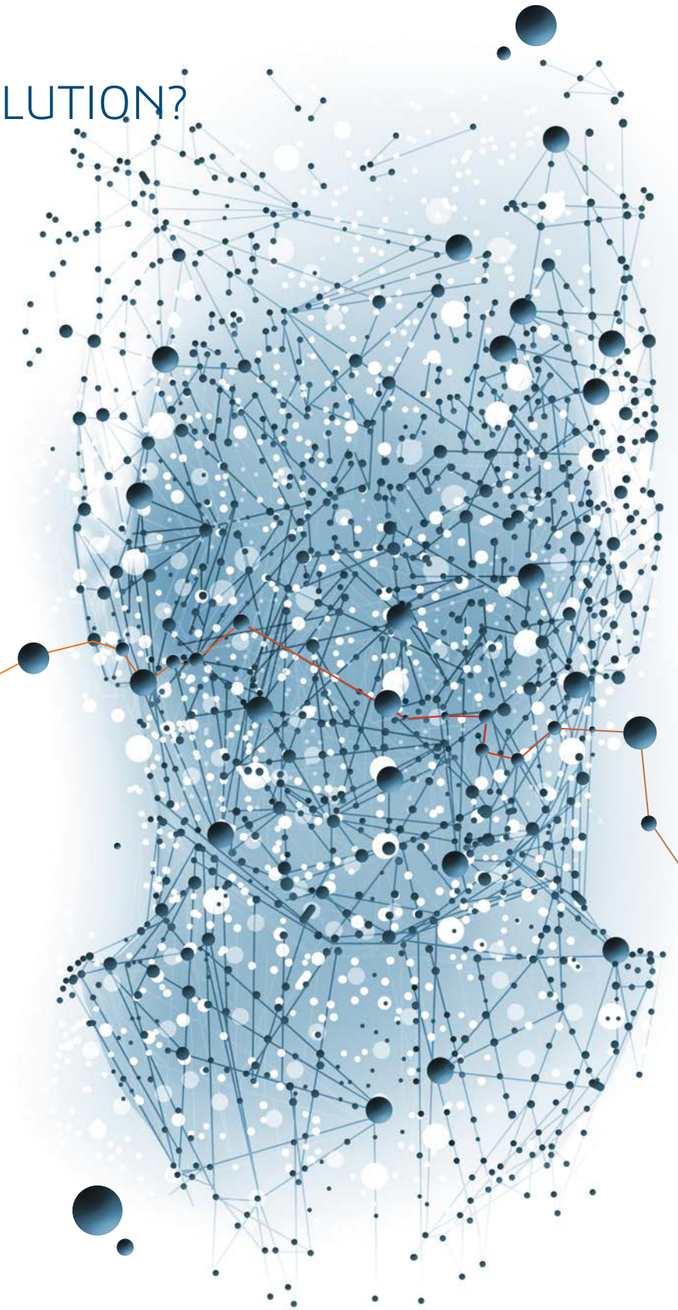
120 teams
took part in the Aakruti competition.

ARE MACHINES, LIKE ANIMALS, GOVERNED BY THE LAWS OF EVOLUTION?

Pascal Picq is a paleoanthropologist and an expert in the evolution of humans and great apes. He has studied their relationship with technical innovations, which also has implications for businesses and societies. His latest book "Artificial Intelligence and the Chimpanzees of the Future" was published in early 2019. He shared some of his thoughts about the development of artificial intelligence with us.

What are the critical factors surrounding the acceptance of artificial intelligence?
Pascal Picq The acceptability of a particular form of artificial intelligence (AI) boils down to what's actually going on in the machine. We sometimes worry about what's in the black box, and opening that box is one of the major recommendations in the report led by Cédric Villani (a report for the French Government, named "Giving a meaning to Artificial Intelligence", to provide some insights for the French strategy in AI). From an evolutionary point of view, what I find interesting is that we are now seeing a current of ideas emerging along similar lines to the behaviorism of some fifty years ago, when researchers worked on animal intelligence without concerning themselves with what was going on in their brains, prior to the emergence of cognitive science. That's where the "black box" concept comes from. Today, we see that machines are capable of coming up with diagrams, hypotheses and analysis, which naturally prompts us to talk about machines being creative. Are we now moving beyond task-oriented "behaviorist" machines – weak AI – and on to sentient "cognitive" machines – the strong AI of the future? Moreover, the best engineers are able to augment the machines' capabilities, and so questions about co-evolution will arise as machines increasingly interact with humans. That's why it's interesting to look at what happened with our knowledge of animal intelligence, as it will help us to understand how we relate to artificial intelligence. We're touching here on the same anthropological foundations of our relationships to other forms of intelligence. For example, there are striking differences between the French and Japanese ways of thinking, which is why the Japanese are more advanced in terms of ethology and accept humanoid robots more readily in their everyday lives. AI disrupts our core ontological beliefs, which go back thousands of years.

Can we talk about evolution for machines as we do for animals?
PP Even though the definition of the term is not fixed, modern artificial intelligence, based on data analysis and deep learning, is inspired by the living world. Robotics draws its inspiration from how children learn to talk and to walk between the ages of two and four. This is known as ontogenesis. Neuroscience has shown that all these areas are linked. In phylogenesis – the evolution and diversity of living beings – when we talk about the evolution of forms of intelligence, both collective and individual forms of intelligence, we see a fascinating variety of designs in terms of their bio-inspiration. For example, self-driving cars apply algorithms inspired by swarms, schools of fish and bird flight. In the latest management practices adopted by the corporate world, I also see collective intelligence (as shown by apes), individual fulfilment, and men and women with augmented cognitive capacities. That all forms part of evolutionary anthropology.



PASCAL PICQ
initially studied physics before switching his focus to paleoanthropology. He is Associate Professor at the Collège de France and his areas of interest include technological change, sustainable development, transhumanism, robotics, innovation, skills networking and bio-mimetics.

You mentioned co-evolution. What is the difference between that and co-adaptation?
PP In an ecosystem, no species evolves in isolation. When two species in a mutualistic arrangement, such as orchids and butterflies, evolve together – with orchids' pollen tubes and butterflies' proboscis both getting longer – we call that co-adaptation. Both species are interdependent, and if one should disappear, so would the other. Co-evolution is slightly more complex. You have a chain of interactions, which means that one species performs a service for another species, which itself performs a service for a third, and so forth. The differential variations and selections in one species will influence the other species it interacts with, and that naturally has repercussions for the entire ecosystem. The first co-evolution was continuous, involving interactions between all the organisms, and we are currently rediscovering this in medicine today with the research into the microbiota. Humans are continuing to co-evolve with the microorganisms we host, and our knowledge of these complex ecosystems is advancing thanks to AI tools. Today, platform economies, such as the IoT and blockchain, are driving businesses forward into new entrepreneurial ecosystems. A section of AI, with its connected objects and learning algorithms, is already evolving towards what we call artificial Darwinism. We have moved into what I call the "Darwinian digital space".

> "Modern artificial intelligence, based on data analysis and deep learning, is inspired by the living world."
>
> **Pascal Picq**
> Paleoanthropologist

What are other examples of co-evolution?
PP The second is exclusively human. It's linked to the fact that technical and cultural innovations are modifying human societies, our relationship to food, production, trade and all aspects of our social lives. We are a very malleable species, and we can change very rapidly from a morphological, physiological and cognitive standpoint. Today, I believe that a third co-evolution is on the verge of occurring, which we can contrast with the ideas put forward the various transhumanist schools of thought. They contend that in the late 20th century we reached the peak state of human development in terms of life expectancy, health, cognitive ability physiology. In response, transhumanism calls for us to augment human capabilities with technological artifacts. I don't believe that is what will happen. However, technologies will completely transform our relationships with ecosystems and our knowledge of other species. What's occurring in veterinary science is very interesting. The One Health initiative, which aims to tackle emerging diseases potentially posing a pandemic threat, advocates an integrated and systemic approach based on convergence between veterinary and human medicine and new technologies. And that will lead to another form of evolution – the third instance of co-evolution.

Where did the phrase "chimpanzees of the future" come from?
PP It comes from one of the pioneers of robotics, who said that those who refuse to accept AI will be the chimpanzees of the future. I don't think he really understands how intelligent chimpanzees are. Nonetheless, we are touching here upon what I call the "planet of the apes" syndrome. The threat posed by machines will not come from the machines but from how we interact with them. If they replace our physical and cognitive abilities, we will end up being enslaved by them – that's where the syndrome comes in – and humankind's days will be numbered. If we co-evolve intelligently with them, and with forms of animal intelligence, we will usher in the anthropological age of intelligence.

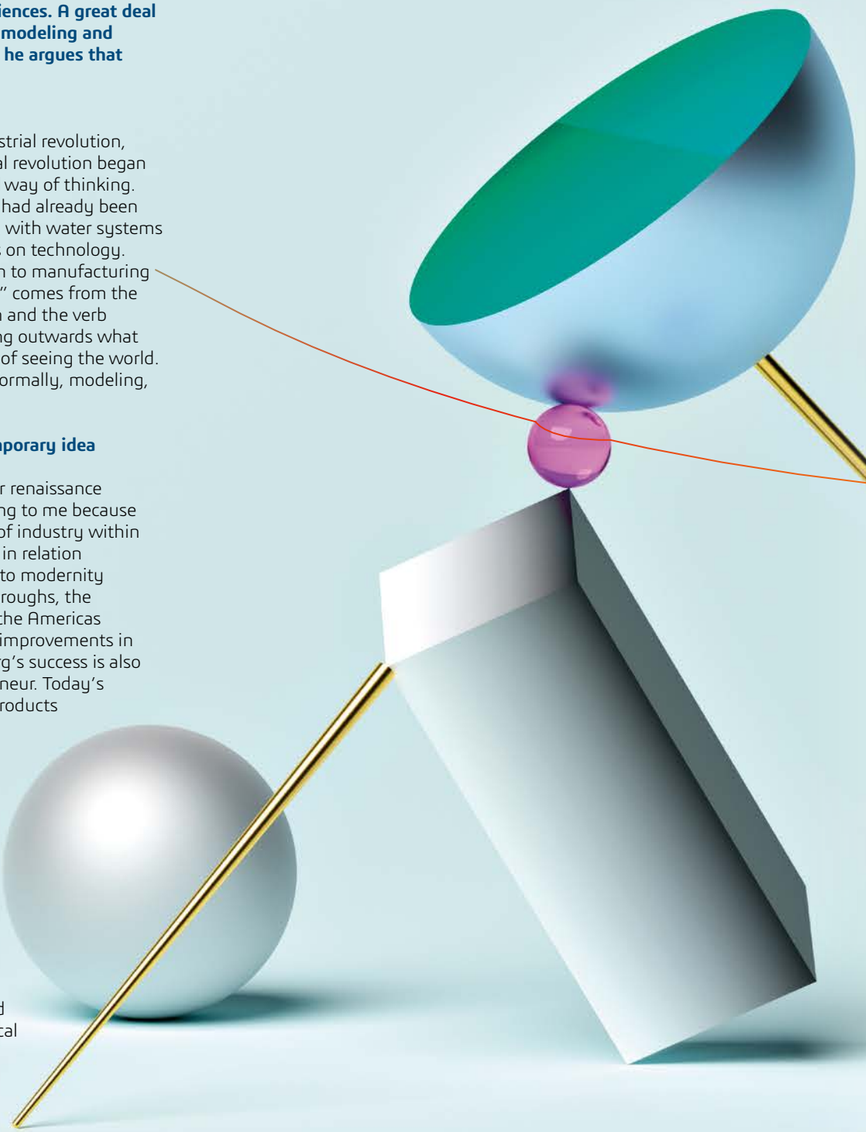
INDUSTRY AS A WAY OF SEEING THE WORLD

Pierre Musso is a philosopher who holds a doctorate in political sciences and is a professor of information sciences. A great deal of his work is devoted to social imaginaries, modeling and networks. In *La Religion industrielle* (2017), he argues that industry is a way of seeing the world.

What is your opinion of Industry 4.0?
Pierre Musso If we talk about the fourth industrial revolution, that means we consider that the first industrial revolution began in Europe around 1800, which is the standard way of thinking. However, that's not really true, because there had already been a first industrial revolution in the 13th century, with water systems and water mills, urbanization and major tracts on technology. But also, industry should not be reduced down to manufacturing activity. The etymology of the term "industry" comes from the Latin prefix "in," meaning the inner self, vision and the verb "struere," to build. The idea is that of projecting outwards what we have in our inner selves. Industry is a way of seeing the world. It's an alliance between setting things down formally, modeling, thinking and action.

How does this alliance fit with the contemporary idea of the renaissance of industry?
PM This idea of the renaissance of industry, or renaissance through industry, seems much more interesting to me because it takes a holistic view of considering the role of industry within society. It's easy to understand the metaphor in relation to the original Renaissance and the transition to modernity in Europe: scientific and technological breakthroughs, the development of perspective, the discovery of the Americas and the arrival of the Reformation, helped by improvements in printing and the spread of the Bible. Gutenberg's success is also the success of an industrialist and an entrepreneur. Today's industry has, of course, the ability to design products and services, but also thinking, creation and fiction, and that's why it's the main source of producing social imagineries.

Who are today's creators of imaginaries?
PM The great creators are always artists, researchers and industrialists in the broadest sense of the term. In other words, they garner skills that, from the trampoline of their internal genius, project outwards to produce works. Software and audiovisual programs and fiction are now drivers because they produce representations of the world and generate new worlds. Every major technological or industrial revolution was preceded or



> Every major industrial revolution was accompanied by a shift in the way we see the world, and in philosophy, the arts, politics, sciences and religion.
>
> **Pierre Musso**
> Doctor of political sciences and professor of information sciences

accompanied by a shift in the way we see the world, and in philosophy, the arts, politics, sciences and religion. We are in a period of great change and revolution, where the main actors are those who manage to bring together arts, sciences, technology and industry. I think that Dassault Systèmes is one of those actors. What really strikes me about this company is the place of research in its thinking and management; in other words its capacity to formulate and reformulate questions before replying immediately through solutions.

How will work change because of this industrial renaissance?
PM Let's get away from opposing views of catastrophes or utopias. Studies on the use of robots and their impact on jobs differ greatly in their conclusions and are linked to how we see the man-machine relationship. The reality is, there will be great changes in skills, activities and work, and the most repetitive tasks, which are often those of the least skilled people, will go. So jobs will go. On the other hand, new activities and services will be created. So the question of skills and know-how, and of their transmission, is key. This is a question of training, both initial and continued. A massive investment in training and reorientation is needed. I like the idea of bringing the school into the company and the company into the school. Interdisciplinarity, which will broach different types of capabilities, is set to become more widespread and this mix will enrich us greatly.

DESIGN FOR LIFE

Collective design is becoming an important way of connecting the challenges of the new millennium with the aspirations of people around the world. Our thoughts and actions will have to be represented digitally, going beyond simple technology. With the "design for life" approach, designers invite us to consider complex systems, aiming to connect our habits as part of a new social contract that addresses the key questions on which our quality of life depends. Anne Asensio, Vice President Design Experience at Dassault Systèmes, spoke to us to explain this concept.

ANNE ASENSIO
is Design Experience Vice President at Dassault Systèmes and a designer. She has held several senior roles as head of design management and innovation strategy at Renault and General Motors. She created the Design Studio, which brings together a multidisciplinary team focusing on strategies for innovating through design (Design Experience), design research, design management and consultancy.

The sophistication and complexity of the world around us can be seen everywhere in our lives: in our objects, vehicles, homes, cities and communities. This calls for new solutions, as well as new ways of engagement. Manufacturers can no longer try to resolve production and sustainability issues by themselves, because the public wants to play a greater role – and an understanding, inclusive approach is required to achieve this. Digital technology has played a central role in innovation for several decades now, and is making Dassault Systèmes a catalyst and driver of change in terms of our lifestyles.

The metamorphosis of design

In our hyper-technological era, what role can design play? Design is a creative force in manufacturing. It has gradually evolved from thinking up and giving shape to products, their packaging and their interfaces as well as giving them an identity and a brand, into a way of enriching the strategies and initiatives adopted by companies, institutions, collective organizations and communities. Designers are cross-fertilizing their efforts and generating new areas of expertise, ensuring that each form becomes an interface, that each product becomes a product of experience. Designers are mediators and experimenters, coming up with new sustainable solutions. The resulting knowledge is increasingly shared, inclusive and profitable. Design helps to address the need for openness, inclusivity and sharing, as well as the broader need to ensure connections with technology, manufacturing and the economy. Designers are making new propositions, coming up with new stories and designing new ways in which objects and people can interact. In response to today's industrial, social and environmental challenges, they are using digital methods to change the old ways of innovating.

Embracing complexity

Shifting from designing an object, a vehicle or a piece of architecture to designing an experience requires a new perspective. We're no longer addressing "users", but people. This means that we need to change the way we think, taking a more non-linear and circular approach by thinking about product lifecycles, not just product lives. We were already taking a holistic view of products, the way they interact and interface, the way they are packaged and unpackaged, where they are sold, how they are maintained and recycled. But that's not enough. Products are now externalized and have taken on a dimension that goes beyond providing a service or being useful; they need to be resilient or regenerative. Design has blossomed to encompass experience, emotion, meaning and imagination. Responding to the world's complexity means leaving behind the physical, leaving behind a static snapshot of the real world, and instead engaging with its systems and changing dynamics. Experiences occur in multiple, diffuse contexts.nteractions become interlinked. Systemic thought processes become dominant.
Design, at the center of that complexity, ensures that connections are made by preserving the real, human aspect of all relationships. The certainty of scientific methods clashes with the fundamental uncertainty of certain issues. As a result, design for life becomes a kind of shared conscience – a desire to work together with the confidence to believe in human inventiveness above all, even in the most vague or intractable situations. Whether the aim is to resolve problems, work together, look forward, understand or just interact, there must be a dialogue between thought and technology, taking into account the ambiguity of future models, in order to make collective intelligence a reality that can create and achieve desirable living conditions.

New ways of doing things

Just as a craftsman's tools are extensions of his or her body, digital technology – the ultimate design tool – must become an extension of designers. Designers regard digital technology as more than just an instrument: it's a culture that helps them explore, a malleable material. This digital extension, inspired by designers' physical actions, helps them engage and concentrate their energies into new, respectful ways of doing things. The designer's thought process must be able to take on board and channel the perspectives of all stakeholders in a given issue. Opening up this new area requires a new social contract, involving responsibility and ethics by working for the good of all. It reconciles human science with hard science. It turns design into a respectful, benevolent mediator that advances human creation as well the conditions of our existence.

ADDITIONAL INFORMATION

HEADQUARTERS
DASSAULT SYSTÈMES
10, rue Marcel Dassault – CS 40501
78946 Vélizy-Villacoublay Cedex,
France
Tel.: +33 (0)1 61 62 61 62

GEO HEADQUARTERS
NORTH AMERICA
175 Wyman Street,
Waltham, MA 02451, United States
Tel.: +1 781 810 3000

LATIN AMERICA
85 Avenue Jornalista Roberto Marinho
13th floor – suite 131
04576-010 São Paulo, Brazil
Tel.: +55 (11) 2348-9900

CENTRAL EUROPE
Meitnerstrasse 8
70563 Stuttgart, Germany
Tel.: +49 711 273000

NORTHERN EUROPE
Riley Court, Suite 9, Milburn Hill Road
CV4 7HP Coventry, United Kingdom
Tel.: +44 (0) 247 685 7400

RUSSIA
Kuntsevo Plaza
Yartsevskaya Street, 19
121552 Moscow, Russia
Tel.: +7 495 935 89 28

SOUTHERN EUROPE
Innovazione 3
Via dell' Innovazione, 3
20126 Milano Bicocca
MI, Italy
Tel.: +39 02 3343061

WESTERN EUROPE
10, rue Marcel Dassault – CS 40501
78946 Vélizy-Villacoublay Cedex,
France
Tel.: +33 (0)1 6162 6162

INDIA
Oberoi Commerz
International Business Park
Goregaon (East)
400063 Mumbai, MH, India
Tel.: +91 2244764567

SOUTHERN ASIA-PACIFIC
9 Tampines Grande #06-13
528735 Singapore
Tel.: +65 6511 7988

CHINA
China Central Place, Tower 2,
Room 707-709 No.79, Jianguo Road
100025 Chaoyang District (Beijing),
China
Tel.: +86 10 6536 2288

KOREA
ASEM Tower 9F, 517 Yeongdong-daero
Gangnam-gu, 135798 Seoul,
South Korea
Tel.: +82 232707800

JAPAN
ThinkPark Tower
2-1-1, Osaki, Shinagawa-ku,
141-6020 Tokyo, Japan
Tel.: +81 3 4321 3500

For more information,
visit www.3ds.com

Investor Relations
Tel.: +33 (0)1 6162 6924
Fax.: +33 (0)1 7073 4359
E-mail: investors@3ds.com

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10, rue Marcel Dassault
CS 40501
78946 Vélizy-Villacoublay Cedex France

tel.: +33 (0)1 61 62 61 62

3DS.com