URBAN TECHNOLOGIES
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Building Climate-Resilient Cities: How Virtual Twins Can Empower Urban Leaders

Illustration of Dassault Systèmes' Virtual Twin as a Service.
Image: Dassault Systèmes

Cities all over are undergoing profound transformation. As urban populations grow, the strain on infrastructure, housing, and services has also intensified. Compounding the problem is climate change, which has introduced new challenges such as flooding, rising sea levels, and extreme weather events. Today, 58% of cities are already highly vulnerable to natural disasters. By 2050, however, over one billion people could become climate refugees, displaced by environmental crises.

To address these challenges, city leaders need to make reducing carbon emissions and adapting to climate change their critical priorities. At the same time, they also need to equip themselves with the right tools to make informed decisions. The advent of big data and generative AI provides a valuable opportunity for cities to make data-driven decisions—and at the forefront of this technological shift is the Virtual Twin.

A city virtual twin is an exact digital replica of an urban area—one that integrates real-time data from sensors, IoT devices, and other sources, enabling simulations, analytics, and informed decision-making.

The Value of the Science-Based Virtual Twin in Sustainable City Planning

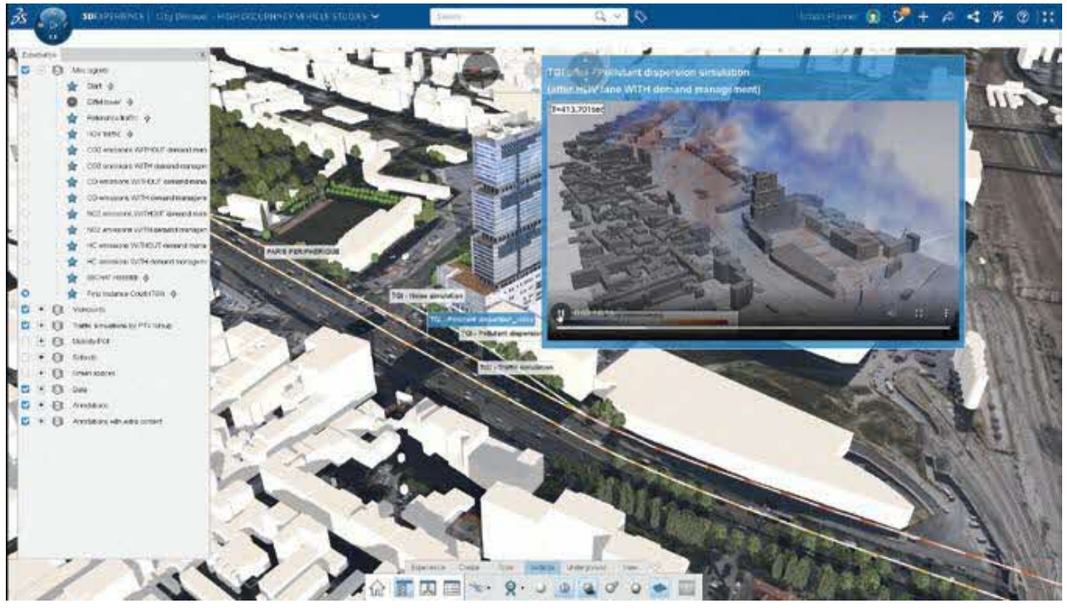
It is important to differentiate between traditional 3D modelling and the virtual twin. Unlike conventional 3D models that focus solely on visual aesthetics, a city virtual twin is a science-based dynamic replica of an actual city. Within one integrated model, the system is able to conduct advanced analyses, such as evaluate airflow patterns to combat urban heat islands, assess flooding risks, and monitor traffic policy impacts on air quality and noise pollution.

The true value of the technology behind the virtual twin lies in its ability to provide city leaders with

a comprehensive understanding of their urban environment, offering a holistic view of the interconnected systems that make up their cities. Virtual twins enable authorities to 'crash test' new public policies in the virtual world before actual implementation, thereby ensuring that decisions are made according to the scientifically sound data points available.

Another key benefit of virtual twin technology is that it streamlines data access across different organisations, enhancing inter-departmental collaboration. For city leaders, this facilitates the designing of sustainable cities that balance between urban growth and environmental stewardship goals. Additionally, virtual twins also improve crisis management by generating simulated outcomes for better decision making.

More than just a tool for city planners, virtual twins also serve as a powerful communication bridge between governments, stakeholders, and citizens. Through realistic 3D models, diverse stakeholders can get a clearer understanding of public policies and urban projects, thereby fostering greater transparency and community support for new governmental initiatives.



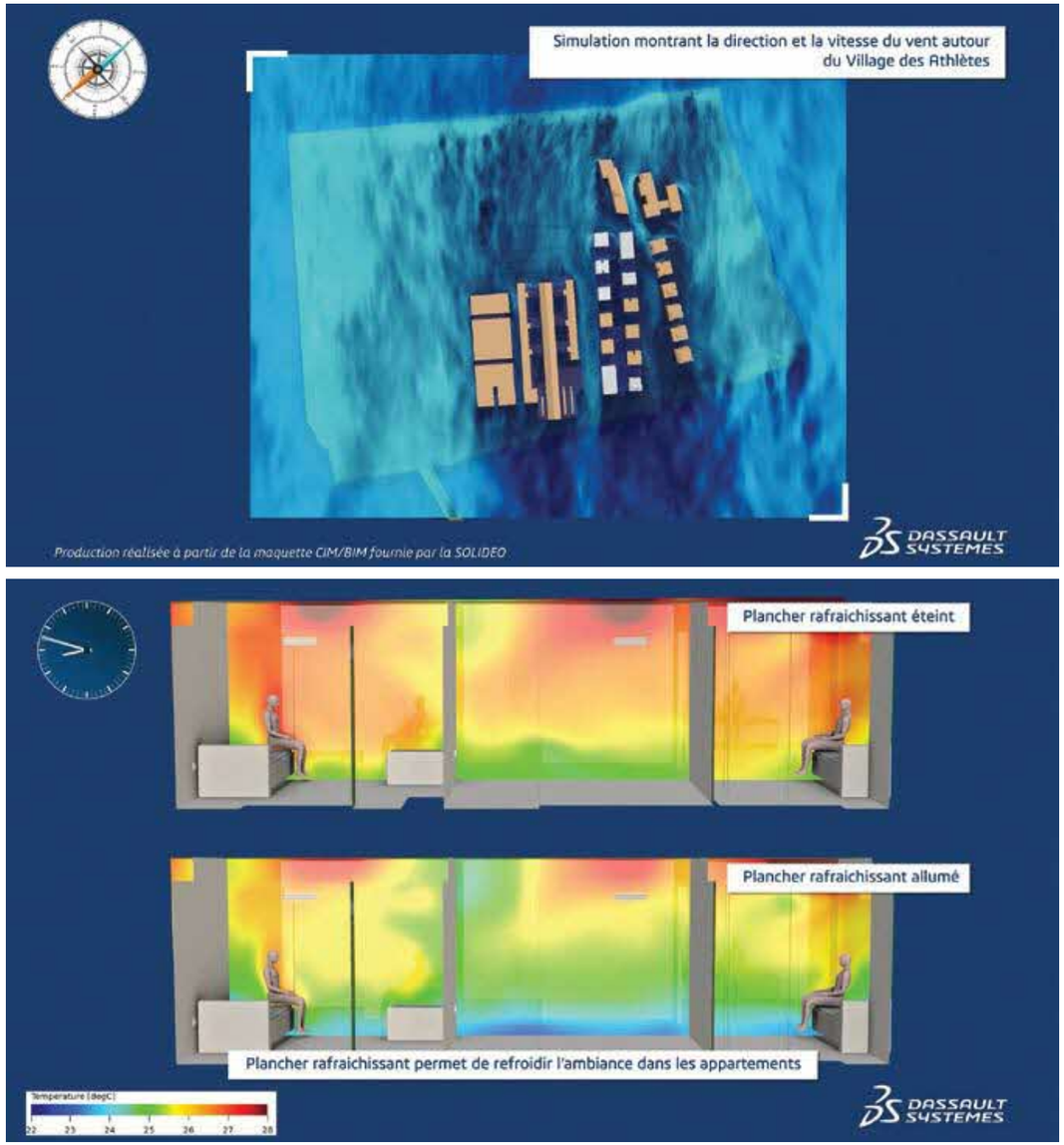
Dassult Systemes modelled the Paris Mayor's decision to allocate a lane of Paris Ring Road to car sharing to help with traffic and decrease carbon emissions. The simulation allowed for analysis of impact on traffic.
Image: Dassault Systèmes

Future-Proofing Cities: Addressing Pollution, Extreme Heat, and Flooding

Today, many cities are already embracing virtual twins. Singapore, Barcelona, Dublin, Seoul, Chengdu, and Porto are among the cities leading the way, each harnessing virtual twin technology to solve their unique challenges. Here are a few examples from Dassault Systèmes:

Traffic, Air, and Noise Pollution
One city that faces significant levels of pollution and traffic jams is Paris. Over 1.1 million trips take place along the ring road each day, which put residents living near the road at risk of toxic air pollution. In light of this, city authorities introduced an Olympic Lane for buses, taxis, and carpools to fluidify traffic during the 2024 Paris Olympics.

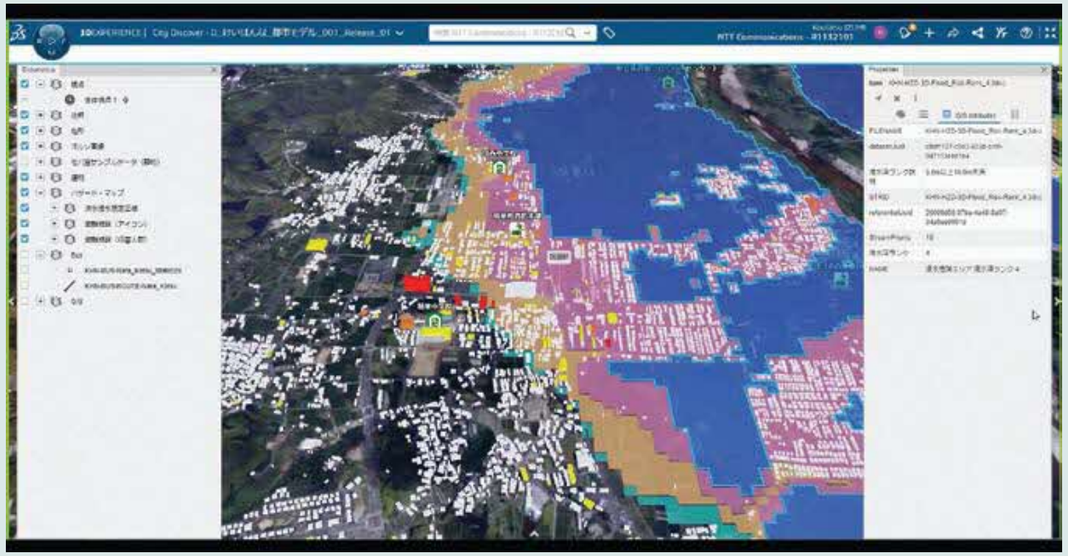
To simulate potential impacts of the new mobility policy on traffic, air quality, and noise levels, Dassault Systèmes used the 3DEXPERIENCE platform to simulate impacts of this new mobility policy, on traffic, air quality, and noise levels, to test various mitigation actions such as placement of soundproof walls.



(Top) Wind simulation for the Athletes' Village. (Bottom) With data provided by SOLIDEO (Olympic Delivery Authority), Dassault Systemes created a 3D model of a floor in the Athletes' Village to calculate indoor temperature.
Image: Dassault Systèmes

Urban Heat and Extreme Temperatures
Urban areas are typically hotter than rural ones due to the "urban heat island" (UHI) effect, caused by the energy consumption, materials, and reduced vegetation in cities. As climate change intensifies, extreme temperatures occur more often causing the UHI effect to worsen.

To address this phenomenon, cities need to minimise the UHI effect early in the urban planning process. This can be done by increasing the presence of nature and water in development projects, as well as by implementing suitable building materials and cooling options. Virtual twins can then be used by cities and construction companies to assess the effectiveness of their planned mitigating strategies



The Keihanna digital twin was a result of collaboration between Japan's NTT Communications.
Image: Dassault Systèmes

for combatting rising indoor and outdoor temperatures,improving citizens thermal comfort through urban planning.

As an illustration, Dassault Systèmes recently supported SOLIDEO, the public agency tasked with financing, supervising, and delivering the Paris Olympics facilities to select the best construction choices that would limit the impact of extreme temperatures within the Paris Olympics athletes' village.

Two simulations were ran—the first to assess the impact of wind speed and direction on surface temperature and heat convection, and the second, a 3D model to simulate parameters such as insulation, ventilation, solar shading, and an ecological floor-cooling system on one of the village's floors.

These simulations demonstrated the efficiency of the solar shades, which adapt based on position and time of day, as well as the effectiveness of the cooling floors in regulating indoor temperatures throughout the day. As a result, SOLIDEO was able to gain crucial insights into how to enhance comfort within the buildings, even during heatwaves.

Flooding Risks

Flooding is one of the primary risks driven by climate change that poses significant human, social, and economic challenges. To better manage these risks, modelling and simulating of potential flood scenarios have become an essential component of urban planning for cities at risk.

In the riverside city of Keihanna, Kyoto, Dassault Systèmes partnered with NTT to demonstrate the power of virtual twin technology in simulating flood risks across various neighbourhoods. Their solution provided authorities with 3D hazard maps, allowing them to develop detailed flood evacuation plans.

> As cities strive to balance growth with sustainability, adopting science-based virtual twins can empower the leaders of today to create resilient, climate-ready urban environments that support both current and future generations.

Is Virtual Twin Technology Suitable to Cities of All Sizes?

Virtual twin technology is relevant for cities of all sizes, not just major metropolises. Smaller and medium-sized cities, too, face challenges that require agile solutions for crisis management and long-term sustainable development.

Hence, to cater to smaller cities with limited fiscal and manpower resources, Dassault Systèmes came up with a virtual twin as-a-service offering, "Sustainability and Resilience Cockpit for Cities" by Dassault Systèmes offers ready-to-use solutions that fit within a limited budget. This solution provides cities with limited technical expertise and which might be hesitant to invest in large-scale IT projects a chance to experiment the power of 3D simulations and data analytics in a virtual twin technology.

Shaping the Future

As cities strive to balance growth with sustainability, adopting science-based virtual twins can empower the leaders of today to create resilient, climate-ready urban environments that support both current and future generations. This powerful solution promises to become a cornerstone for modern urban planning, enabling cities to evolve into smarter, more sustainable environments. It will shape how cities, regardless of their size, anticipate challenges, optimise resources, and enhance the quality of life for their residents.