Kaunas City Digital Twin Creates a Digital Campus Ecosystem that Extends Beyond the University's Walls

Kaunas University of Technology Aims to Support Sustainable Renovations to Lithuania's Aging Buildings

In recent years, Lithuania has set ambitious goals for improving the emissions performance of its building stock. The roughly 661,000 structures in the Eastern European country are subject to rigorous national emissions performance requirements specified in Lithuania's building codes. An estimated 75% of these buildings were constructed before 1992 and have poor energy performance. The national building stock, including many Soviet-era structures, emits roughly 5.3 metric tons of carbon dioxide per year.

As laid out in Lithuania's long-term renovation strategy, approved in 2021, all these structures must be updated to improve energy performance by 2050. This plan is in line with the European Union's 2018 directive to address the energy performance of aging buildings and infrastructure, including the decarbonization of the national building stock.

With this use case in mind, Kaunas University of Technology's (KTU's) Centre for Smart Cities and Infrastructure has created the Kaunas City digital twin, a digitization of the university campus' built environment. The digital twin also stretches beyond the campus into Kaunas, Lithuania's second-largest city, offering 3D visualization of Old Town Kaunas.

KTU's Centre for Smart Cities and Infrastructure used Bentley's OpenCities Planner software as its main platform, allowing for the integration of various digitization technologies to enable multiple use cases for a digital twin—from energy performance simulations to real-time air quality monitoring.

For example, using Bentley's ContextCapture software intended for UAV-based reality modeling, KTU created a thermophotogrammetry model of KTU's campus area, which will be intended to analyze the heat loss of aging buildings and estimate the future heat loss of buildings still in the planning stages.

This functionality has already proven useful to the university as it considers renovations of buildings on its own campus. However, according to Darius Pupeikis, head of the Centre for Smart Cities and Infrastructure, this use could be expanded to buildings in Kaunas and beyond, both in Lithuania and internationally.

"We will have an opportunity to assess the heat loss of an entire block or district of buildings almost in real-time—that's why it could be quite an interesting technology," Pupeikis said.

Furthermore, the digital twin includes a "smart campus," a concept that uses a combination of reality capture, Internet of Things (IoT)Internet of Things and building information modeling (BIM) technologies to show and tag real-time sensor data on air quality and other conditions affecting human health within buildings at KTU. The "smart campus" also incorporates visualization functionality to display and simulate the shadowing effects of installed photovoltaic solar panels, showing where these units may face obstacles to producing their maximum energy output.

As the Kaunas City digital twin serves as an example for how aging buildings can be altered to prioritize energy efficiency, the center is also using digital twin technology to create 3D models of abandoned heritage buildings in tandem with Lithuania's Public Department of Heritage. They are digitizing historic structures now so that, even as these heritage buildings experience wear and tear or collapse in the years to come, they will be digitally preserved and may eventually be authentically renovated in a manner faithful to history. This effort includes buildings such as the Church of the Transfiguration of the Lord in Kaunas, which is listed in Lithuania's Register of Cultural Values.

"We have many heritage subjects. We need to find technologies that digitize Cathedral-Basilica of St. Peter and St. Paul, and a customs building at Latvia's and Lithuania's border, because each day, erosion causes destruction for those buildings," Pupeikis said.

The function of the digital twin model has also been tested during the process of erecting new buildings. Currently, the center is using a digital twin to monitor the construction of KTU's new MLab, a prototyping lab on campus. Using the capabilities of the BIM model developed by Bentley's OpenBuildings Designer software, KTU can ensure safe conditions through all stages of construction, from laying foundations to topping out the building's fourth floor.

A Digital Sandbox

Aside from its practical uses for energy efficiency monitoring and infrastructure upkeep, the Kaunas City digital twin also offers a rich tool for students' development as they move into careers that are increasingly digitally focused. Students studying architecture at KTU, for example, have the opportunity to see their own projects reflected in a digital twin.

"Our civil engineering and architecture students can accommodate the project and educate themselves by using this platform. This digitized environment is like a sandbox for our students," Pupeikis said.

The digital twin also enables virtual campus tours, using 360 panoramas technology to take users inside 19 of KTU's facilities, giving them a peek inside classrooms, libraries, labs, dorms, and other spaces. Students or other users can even click on facilities and devices to learn information, such as what kind of equipment might be available in each lab or classroom.

This "sandbox" is not just open to KTU students and faculty, but the larger Kaunas community as well. In the future, Pupeikis imagines that citizens could use the Kaunas City digital twin or a similar tool to view municipal projects that are under construction, thus empowering civic participation in Kaunas and beyond.

Spotlight on Darius Pupeikis

Head of Kaunas University of Technology's Centre for Smart Cities and Infrastructure Leads Digital Twin Initiatives

Established in 2019, Kaunas University of Technology's Centre for Smart Cities and Infrastructure has a vision to establish a point of community for people dedicated to creating "smart cities"—digital twins that offer interactive insights on infrastructure, sustainability, and development. Darius Pupeikis, the program's leader, feels passionate about making that community an interdisciplinary one.

"We need information technology experts, civil engineers, HVAC engineers, construction engineers, site engineers, facility managers, even data scientists on our team," Pupeikis said. "That's why an interdisciplinary between civil engineering, architecture, information technologies, electrical engineering, automation, data science and others is crucial—because if all the team members work in separate ways, we probably wouldn't be fruitful."

Pupeikis' own background primed him to see the connections between various specialties. Initially, he had an interest in computer science, as well as the technical sciences, and gravitated toward the engineering field. He earned a bachelor's degree in construction materials, a specialization of civil engineering, and went on to earn his master's degree in construction technologies at KTU. For his Ph.D., also at KTU, Pupeikis shifted slightly to focus on building physics.

While he focused on engineering built environments throughout his academic training, Pupeikis maintained an interest in computer science, and saw the marriage of these interests in the emerging arena of digital twin technology.

As an associate professor of civil engineering and architecture at KTU since 2013, Pupeikis focused on projects related to infrastructure digitization as the construction industry increasingly began to look toward digital innovations. By 2019, he had officially been tapped to lead the campus' new Centre for Smart Cities and Infrastructure, which was created in partnership with Bentley Systems and the companies YIT Lietuva, INHUS Group, Staticus, and Kauno Tiltai, as well as Skaitmeninė statyba, a public institution in Lithuania.

"I have a good opportunity now to mix those various competencies that I gained in the past. Currently, my main interest is digitalization. It's become a good interdisciplinary field to combine engineering with information technology," he said.

As he sees it, however, there is still work to be done to streamline efforts in what he sees as a "fragmented" industry, even in terms of the software required to bring construction projects into the digital age.

"The main challenge we face is a problem with interoperability," Pupeikis said. "We have plenty, even hundreds, of software packages [used in] the lifecycle of buildings and infrastructure."

Bentley software has helped him to make headway on this issue. With the current digital twin projects at KTU, Bentley's OpenCities Planner has served as a synergetic platform for various Bentley applications. Looking to the future, Pupeikis said he is also interested in employing OpenStack virtual machines as they become available to further improve interoperability.

Image Link:

Image Caption: Aside from its practical uses for energy efficiency monitoring and infrastructure upkeep, the Kaunas City digital twin also offers a rich tool for students' development as they move into careers that are increasingly digitally focused. *Image courtesy of Kaunas University of Technology.*

Author: *Prathamesh Gawde is a senior product marketing manager at Bentley Systems. He can be reached at prathamesh.gawde@bentley.com.*

2022 *Going Digital* Awards Winner