

WE
ARE
WHERE...

Digital innovations are helping city planners rethink the built environment and embrace a more sustainable and resilient urban universe. These solutions help engineers, architects and local authorities to design, build and manage efficient, eye-catching and open structures and urban systems, helping to safeguard the quality of life for future generations.

CITIES
TAKE
SHAPE

Most creativity is converging around the city of the future. Two thirds of humanity will be living in cities in 2050, so urban settings will be the focal point for most creation, both imaginative and practical. This is where our future lies: one that must be sustainable, where products, nature and life exist in harmony.

The challenge is significant, because cities are the most complex of human creations. We cannot treat them simply as objects. They are the venues of an entire life experience: material flows (transport, energy, waste etc.), a balance between resources and spaces of various kinds, and of course life scenarios that include health, work, housing and safety. Improving our infrastructure and our cities means rising to the major challenges that will determine the quality of life, attractiveness and leadership of a community. It means working on all parts of our economies.

A community is a system. It's multi-disciplinary, multi-level. From mining to construction, from the design of innovative materials to the work done by local authorities, we must think of a community as a system that includes services, resource management and planning, driven by usage flows and virtual models, in a data economy. Communities represent new value networks, new business models, new knowledge. We can see this clearly in value networks that involve new energy infrastructure. Transformation must be supported by fresh innovation, using all the tools that science and engineering have to offer.

For 40 years, Dassault Systèmes has been pushing back the boundaries of complexity in innovation when it comes to aircraft, production systems, even the human heart. We also are rising to this challenge with communities. It's clear that the future of infrastructure and cities depends on virtual universes and collaborative platforms. Tomorrow, no one will think about or manage any community without taking into account its virtual twin.

As well as using technology, we must bring citizens, governments and businesses together to develop solutions that allow sustainable urban development and a better quality of life, addressing regulatory, educational and scientific needs. With its **3DEXPERIENCE** collaborative innovation platform, Dassault Systèmes allows users to design, simulate, plan, develop, analyze and manage the communities of tomorrow. Virtual twin experiences (dynamic digital models), fed by a huge set of geometric, topological, demographic and climate data, allow users to simulate scenarios and create experiences, and eventually to find sustainable solutions to all these challenges.

For example, by making a building off-site, we can reduce construction time as well as the building's carbon and materials footprint, while also offering a viable business model for both consumers and the building industry. Also, the positive impact of an electric vehicle can be increased by integrating it into a smart grid, increasing the proportion of intermittent renewable energies accepted by the grid.

In the experience economy, the infrastructure of tomorrow is determined by uses. Let's invent the uses of tomorrow.

Sylvain LAURENT
Executive Vice-President,
Chairman of the Infrastructure & Cities Board



MODELING AND MANAGING POWER GRIDS

ModeliScale is a collaborative and innovative project led by Dassault Systèmes, at the place where the worlds of academia and industry meet. The project plan is to create a virtual twin of an entire energy system, covering generation, transmission, supply and use. The aim is to simulate scenarios in order to plan the scale of the facilities required and how they will be managed at the building, district or city level. Power grids are increasingly decentralized and are involving more participants and consumers. The gradual inclusion of new sources of power generation and consumption is changing the architecture of these grids. The use of vehicle batteries to store power means that the future energy mix will have to be managed with great precision, requiring new modeling and simulation capabilities. ModeliScale is rising to the challenge by using CATIA Systèmes' ModSim (modeling and simulation) solutions, with support from Bpifrance and Région Île-de-France.



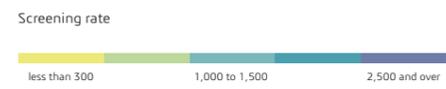
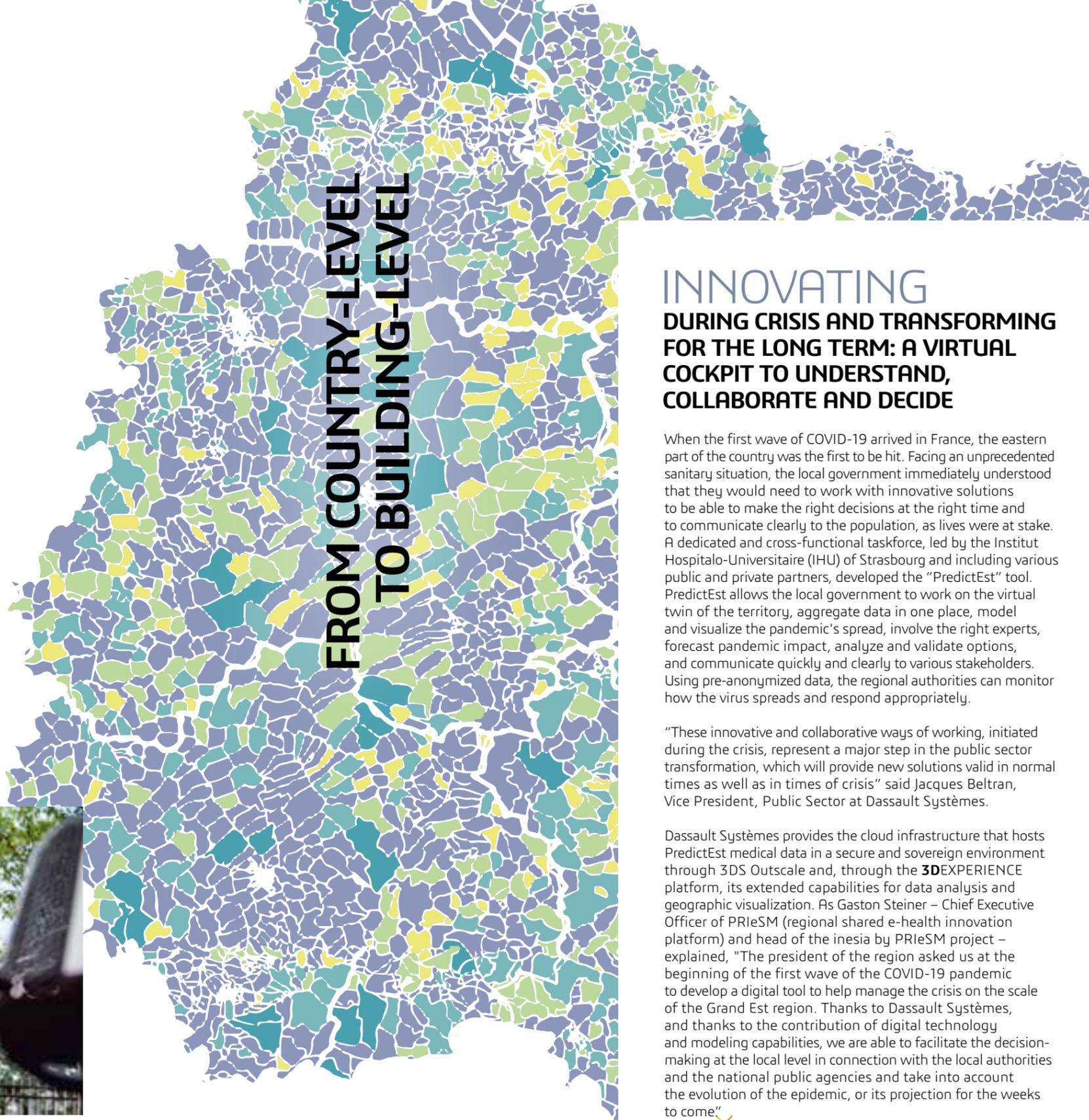


ANTICIPATING THE CITY OF TOMORROW

The sustainable growth of cities has entered a new era, facing up to new challenges and pressures arising from population growth, regulatory developments and climate change. Municipalities and regions are now the driving forces behind a global sustainability effort, and must address people's desire for a better life in cities that are more resilient, digital and attractive. Creating smart cities does not just involve installing digital interfaces in traditional infrastructure or streamlining operations. It involves rethinking cities, defining stronger, more integrated policies in order to provide people with a better quality of life, while keeping costs under control.

The introduction of construction virtual twin technology at the whole-building level will radically transform the construction sector. It will make it easier to minimize waste, achieve energy efficiency, use bio-sourced materials and calculate carbon footprints. Although information of this kind is already being disclosed, in future it will be produced and documented with precision. The first imperative in terms of sustainability is to build structures that are more energy-efficient. The **3DEXPERIENCE** platform allows users to take a multidisciplinary, modular approach when designing a building instead of one based on individual trades, helping to create new, highly customizable experiences and interactions that improve quality of life in its various areas.

More broadly, as cities expand and become denser, planners must anticipate their transformation and rethink their infrastructure to keep up with rapid, complex change, particularly regarding transport. Dassault Systèmes is working with city authorities to consider that transformation from the angle of energy flows and mobility. By anticipating flows and addressing sustainability criteria, we can visualize the city of tomorrow, with virtual twins allowing us to consider various scenarios and encouraging collaboration among designers, construction companies and municipal authorities to regulate, consider, structure and guide development plans in the most effective way. Virtual twins make it possible to share data, work collaboratively and monitor the implementation of all projects, all in one place. They enable city planners to carry out better thinking in the virtual world, in order to achieve more effective change in the real one. ✕



INNOVATING DURING CRISIS AND TRANSFORMING FOR THE LONG TERM: A VIRTUAL COCKPIT TO UNDERSTAND, COLLABORATE AND DECIDE

When the first wave of COVID-19 arrived in France, the eastern part of the country was the first to be hit. Facing an unprecedented sanitary situation, the local government immediately understood that they would need to work with innovative solutions to be able to make the right decisions at the right time and to communicate clearly to the population, as lives were at stake. A dedicated and cross-functional taskforce, led by the Institut Hospitalo-Universitaire (IHU) of Strasbourg and including various public and private partners, developed the "PredictEst" tool. PredictEst allows the local government to work on the virtual twin of the territory, aggregate data in one place, model and visualize the pandemic's spread, involve the right experts, forecast pandemic impact, analyze and validate options, and communicate quickly and clearly to various stakeholders. Using pre-anonymized data, the regional authorities can monitor how the virus spreads and respond appropriately.

"These innovative and collaborative ways of working, initiated during the crisis, represent a major step in the public sector transformation, which will provide new solutions valid in normal times as well as in times of crisis" said Jacques Beltran, Vice President, Public Sector at Dassault Systèmes.

Dassault Systèmes provides the cloud infrastructure that hosts PredictEst medical data in a secure and sovereign environment through 3DS Outscale and, through the **3DEXPERIENCE** platform, its extended capabilities for data analysis and geographic visualization. As Gaston Steiner – Chief Executive Officer of PRISM (regional shared e-health innovation platform) and head of the inesia by PRISM project – explained, "The president of the region asked us at the beginning of the first wave of the COVID-19 pandemic to develop a digital tool to help manage the crisis on the scale of the Grand Est region. Thanks to Dassault Systèmes, and thanks to the contribution of digital technology and modeling capabilities, we are able to facilitate the decision-making at the local level in connection with the local authorities and the national public agencies and take into account the evolution of the epidemic, or its projection for the weeks to come." ✕

AIR QUALITY: A KEY ISSUE FOR THE CITY OF TOMORROW



SIMULATING AND ASSESSING VIRUS DISPERSION IN A WUHAN HOSPITAL

At the start of the COVID-19 pandemic, people all around the world saw many pictures of the Leishenshan modular field hospital in Wuhan, China, which was built in only 14 days. Engineers used the 3DEXPERIENCE platform to simulate how the virus could spread through the hospital's ventilation system. This helped the designers prevent unplanned risks and avoid infection in neighboring areas, particularly by minimizing cross-infection within the hospital, and preventing any virus repercussions in the surrounding communities. SIMULIA's CFD solution, XFlow, was able to simulate internal airflow to ensure optimal removal of contaminated air from negative-pressure isolation rooms protecting hospital staff as effectively as possible. XFlow also simulated the impact of aerosol and gas emissions into the external environment near the hospital, helping to determine the design and location of the modular hospital. ✕



ENSURING SAFETY IN COMPANY CANTEENS

German company GEA is a major player in plant engineering, providing technologies and machines in the food, beverage, and pharmaceutical sectors. For its factory in Oelde, North Rhine-Westphalia, the company contracted Dassault Systèmes' Engineering Services organization to simulate airflows in the cafeteria, which is used by the site's 1,900 staff members, with the 3DEXPERIENCE platform.

By using SIMULIA CFD / Fluid solutions, along with key technologies that included PowerFLOW, Dassault Systèmes was able to achieve precise modeling of airflows and the ways in which particles move and are deposited on surfaces in complex environments. The site closed in March 2020 because of the pandemic, and GEA needed a comprehensive risk assessment for the potential re-opening of the cafeteria. In particular, GEA asked Dassault Systèmes to study the way in which the virus spreads in the air, but also the ways in which it can contaminate surfaces such as plates, trays and tables; the virtual twin showed potential areas where unexpectedly high levels of the virus could accumulate.

GEA used the simulation results to identify and implement an effective strategy to create a safer working environment; it made changes to entrances, exits and seating arrangements, created a separation between the kitchens and the dining room, and adjusted the ventilation system. The simulation results and 3D renderings have the additional advantage of enabling a far more effective communication regarding the protection measures adopted. ✕





REDUCING RISKS OF AIRBORNE CONTAMINATION IN PUBLIC AREAS

The COVID-19 crisis has put the spotlight on how viruses circulate in the air. In order to be able to maintain public areas safely open or to re-open them when economic and social activity resumes, Dassault Systèmes solutions enable simulating scenarios and identifying efficient mitigation measures. This is true for a wide range of venues, including hospitals, administrative buildings and office spaces, cultural and tourism venues, transportation and more.

During the pandemic, Dassault Systèmes initiated collaboration with several French hospitals (AP-HP) to simulate airborne particle flows and the deposit or carriage of pathogens. These projects were essential to confirm the scientific value of simulations deployed around patients, their environment and the risk of contamination within the hospital. The pooling of medical and field expertise of the AP-HP team, plus the simulations performed by Dassault Systèmes, allowed a new approach for scientific understanding. These projects provided outputs immediately exploitable by the hospitals to confirm or adapt the mitigation actions they were planning to adopt: As an example, the simulations performed enabled Bichat Claude-Bernard AP-HP hospital to reorganize a trauma room by optimizing the orientation of patient beds, understanding surface contamination and adding air filtration systems in the ceilings over COVID-19 patients.

Dassault Systèmes' SIMULIA teams also assessed, with "La Pitié-Salpêtrière" hospital in Paris, the adequacy of reorganizing a post-intervention monitoring room, which could be occupied to modifications. Together, they ran different scenarios inside this room, which could be occupied by a dozen infected or healthy patients, to define the best arrangements for both medical staff and patients' security. "We must continue to take a proactive approach in helping minimize the impact of this virus on our fellow citizens and healthcare systems," said Claire Biot, Vice President, Life Sciences Industry, Dassault Systèmes. "Simulation can be used to improve safety in hospitals, nursing homes and specialized clinics, as well as to optimize the floor plans of hospitals that have not yet been built. This collaboration is all part of our mission to harmonize product, nature and life, and make the world a better, safer, healthier place."

Thanks to the expertise developed with hospitals, Dassault Systèmes also helped La Philharmonie de Paris, the French capital city's philharmonic landmark, prepare to safely reopen its largest concert hall. With a capacity of 2,400 seats, the Grande Salle Pierre Boulez features an enveloping configuration that immerses the concert hall audience in the music, and a unique ventilation system in each seat that quietly introduces fresh air and regulates its direction and speed. Equipped with data provided by the Philharmonie de Paris, Dassault Systèmes created a model of the concert hall at full capacity in 3D, and simulated the airflow from the uppermost balconies to the orchestra floor, in order to assess the impacts of mask-wearing and airflows on virus-particle dispersion. Simulation was used to experience and understand how air circulates within the space, evaluate the effectiveness of the Philharmonie de Paris' preventive measures, and identify new ones if necessary.

"Safety is non-negotiable, for our public, artists and staff. This is why we decided to partner with Dassault Systèmes. Thanks to their cutting-edge simulation technology, we are prepared to reopen our concert hall in the best possible conditions." — Laurent Bayle, Managing Director, La Philharmonie de Paris.

"Our collaboration with the Philharmonie de Paris is part of our ongoing efforts to help organizations simulate, visualize and analyze existing conditions, evaluate the impact of 'what-if' scenarios, and identify solutions to open and operate safely," said Florence Verzelen, Executive Vice President, Industry, Marketing and Sustainability, Dassault Systèmes. "There are no rehearsals in life. As the real world struggles to emerge from pandemic-related lockdowns, the virtual world allows for experimentation to reveal these unknowns" ✕

REAL ESTATE CONSTRUCTION IN TRANSFORMATION



ABC building
in Grenoble, France
(Autonomous
Building for Citizens)

After an initial phase of digitalizing and automating its processes, Bouygues Construction – a long-standing partner of Dassault Systèmes – is embarking on the second phase of its digital transformation. The aim is to make construction more affordable, to build more sustainably and to improve health and safety. Bouygues' Integrated Built Environment and Creative Building Design (ABC) solutions are based on a systemic approach to project management, involving integrated and collaborative models that use virtual twin technology. The approach is also used to pursue an ambitious climate strategy, in order to reduce the carbon footprint of buildings. For example, Bouygues Construction uses more and more timber, which stores more carbon than it emits. This involves changes across the whole sector, including architects, suppliers, manufacturers and contractors. The 3DEXPERIENCE platform is also helping the company create a database of components, so they can be reused in other structures. Finally, Bouygues Construction and Dassault Systèmes are supporting the environmental transformation of cities using bioclimatic design features such as solar and wind power generation, the collection and reuse of rainwater and wastewater, and the development of urban farms. ✕



WHEN ROBOTS PUSH THE BOUNDARIES OF POSSIBILITY

Today, agriculture requires large-scale investment in machinery, but generates relatively limited revenue. In addition, to meet environmental requirements, farmers must spend more time on certain tasks, like removing weeds mechanically instead of by spreading chemicals. Robots can help farmers by performing this time-consuming and low-value-added work. French company Agreenculture, supported by the 3DEXPERIENCE Lab, aims to make environmentally friendly techniques affordable, using a common agricultural platform that allows equipment to be shared, rather than each type of crop having its own specific robot and processes. The company is using the 3DEXPERIENCE platform for modeling and simulation purposes, helping it to turn its novel idea into a finished product more quickly. Agreenculture has developed an exclusive system that allows centimeter-level accuracy, along with a cloud access box that allows the agricultural robots of partner companies to connect to a guidance and positioning system that uses artificial intelligence technology. ✕

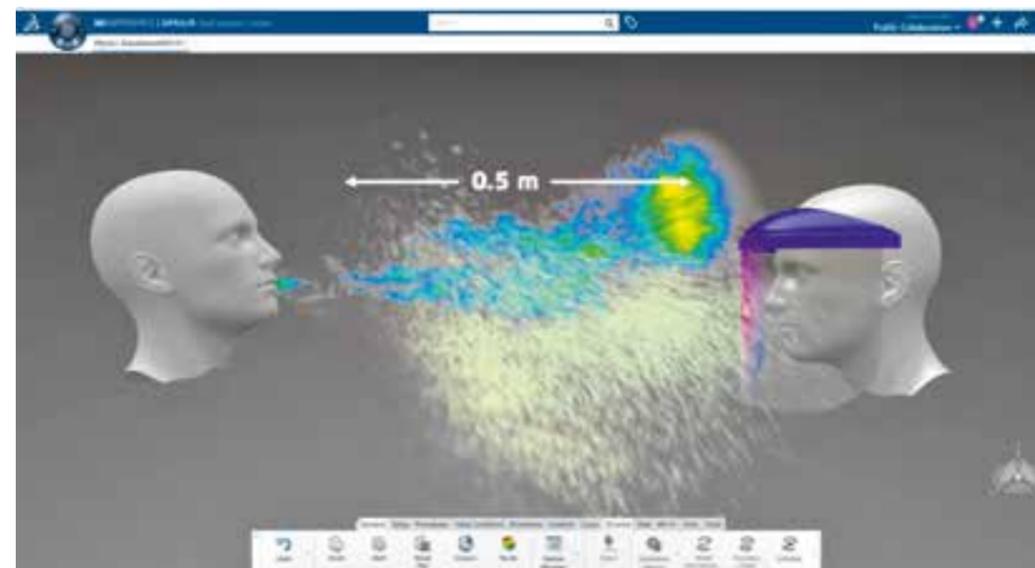
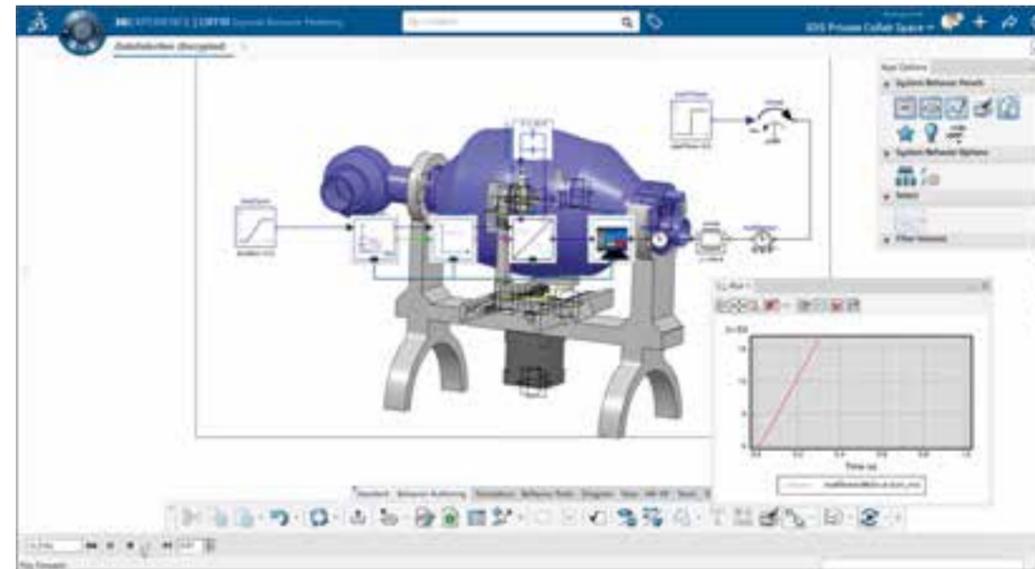
WE WILL BE THERE TOMORROW

Because today's world demands collective intelligence, innovation and creativity that will require new talents to face the challenges of the future, we are championing initiatives to open up new horizons.

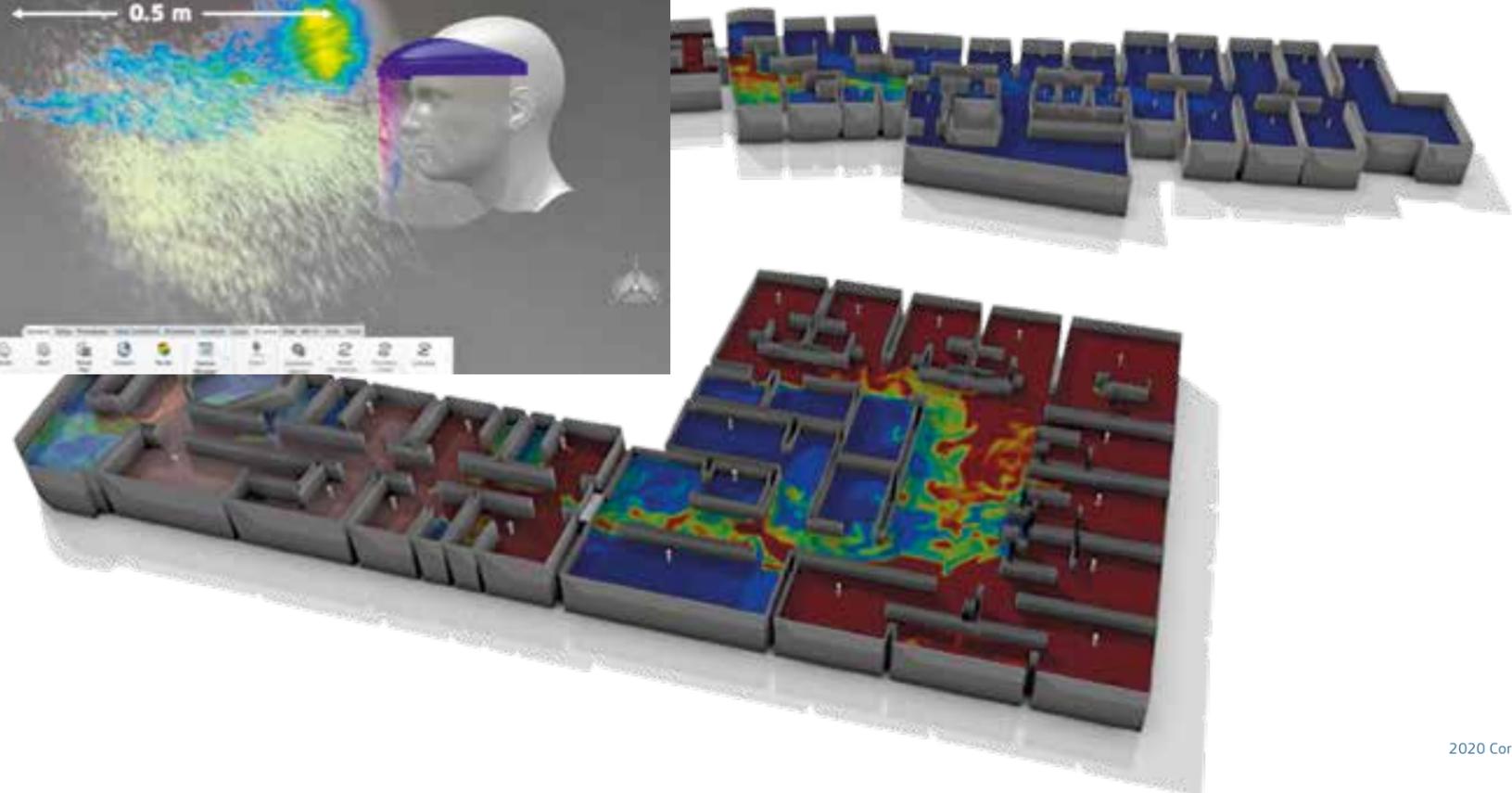
HARNESSING COLLECTIVE INSIGHTS TO DEFEAT COVID-19

As soon as the pandemic began spreading, the **3DEXPERIENCE** Lab identified needs and difficulties arising and found that many people working on COVID-19-related projects were doing so in isolation. The Lab team brought together these designers, engineers, scientists and decision-makers to pool their energy, harness collective insights and share needs and solutions; in turn the team classified and supported the projects. The Open COVID-19 community created an effective way of gaining an overview of efforts to combat the pandemic, aggregating the latest information concerning pharmaceutical and scientific advances, ventilators, face shields, and progress by manufacturers and labs. Over 150 projects received backing, including design and production of face shields in Fab labs, digital simulations of virus dispersement into the air when a patient coughs or sneezes, airborne propagation simulations, ventilators, etc.

Three projects really stood out: in India, the Inali Foundation startup, which had already made a name for itself by creating an artificial arm for people with disabilities, built a prototype smart ventilator. It took just eight days thanks to the support provided by the **3DEXPERIENCE** Lab's team in India and input from mentors and designers from around the world via the cloud. In the United States, the Lab guided the design process for face shields via the network of Fab labs, with support from US-based teams of **3DEXPERIENCE** and SOLIDWORKS experts. Geolocation data was used to put these Fab labs in contact with nearby hospitals and healthcare professionals. In France, the SIMULIA team helped simulate air flows in the Saint-François hospital in Marange-Silvange, to rapidly identify the safest way of accommodating COVID-19 patients and to show the way forward to have optimal air flows.



From top to bottom:
Inali's virtual prototype of its smart ventilator, a simulation of face shield protection and another one of the premises of Saint-François hospital in Marange-Silvange



SUPPORTING RESEARCH AND EDUCATION DURING THE PANDEMIC

La Fondation Dassault Systèmes rapidly deployed its teams as the COVID-19 pandemic spread and lent its support to various initiatives driving change in education and research by harnessing the power of 3D technology and virtual universes. It made a donation to the Institut Gustave Roussy (Villejuif, Paris) for its research into the effects of SARS-CoV-2 on cancer patients. Through a second donation to the BREATHE Center at the University of California, Riverside School of Medicine, its support furthered work on identifying engineering solutions to mitigate damage caused by artificial respiration and helping improve patients' condition. The Foundation also established a partnership with Ecodair, an association promoting community employment, to provide computers to students at the Apprentis d'Auteuil home for young workers in Versailles (France), so they could continue taking their classes online. Lastly, ConnectNext, a program launched in 2020 to forge closer ties between academia and industry in India, connected 16,000 students, teachers and industry professionals during the lockdown period. The Franco-Indian chamber of commerce gave this initiative a CSR Award.



DEVELOPING RURAL AREAS AND NURTURING TALENT IN INDIA

La Fondation Dassault Systèmes India supported a number of projects in 2020 championing the development of rural areas. Photovoltaic solutions powering irrigation pumps, spraying devices and water purification systems play a key role in this program. Solar energy is also used in new pasteurization, dehydration and portable refrigeration systems for transporting drugs. The ultimate goal is to make villages self-sufficient in both energy and food by implementing innovative, sustainable and local fruit and vegetable production strategies. The foundation for a circular ecosystem will be laid through a shift from managing waste to recycling useful materials. Water-related issues are the focus for two of the other projects supported by the Foundation — a floating

system that collects the waste from lakes and rivers, and another that curbs pollution on waterways. **La Fondation Dassault Systèmes** India also took its talent development initiative to the next level. The “Made in 3D” program introduced by **La Fondation Dassault Systèmes** in Europe in 2016 to inspire students to become future innovators and entrepreneurs was successfully adapted to India in 2020. Lastly, the ConnectNext initiative introduced a new form of collaboration and interaction between industry and academia in India, giving businesses the opportunity to spot talent while allowing students to showcase their skills and abilities through webinars and virtual events. ✕

TRAINING FUTURE GENERATIONS OF ENGINEERS IN AFRICA

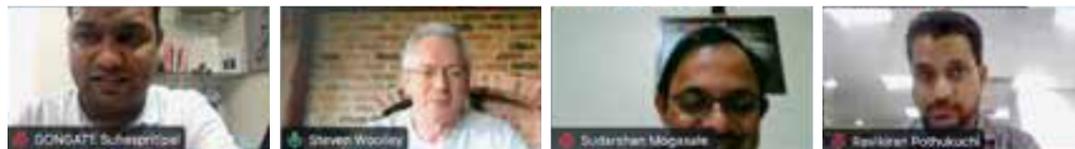
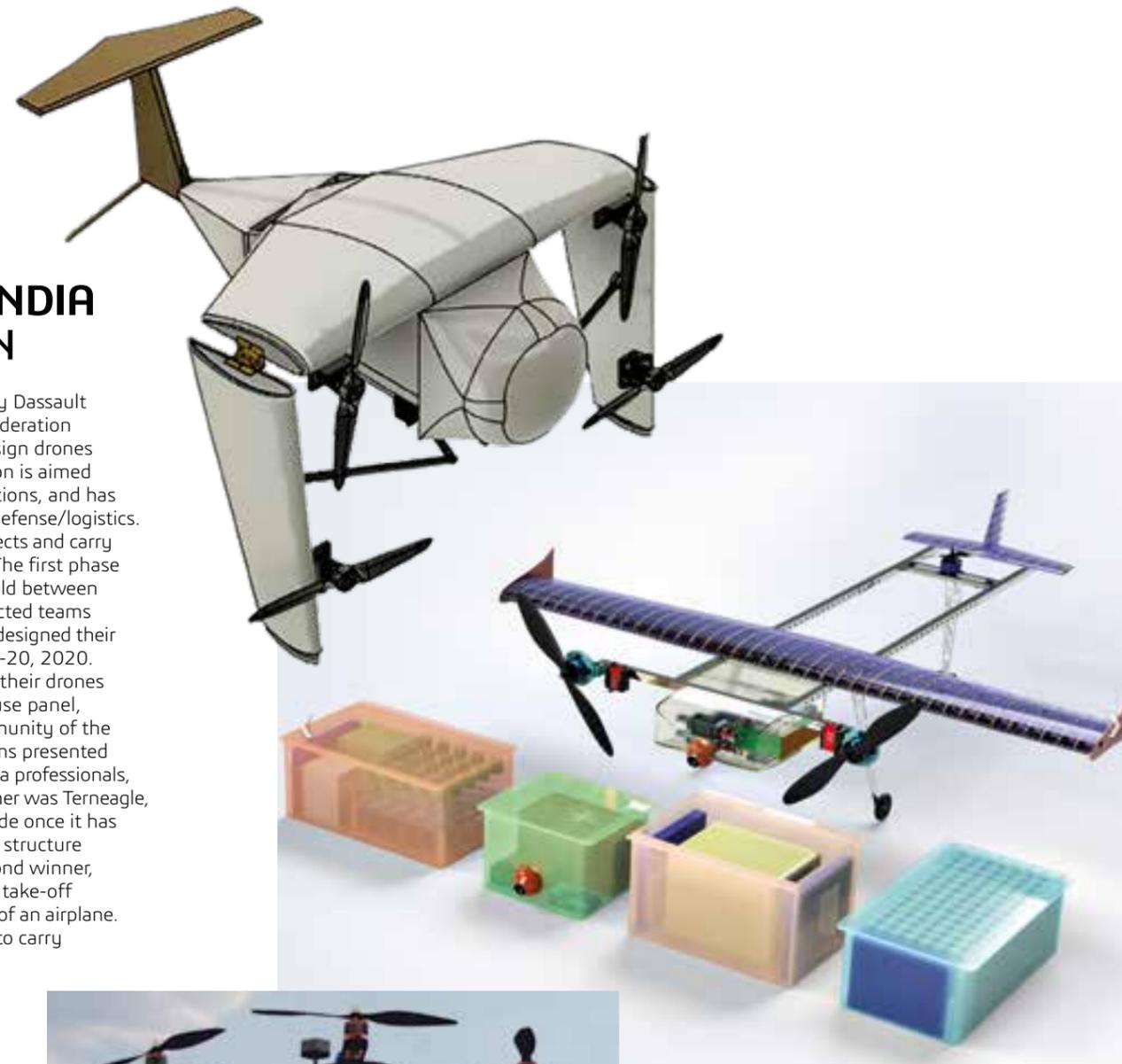
InnoTechLab, which was established with support from **La Fondation Dassault Systèmes**, is a tech innovation lab held a launch event in October 2020 in Yaoundé (Cameroon) in the presence of the minister for employment and professional training and the minister for small and medium-sized enterprises. The center will foster experimentation with and training in digital technologies and 3D simulations. Dassault Systèmes employees will share their knowledge under a skills-based volunteering program and help to train a new generation of African engineers. Industrial engineering, urban planning, energy, agriculture, logistics, mobility, life sciences and connected health are fields covered

by this initiative. InnoTechLab is also the cornerstone of a strategy for upskilling young engineers across Africa. In parallel, the Haile-Manas Academy has initiated a plan to build an innovative school at Debre Birhan thanks to support from **La Fondation Dassault Systèmes** US. It will educate 400 talented students from across the country. They will receive high-caliber teaching spanning multiple disciplines and will gain professional skills through access to a “makers” space. The teachers will be trained in how to support and guide students in extra-curricular workshops during which they will learn the basics of 3D design and engineering technologies. ✕



PURSuing SUSTAINABILITY IN INDIA WITH DRONE-A-THON

Drone-a-thon is a virtual hackathon organized by Dassault Systèmes 3DEXPERIENCE Lab and the Drone Federation of India to encourage students and others to design drones using the 3DEXPERIENCE platform. Drone-a-thon is aimed at universities, startups and non-profit organizations, and has four categories: agriculture, city, healthcare and defense/logistics. Participants use the platform to design their projects and carry out simulation and systems engineering work. The first phase involved a challenge that narrowed down the field between October 19-31, 2020. In the second phase, selected teams received training in how to use the platform and designed their drones as part of a hackathon from November 9-20, 2020. In the third phase, 10 selected teams presented their drones to Dassault Systèmes employees and an in-house panel, and five were selected through a vote by a community of the platform's users. In the final phase, the five teams presented their concepts to a panel of industry and academia professionals, and three winners were selected. The overall winner was Terneagle, a quadcopter drone that can switch to glider mode once it has reached a certain altitude, since its aerodynamic structure is compatible with both types of flight. The second winner, Pegasus, a tilt-rotor VTOL, combines the vertical take-off capability of a helicopter with the cruising speed of an airplane. Finally, Agro-Raptor is a robust drone designed to carry heavy loads.



SPEAKING THE LANGUAGE OF INNOVATION AT THE PURDUE CENTER

"The language of innovation in the future will be simulation," said Dr. R. Byron Pipes at the opening of the 3DEXPERIENCE Education Center of Excellence in Advanced Composites. Dr. Pipes, Distinguished Professor of Engineering and Executive Director of the Composites Manufacturing & Simulation Center (CMSC) housed at Purdue University's Indiana Manufacturing Institute, is a world-renowned specialist in the field of composite materials. "The knowledge base we've created currently resides in books, magazines and academic papers. Eventually, it will reside in simulation tools. This is where the future is going," he added. The aim of the Center of Excellence is to create a learning environment for research into the manufacturing and performance of advanced composites and the engagement of all levels of students, in order to develop the knowledge required for Industry 4.0. Dassault Systèmes' center is located within the Indiana Manufacturing Institute at Purdue Research Park. One of the materials being developed there, a new thermoplastic composite, could help drive development in urban air mobility, drones and aerospace platforms. By giving designers a way of trying out innovative new materials and manufacturing processes virtually, the aim is to speed up the creation of new systems with the students of today and generations to come.

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