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Centre for Smart Cities and Infrastructure

ANNUAL REPORT 2020

During the past year, the COVID-19 pandemic situation revealed how much digitalization was important for humanity. The construction sector and built environment, in general, were no exception. Motivation to undertake digitalization increased and changed people's mindset regarding the necessity to apply modern innovations. One can say that CSCI is on the right way.

Despite the fact of the pandemic situation, 2020 was intensive for the CSCI team. We have performed 2 non-formal upskilling programs for construction practitioners, carried on the development of the national BIM methodology in Lithuania, achieved 2 international EU H2020 and 1 national R&D grants, successfully finished the first season of DEC LT project for school students and launched a new one.

2020 was rich in virtual events. Some of the most important events were the conference Construction 4.0, organized by CSCI during the virtual exhibition RESTA and Digital Twin awareness Day, wherein KTU CSCI was represented together with the University of Cambridge, Volkswagen, General Electric, etc.

Moreover, several colleagues from the University joined the CSCI team to speed up the development of Digital Twin of Kaunas and KTU Campus.
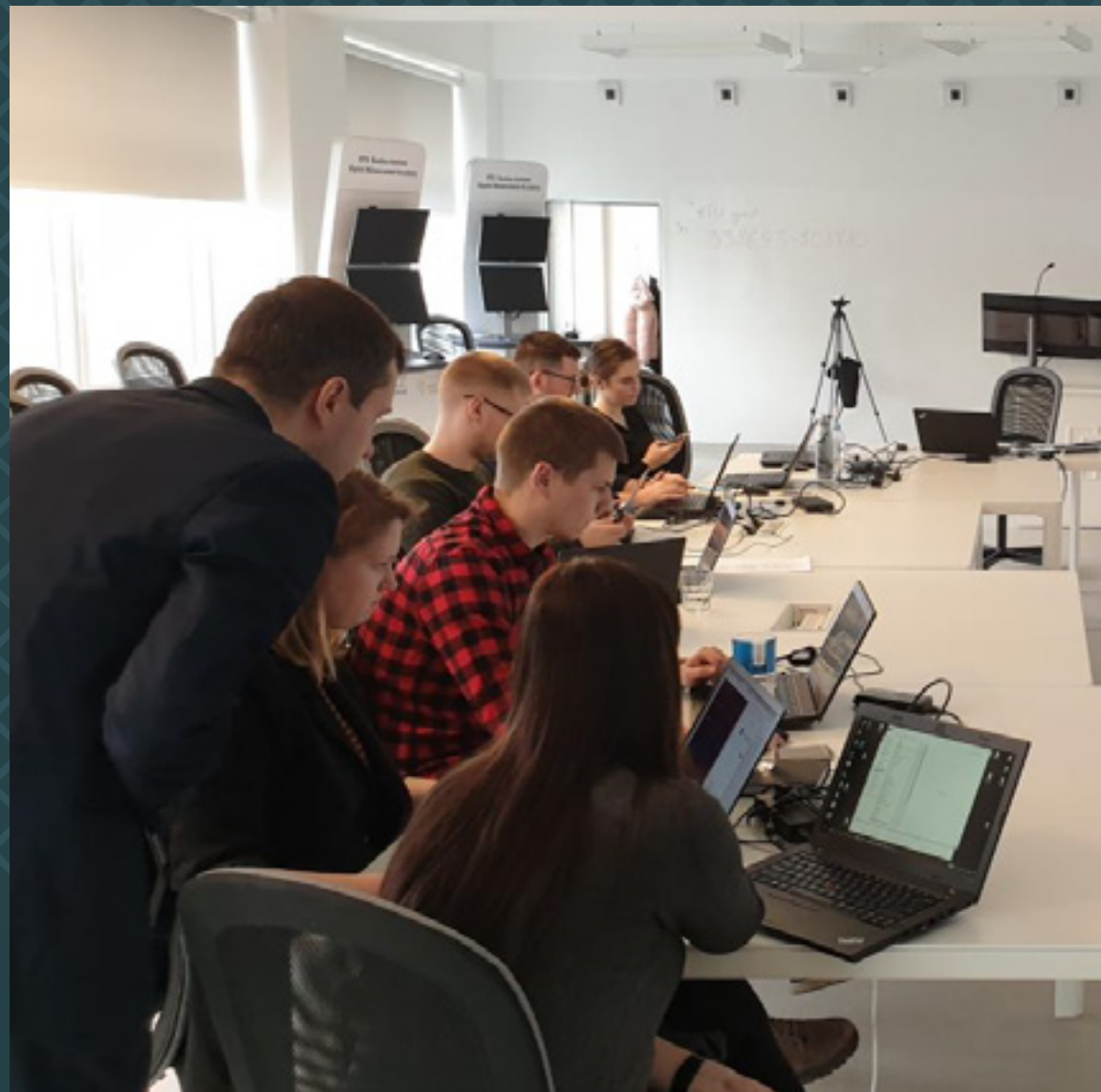
We are glad for having the possibility to undertake activities related to construction digitalization and looking forward to taking up new challenges in 2021.

Head of CSCI

Darius Pupeikis

TIMELINE

3/3/2020 ◇ Data Analytics and Machine Learning course for the AEC sector
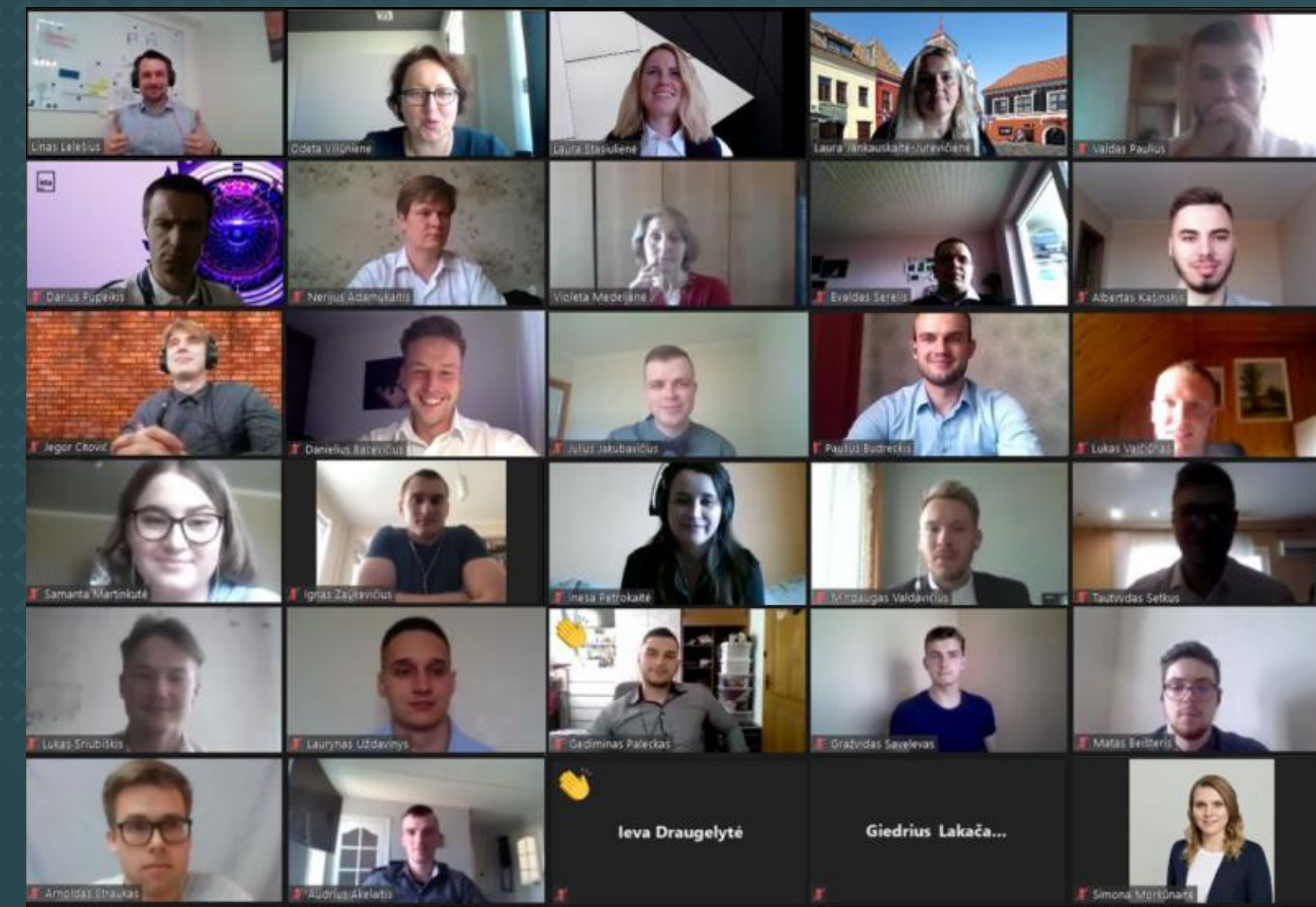
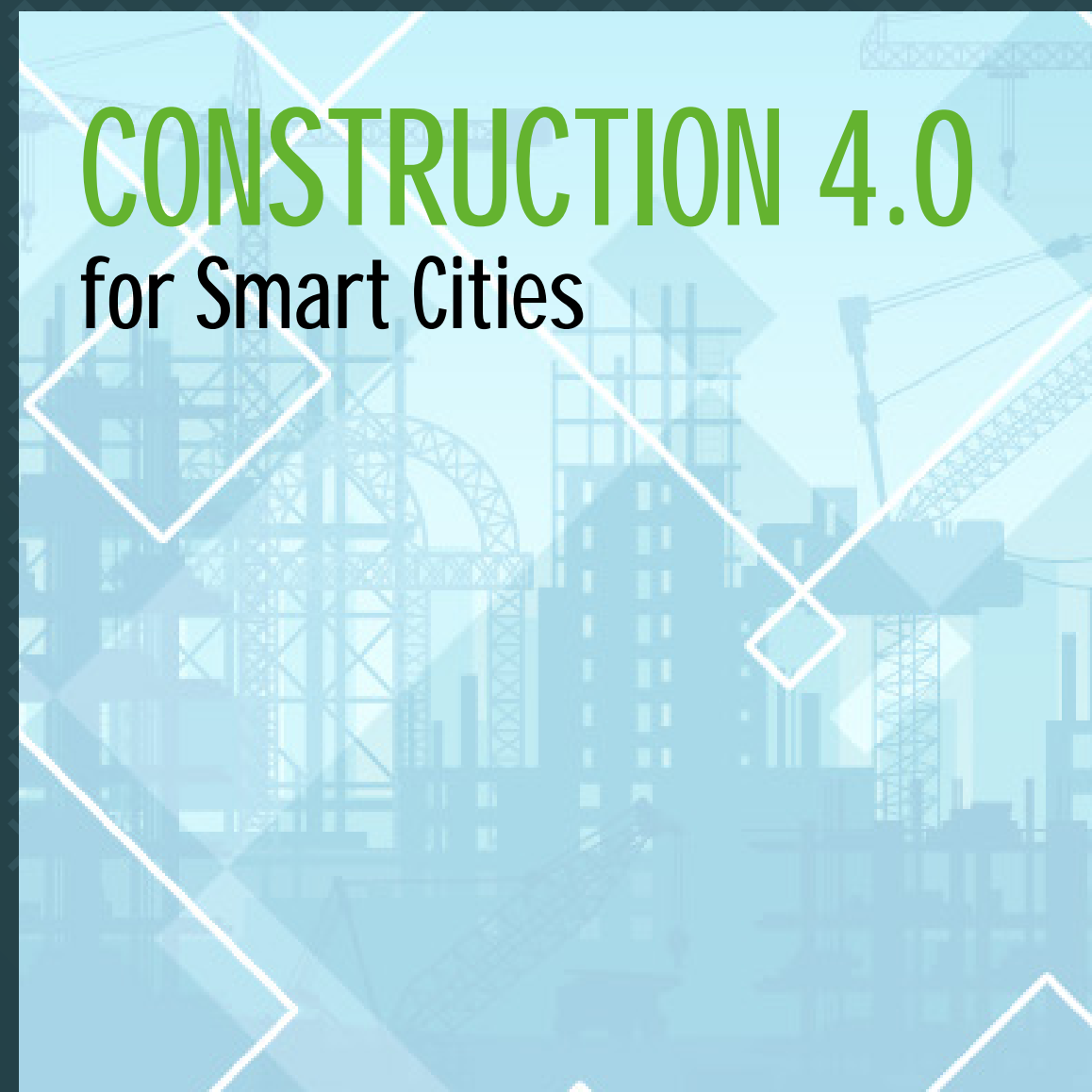5/13/2020 ◇ Kaunas Digital model first time published for public use

5/28/2020 ◇ First year of DEC LT project finished! 12 Teams projects evaluated by experts and 6 of them nominated for prices

6/1/2020 ◇ Final Thesis organized online for the first time at the Faculty of Civil Engineering and Architecture, KTU

CONSTRUCTION 4.0
for Smart Cities

6/3/2020 ◇ The conference "Construction 4.0 for Smart Cities" organised

7/28/2020 ◇ Andrius Jurelionis, Initiator of the Centre for Smart Cities and infrastructure and Timo Tuukkanen, M.Sc. in geomatics from the Helsinki University of Technology, participated in online discussions about smart cities

8/19/2020 ◇ The establishment of the Lithuanian National Construction Classification System and the creation of its information system approved by Government. The project was created by KTU CSCI and VGTU teams
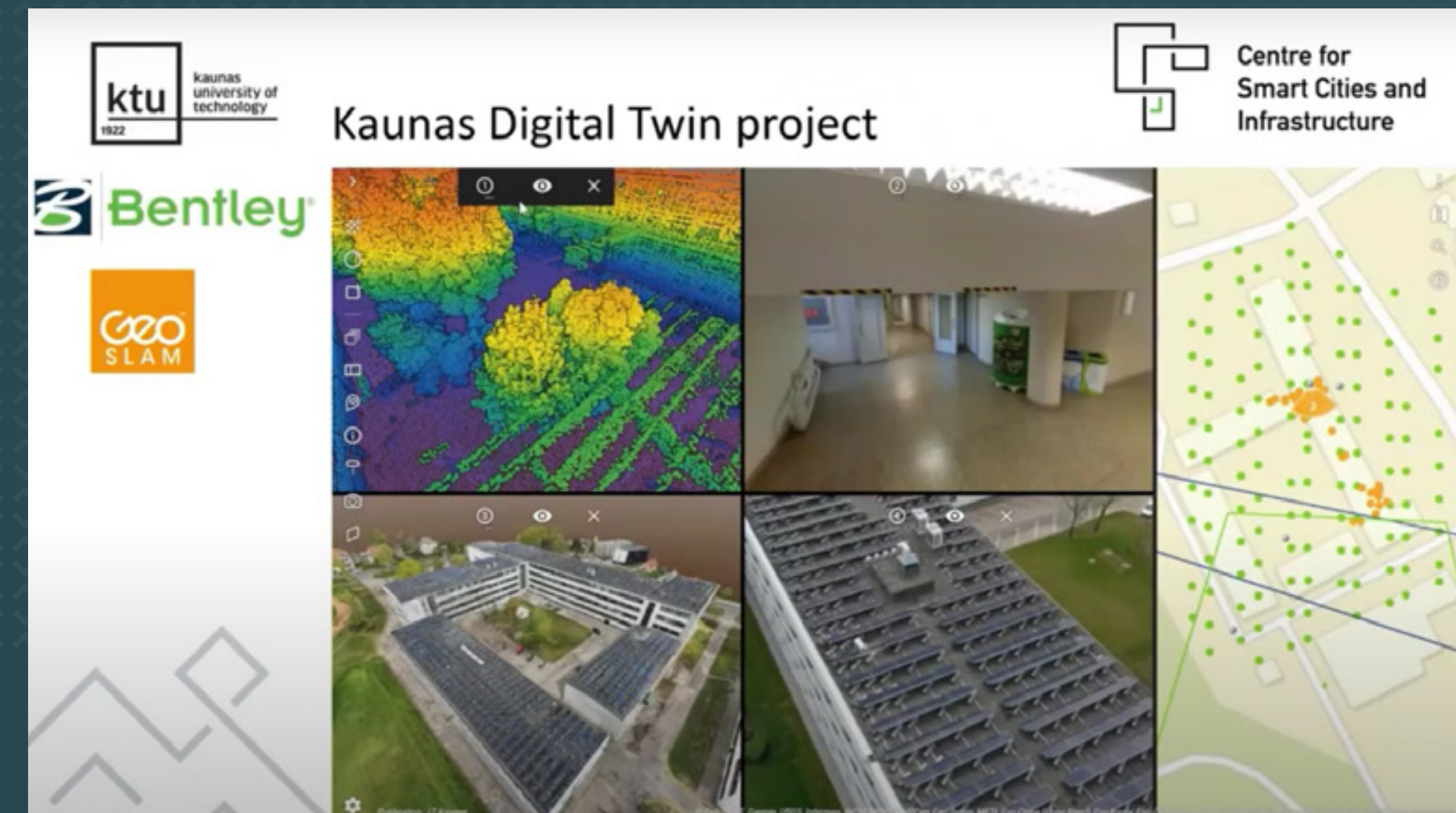
9/22/2020 ◇ CSCI presented by Andrius Jurelionis in the international event "Digital Awareness Day" organized by Bentley Systems

9/29/2020 ◇ New Session of DEC LT
project with 4 schools
and a new challenge in
the Music House, Kaunas
(LRT OPUS joins as one
of project partners)

12/17/2020 ◇ For 80 birthday of the
Faculty of Civil Engineering
and Architecture, a movie
was made where our team
members presented CSCI
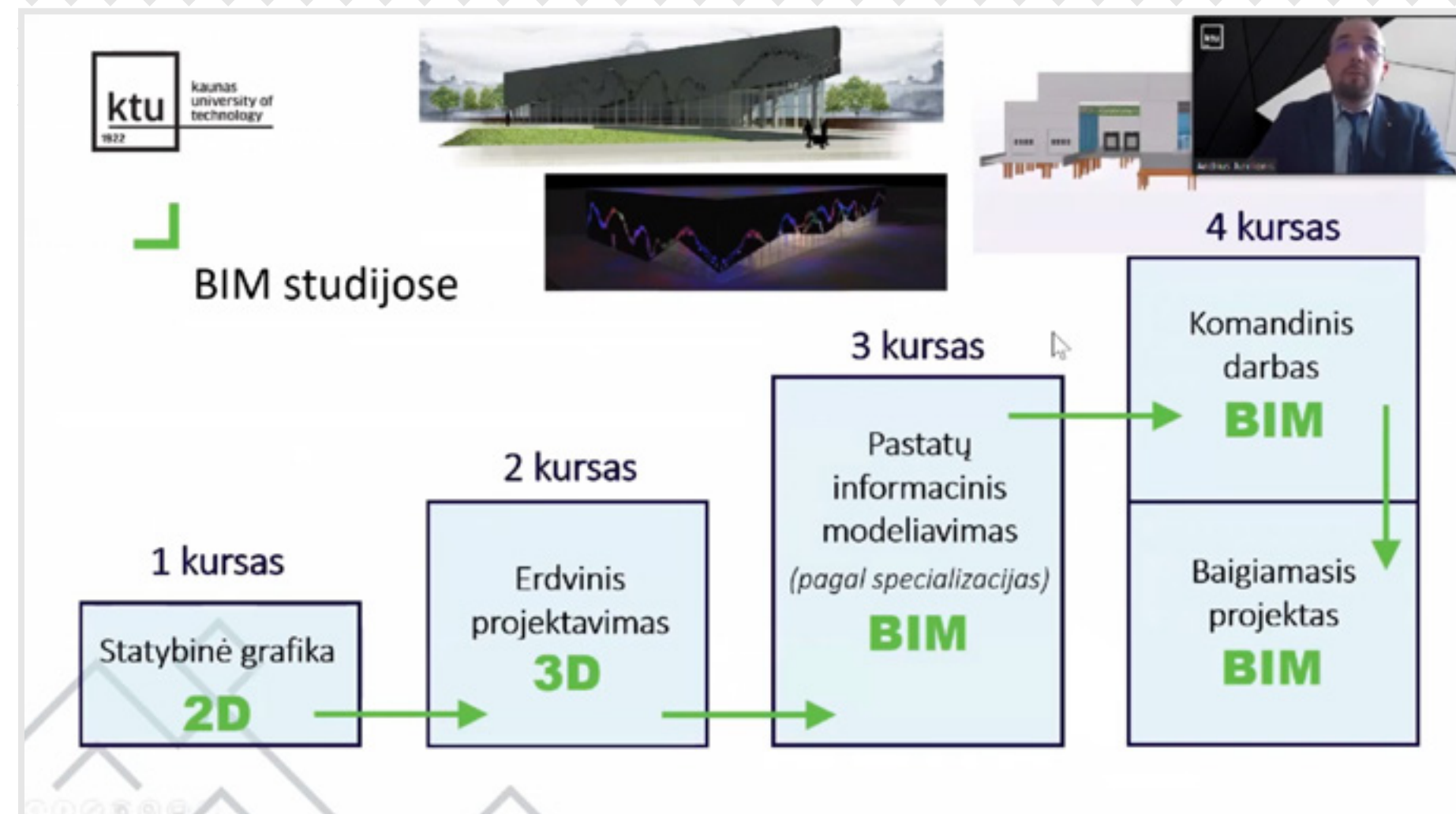goals and ideas of
digitalized future

How did it happen that construction, one of the main areas of the economy, is often mentioned as an inefficient industry?

It is no secret that high fragmentation among the participants in the process contributes significantly to this. Lack of cooperation is one of the main problems, leading to the implementation of unanalysed solutions, the creation of unreliable data on buildings and the waste of raw materials, human and financial resources. Digitization of buildings and environments can help address this by developing their information models, digital twins, and using a common structured data environment. The benefits of digitization are evident in both public and private sectors, enabling rational and informed decisions to be taken at the appropriate stages of the life cycle of a building, site or other property. This is important for the development of cities, states and various types of organizations.

In 2020, we joined *RESTA*, the biggest expo event of construction in Lithuania, and organized online conference *Construction 4.0 for Smart Cities* to see what academia and businesses think about the implementation of digitalization.

CONSTRUCTION 4.0
for Smart Cities

🗓 3 June 15:00

KTU Faculty of Civil Engineering and Architecture
Centre for Smart Cities and Infrastructure

imic.ktu.edu

Prof. dr. **Andrius Jurelionis**

Dean of the Faculty of Civil Engineering and Architecture, KTU: "Digitization Opportunities for Universities and Their Graduates" (LT)

"Digital technologies, consistently incorporated into the studies, unlock completely new opportunities to attract talented young people to architecture and civil engineering."

David Robertson

Director of Digital Advancement Research for Bentley Systems: "Disruptive Technology - Really!" (EN)

"Digitalization is our new reality. If you got a camera inside your phone and go outside, see a hole in the building take a video of it we will be able to build a model of that too."

⌃
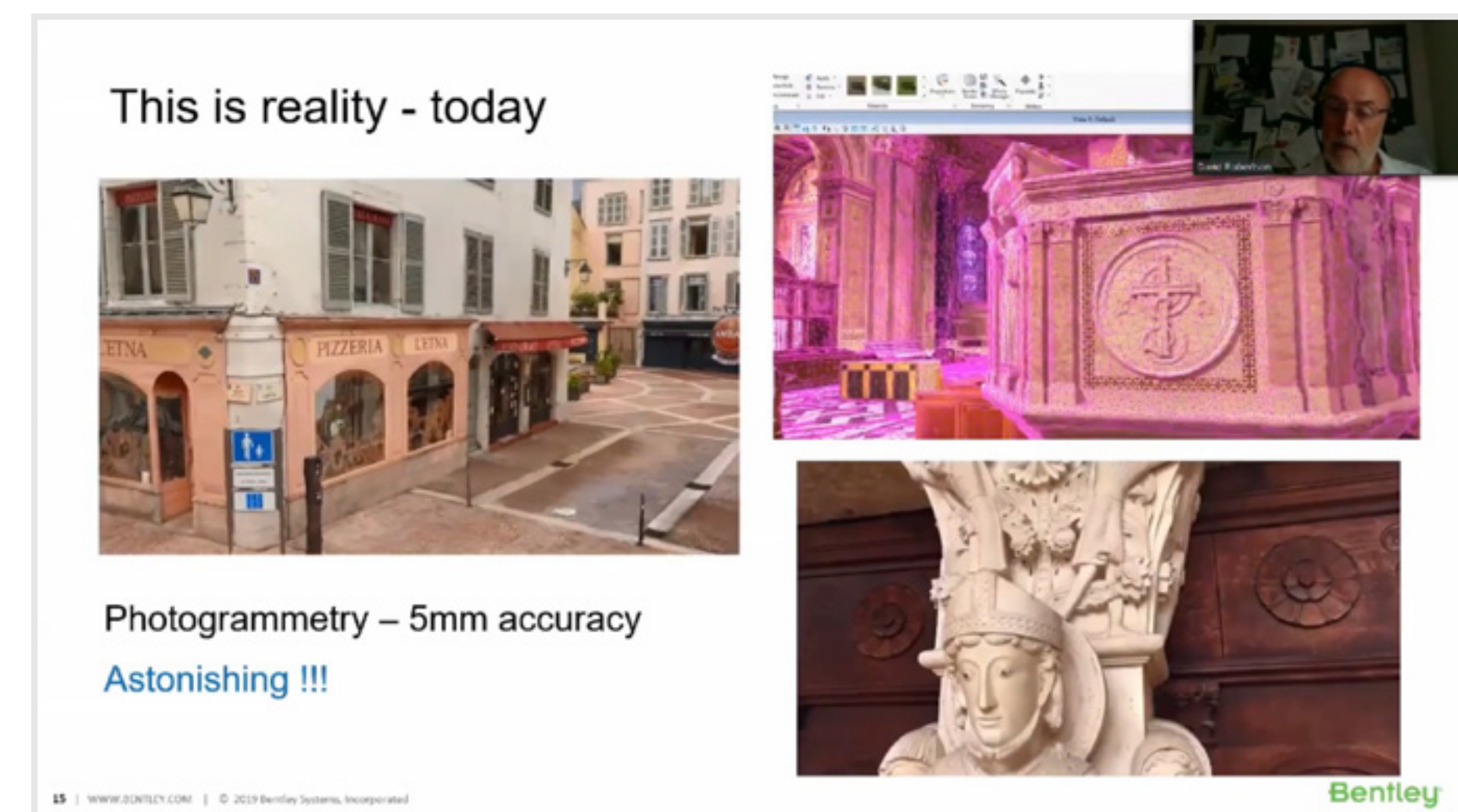
Prof. dr. **Kęstutis Zaleckis**

the Faculty of Civil Engineering and Architecture, KTU: "Digital Urban Models: An Example of Public Transport System Modeling" (LT)

"Examples of public transport modeling open up opportunities to improve urban transport planning, change in stops positions, routes and etc."
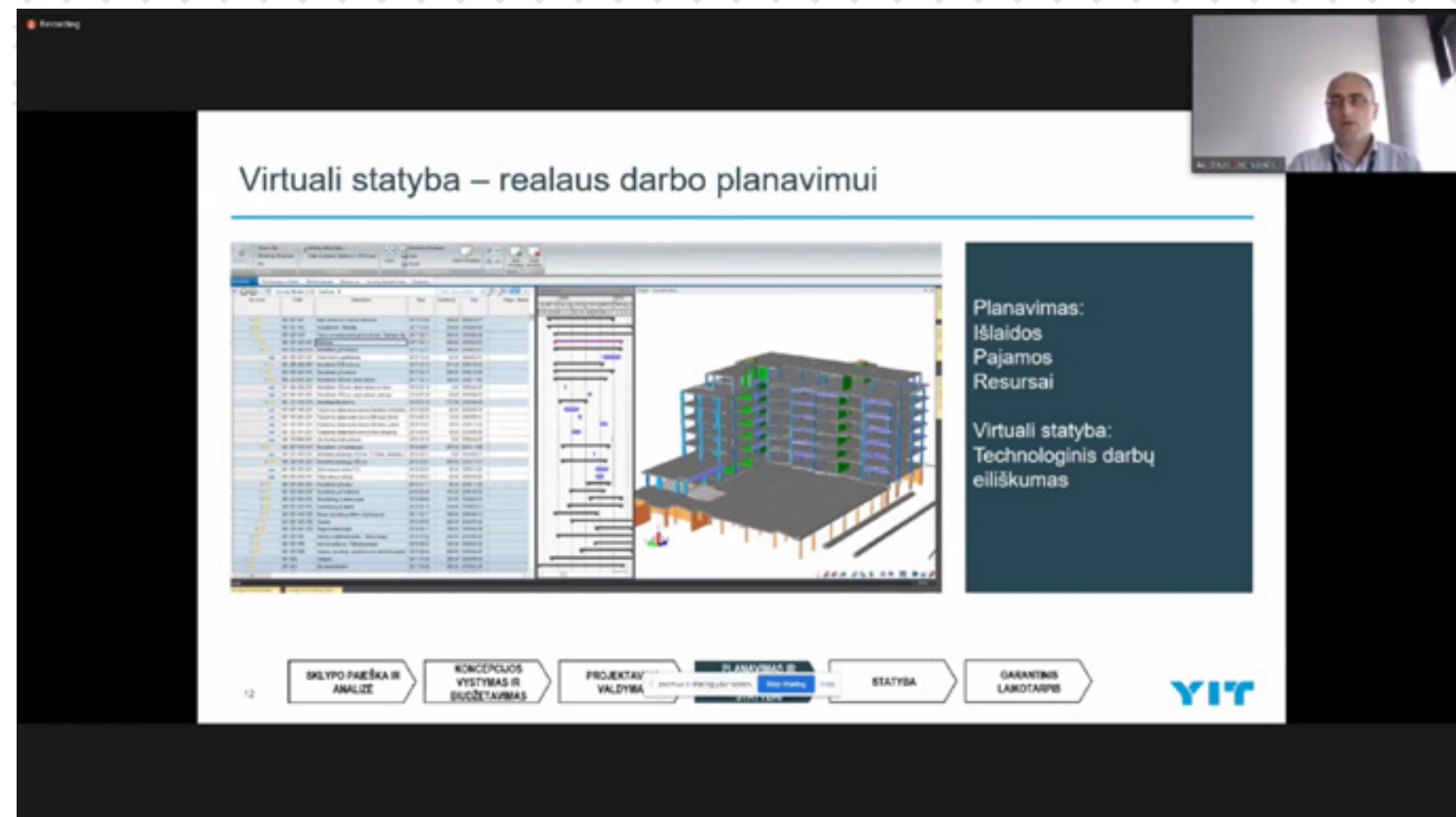
Tomas Mažeika

Head of Geodesy Department, Kauno tiltai: "Digital technologies used in our construction objects" (LT)

"Digital technologies reduce the possibility of errors and save material. We believe that the economic benefits of digitization are 20%."

⌄
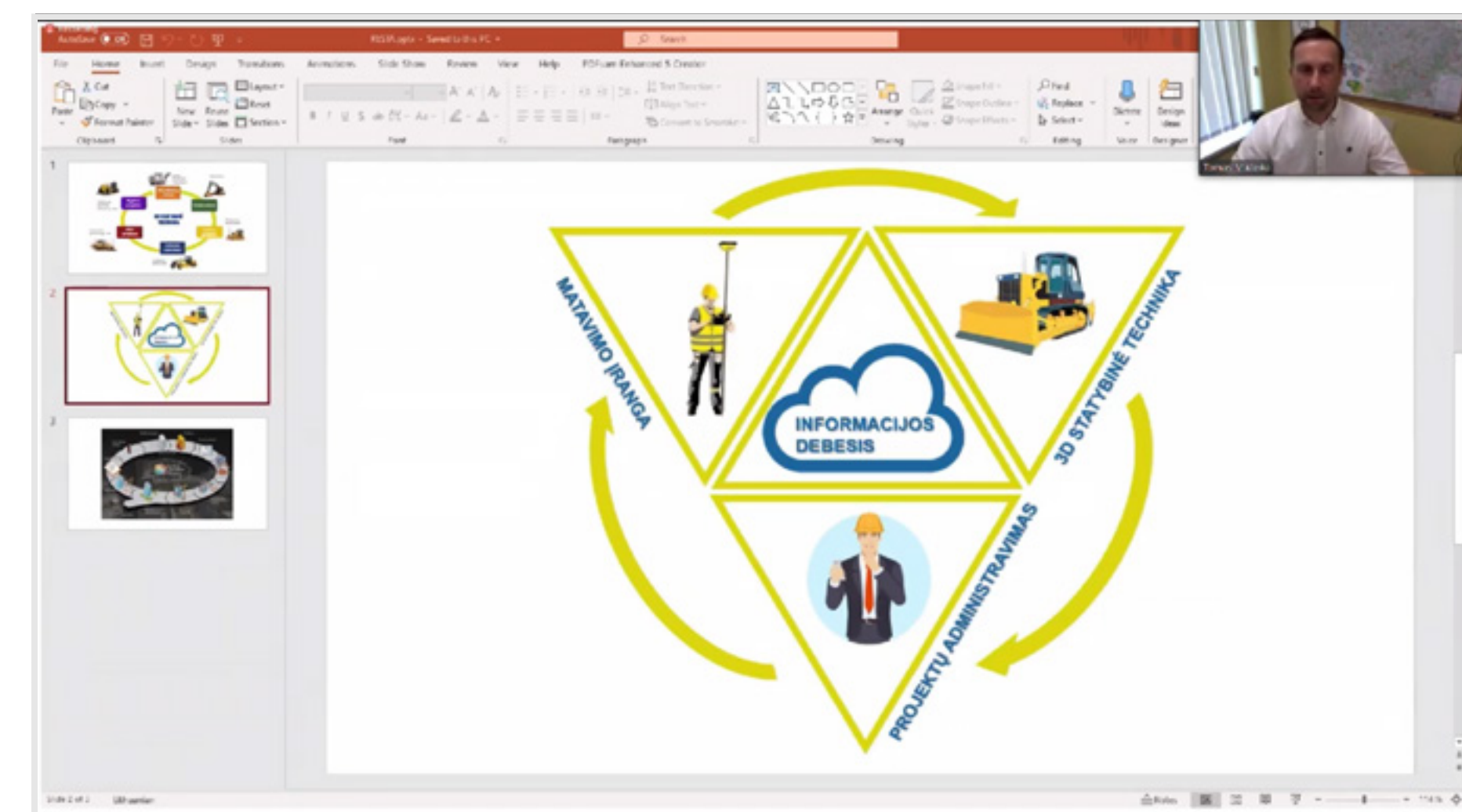
Audrius Leonavičius

YIT Lietuva BIM CEO: "BIM - efficiency leap in construction"

"The IT sector is evolving very rapidly, with many tools emerging that have made it possible to facilitate day-to-day work, but their adaptation to digital construction is not rapid. The company's processes must change, people must acquire new competencies.

Dr. **Darius Pupeikis**

Head of KTU Smart Cities and Infrastructure Center: "BIM Strategy for Lithuania"

"In 2020 we prepared standard, now in 2021 we will be testing and improving all of it: methodologies, standards and qualifiers."
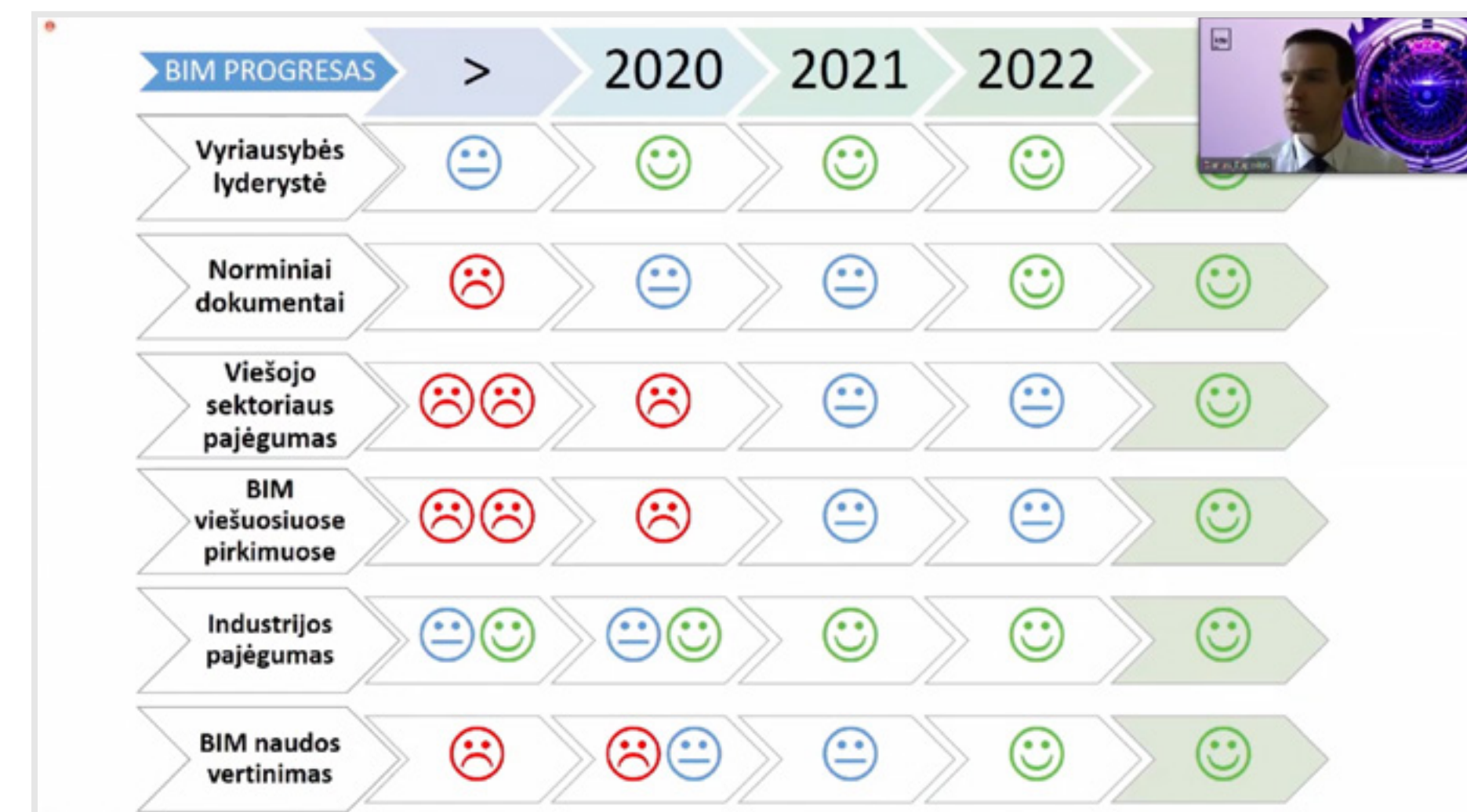
Dalius Gedvilas

President of the Lithuanian Builders Association and Director of Digital Construction: "BuildingSmart: What are the benefits of BIM process standardization?"

"There is a need to establish clear standards for the data generated and processed by the Internet of Things and other equipment."
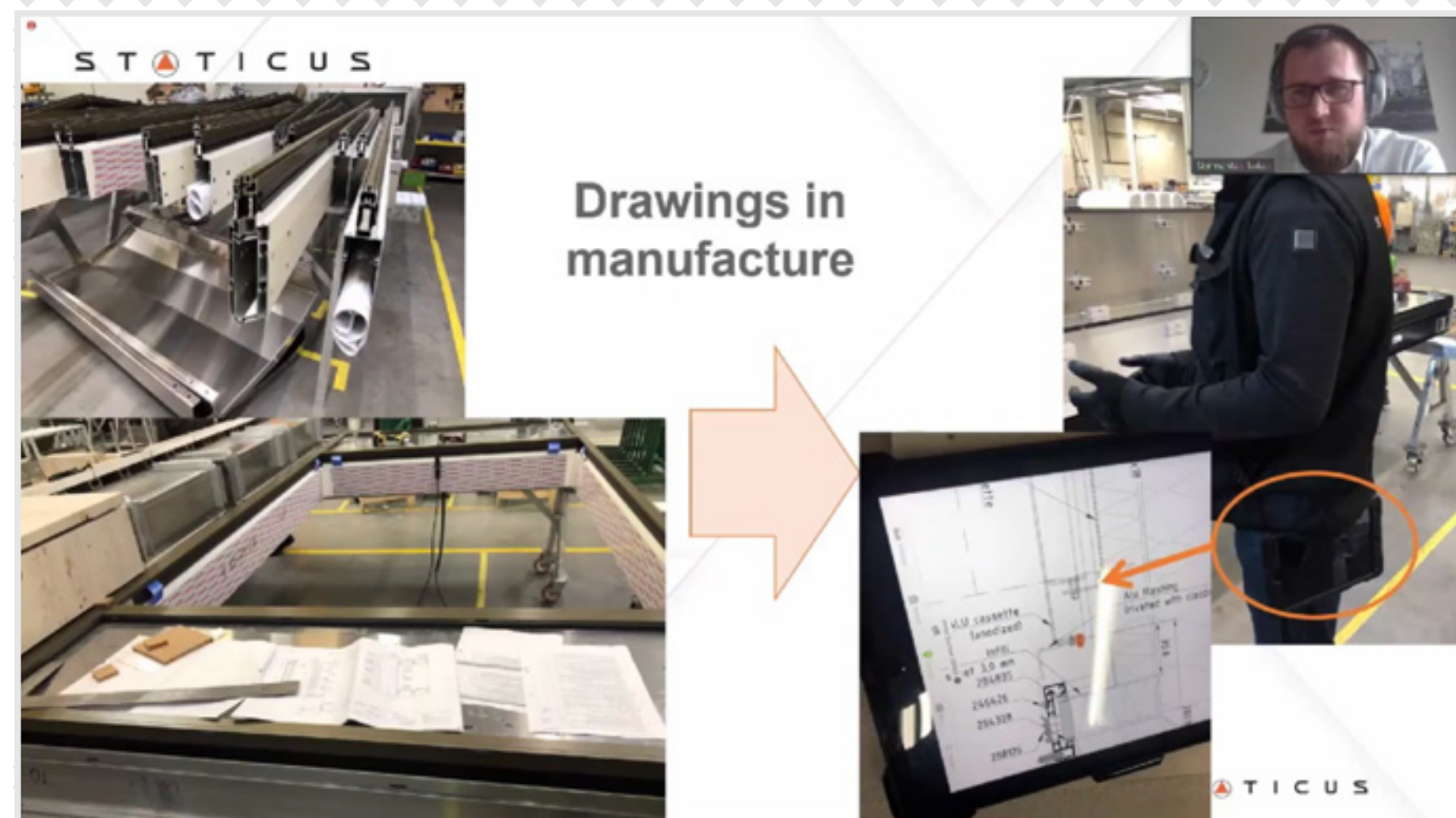
Audrius Tulaba

CEO of INHUS Group: "Visible and invisible benefits of digitization"

"There will be less work on construction sites and more buildings will be manufactured in factories."

Skirmantas Bakas

Head of Staticus Design Department: "Digitization of Production in the Face of a Pandemic"

"We have digitized the communication between projects and production departments. All drawings are not only displayed and interactive, but the production line can communicate directly with the designer, marking the notes in the drawings."

MOVING KAUNAS TO THE DIGITAL WORLD

How to be more open to public and show what the city really is? Let them fly over it and look at it from the sky. Play with the sun, choose between different projects of new buildings and structures. Measure everything and see real life data in one place. All you need for that is the Digital twin of the city.

In a broader approach, the digital twin of the city is a digital model that replicates the main urban and architectural features of the city. Such a model can be supplemented with various data, such as GIS layers, projects under development, city vision, etc. KTU IMIC is creating a digital twin of Kaunas following the good examples of Panevėžys and Vilnius.

What we are doing with it

The development of the project started from the Old Town, followed by other historical parts of the city (Naujamiestis, Šančiai). The digital twin of Kaunas city is being developed on the Open Cities Planner (OCP) platform. Such model is linked to the coordinate system (LKS 94) and can be populated with various data as needed after loading into the OCP. It can be:

> open digital maps;

> 3D models of individual objects (e.g., projects under development (*Fig. 1*) or historic buildings (*Fig. 2*));

> various databases (GIS);

> links to other websites, OCP projects or other integrated media.

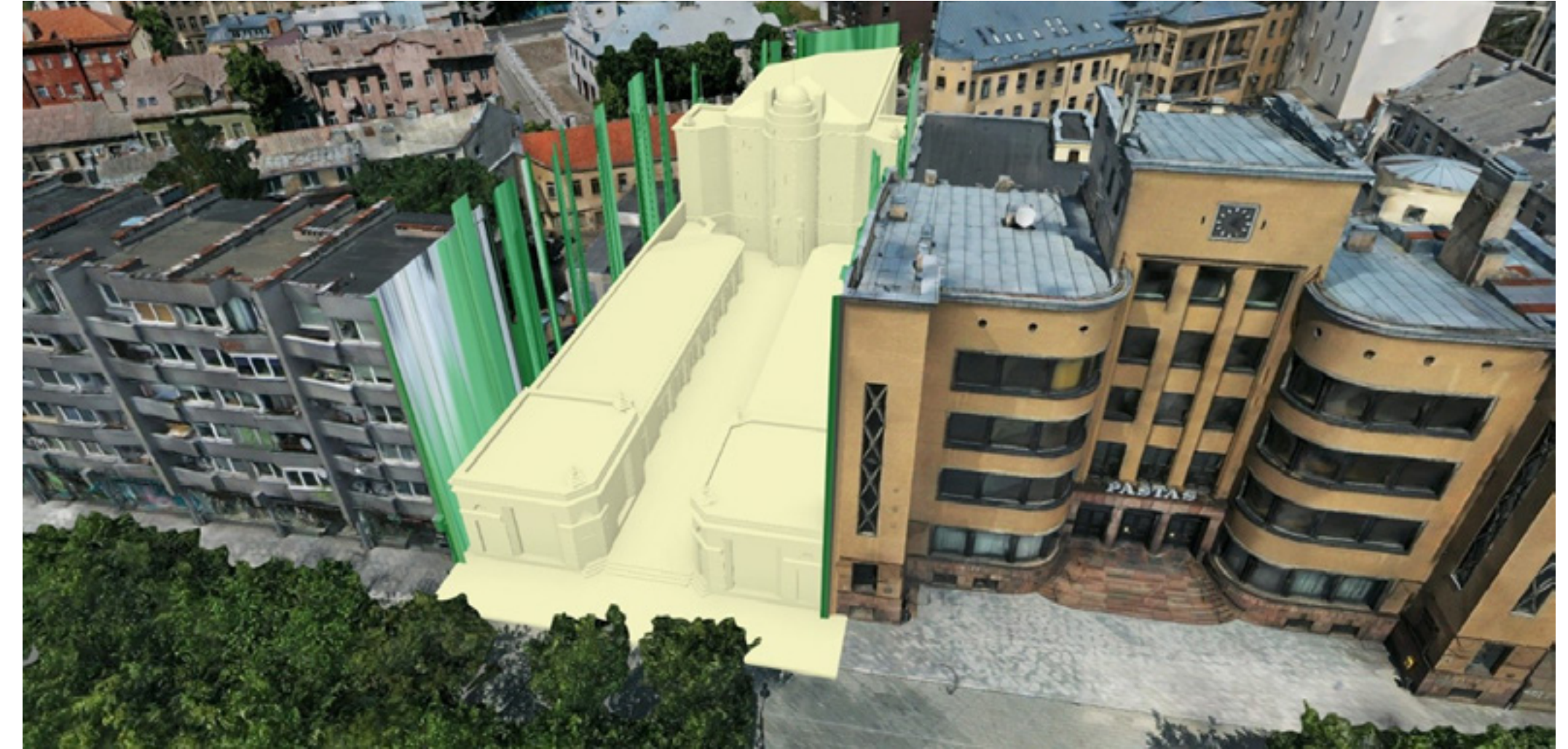**Fig. 1. Project of a residential quarter under development**

Fig. 2. Historic Central Jewish Bank

A properly made digital twin of the city allows you to look at the area from new angles, generate images (a picture or a video), simulate sunlight and shadows. The OPC also has the possibility to conduct surveys on the area or an object in question. The digital twin city is a tool for publicizing ongoing construction projects, preserving the appearance of cultural heritage sites, creating architectural experiments or conducting research, shaping the city's image and promoting tourism.

The uploaded project of a building or a site can be viewed by everyone. It is so easy to assess how the project is compatible with the existing environment and whether it does not cause visual pollution. It also allows to compare several sites or building variants. For these reasons, the digital twin is a great platform to publicize and evaluate the projects of architectural contestants and get feedback from local people.

KTU FCEA has been integrating the Kaunas city digital twin into the study programme as a platform for students to create their own course and final projects, as the developed project is uploaded to the environment in which it is designed: Fig. 3 and Fig. 4.

Currently, a model of Kaunas city has been created, covering the territories of Old Town, Naujamiestis, Aukštieji Šančiai and KTU Campus and separate parts of Kaunas district. We plan to further expand the size of the model to include Žemieji Šančiai, Panemunė, Žaliakalnis. Along with the expansion of the model, the quality of the model itself is improved. It is planned not only to expand the model, but also to constantly update it. Sadly, we are depending on weather and seasons.

Fig. 3. Project of student G. Viliūnas

Fig. 4 Work of student T. H. Busse

How it's done?

The photos required for the creation of a photogrammetric 3D model of Kaunas city were taken with the help of an unmanned areal vehicle (UAV) Applied flight and photo-taking techniques for large areas have helped to optimize the processes of photo-taking and 3D model reproduction, as well as the quality of the model itself. The COVID-19 pandemic factor was also exploited. During the spring quarantine, the streets of the old town were empty, so the beauty of old-time architecture was immortalized by the abundance of cafe umbrellas and visitors to the old town. Some difficulties were inevitable:

> weather conditions (cold, heat, strong wind, rain);

restrictions on unmanned aircraft flights (military areas, municipality restricted areas).

Bending exteriors with interiors

We want to be able not to just observe what buildings look like from outside but to create opportunity to see them from the inside as well. During the quarantine period, we made our main building 3D interior model as it's build with lasers and photo fixation. Now our goal is to integrate it in Kaunas Digital model with exact coordinates. But it is not so easy. Inside the building, the GPS signal is blocked due to environmental disturbances, obstacles or a small number of satellites, etc. Thus, it is not possible to calculate and eliminate satellite signal errors in real time. So we needed to integrate tacheometer and over ways of calculation, which ensured accuracy, reliability and further use of the 3D city model.

Fun Fact: In 2020, 39,969 photos were taken using a drone to create digital twins. When taking the photos, 1,008 km were flown.

2019 · 2020

If digitalization creates guaranteed benefits for structure owners, builders and users, why is our public sphere behind it? One of tools is to implement it at national legal system. That's where BIM-LT project works towards the goal of developing National Construction Classification System. And CSCI is part of the main team.

In general, the aim of the BIM-LT project is to increase the efficiency of the use of resources allocated for the planning, design, construction, operation and management of construction within the public sector buildings and infrastructure by applying Building Information Modelling methodology.

The main outcomes are focused to develop the National Construction Classification System, BIM value benchmarking methodology for Lithuania, common rules and the so-called BIM protocol intended for the BIM-based public procurement process. Normative documents for building information management, as an employer information requirement (EIR), BIM execution plan (BEP), BIM guide, vocabulary, common data environment and level of information need to be standardised. Another commitment is to find solutions for possible BIM data integration and information exchange within the existing public information systems. Moreover, one of the project's tasks is to educate representatives from governmental and municipality institutions, responsible for construction-related administrative processes and for the development and maintenance of public assets, such as buildings, roads, utilities, etc.

2019 · **2020**

In 2020, the Government of the Republic of Lithuania made several significant decisions related to BIM-LT project. On the 20th of May and the 1st of July , 2020, the Lithuanian government decided to apply the BIM obligation to a part of public buildings, which estimated construction cost exceeding 5 million EUR and construction cost for infrastructure objects exceeding 10 million EUR. On the 12th of August, 2020, the Government has taken another important decision for the future of the construction sector. The establishment of the Lithuanian National Construction Classification System and the creation of its information system were approved.

Currently, the project is getting more accelerated and initial versions of the mentioned documents and methodologies have already been prepared. The following stage will be related to piloting and testing project's outcomes in real cases and different scenarios by taking public buildings and infrastructure as a pilot object.

The CSCI team are proud to have the opportunity to develop national BIM standards and are keen to be a part of the BIM community in Lithuania.
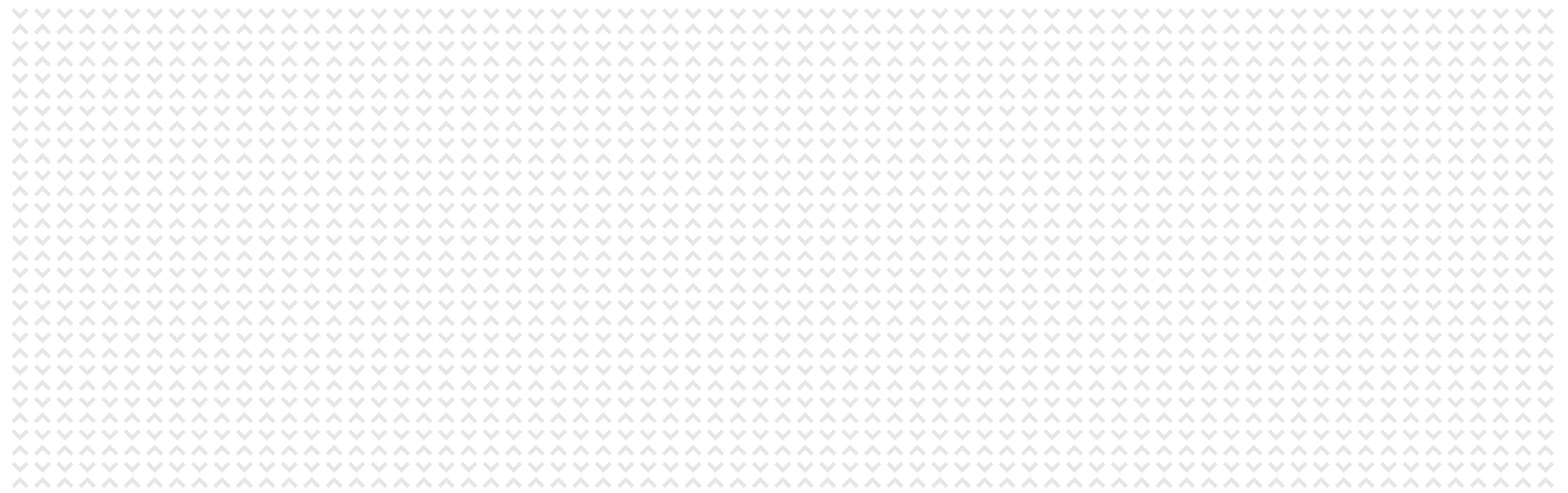
The technology for generating electricity using photovoltaic solar modules is one of the fastest growing at the moment. However, the practical experience of installing such power plants in buildings in Lithuania is just beginning. The countries that most commonly apply such technologies are the ones that differ from Lithuania with regard to their climatic conditions, financing practices and other characteristics of the building sector.

Therefore, it is necessary to identify technical and economic solutions suitable for Lithuanian conditions when installing solar module power plants. The most accurate results are obtained by examining specific real buildings, territories and their adjacencies, which affect the attractiveness of project implementation. Case analysis by creating 3D models of specific objects using unmanned aerial vehicles and photogrammetric methods allows to accurately assess the attractiveness of the implementation of technologies for the production of electricity by solar modules.

Using our digital 3D models of the environment (buildings and other adjacencies) together with the Lithuanian Energy Institute (LEI), we have made the evaluation of possibilities of installing a solar power plant in the Institute territory.

The shadow falling on the photovoltaic power plant module can greatly reduce the amount of energy absorbed. This results in lower electricity production, which reduces the overall efficiency of energy production and increases the financial loss to the investor. Shadows can be cast by elements on the roof, such as edges or skylights, engineering equipment and various adjoining areas (buildings, vegetation, etc.). Properly estimating the influence of proximity requires a photogrammetric image of the terrain, as it is difficult and labour-intensive to manually create such a large model.

The following direction of our research is combination of solar power plants with other electricity and heat production technologies (heat pumps, solar collectors) after assessing the peculiarities of energy used in buildings and adjacent buildings (e.g., a stadium near a renovated school as a potential land, water accumulation).
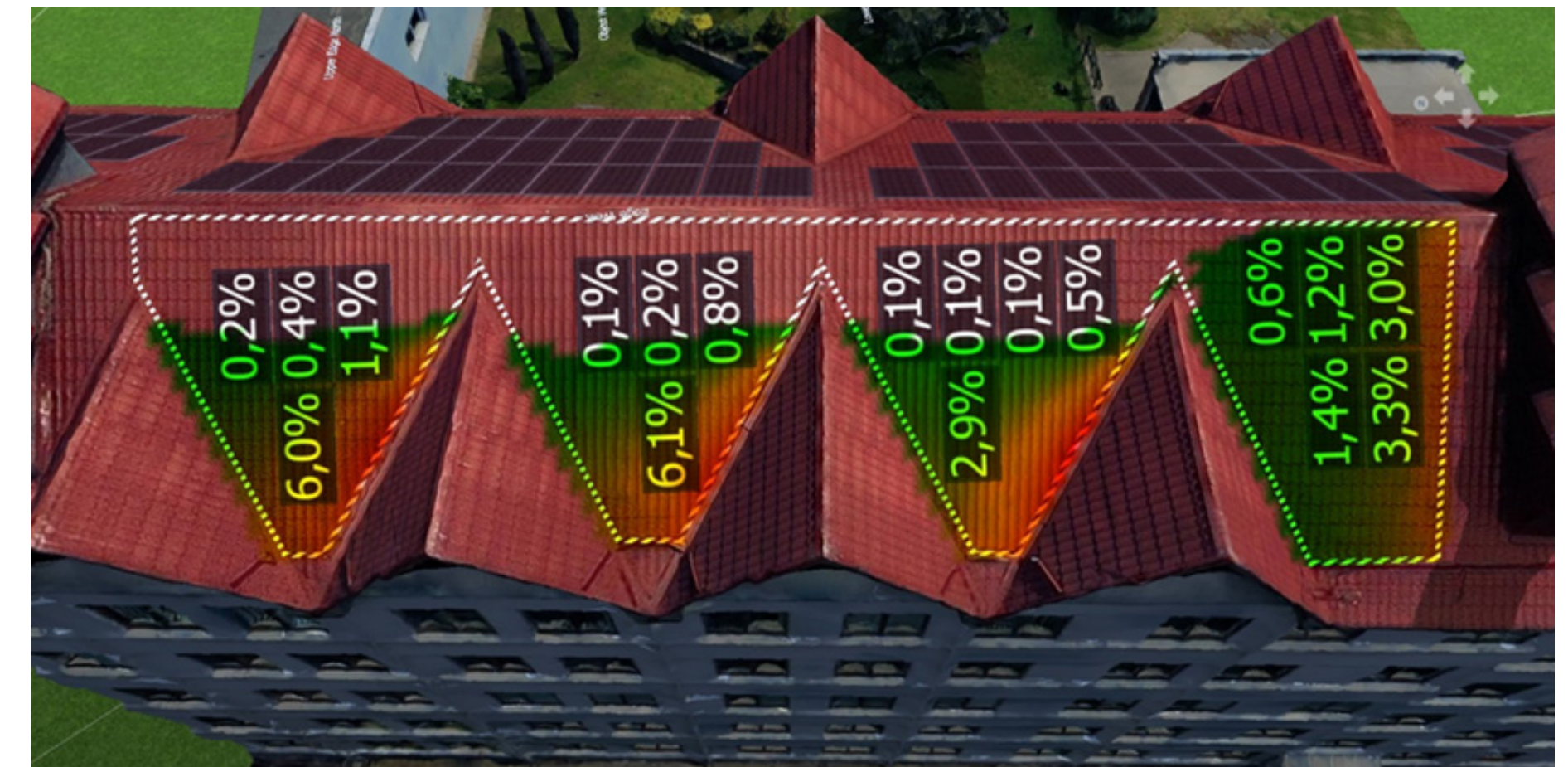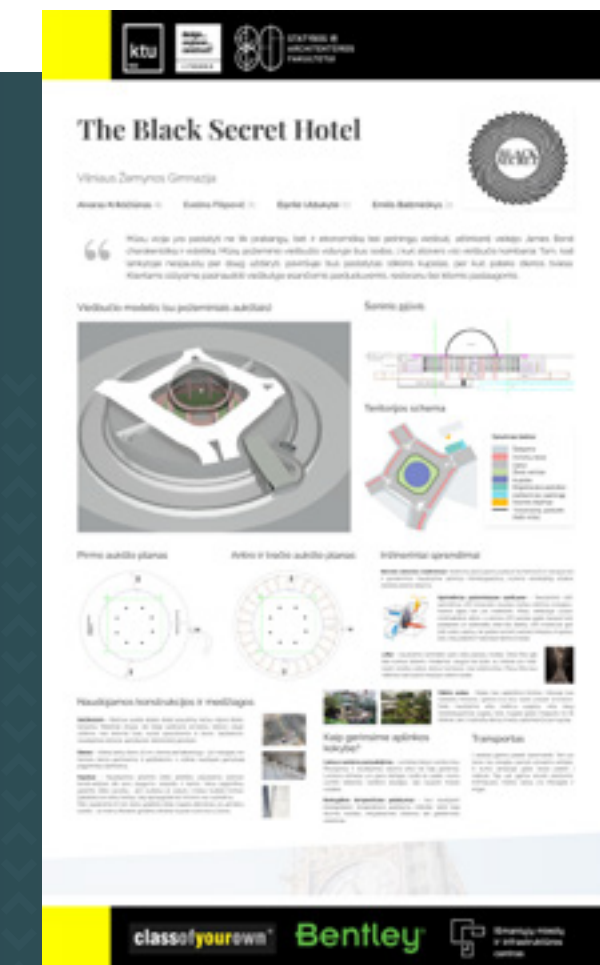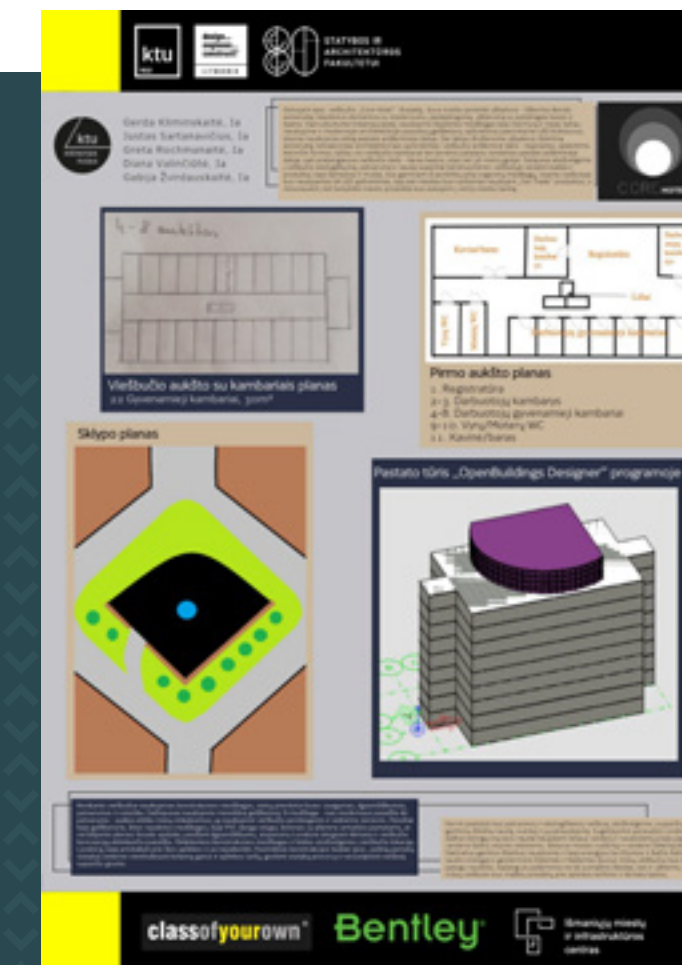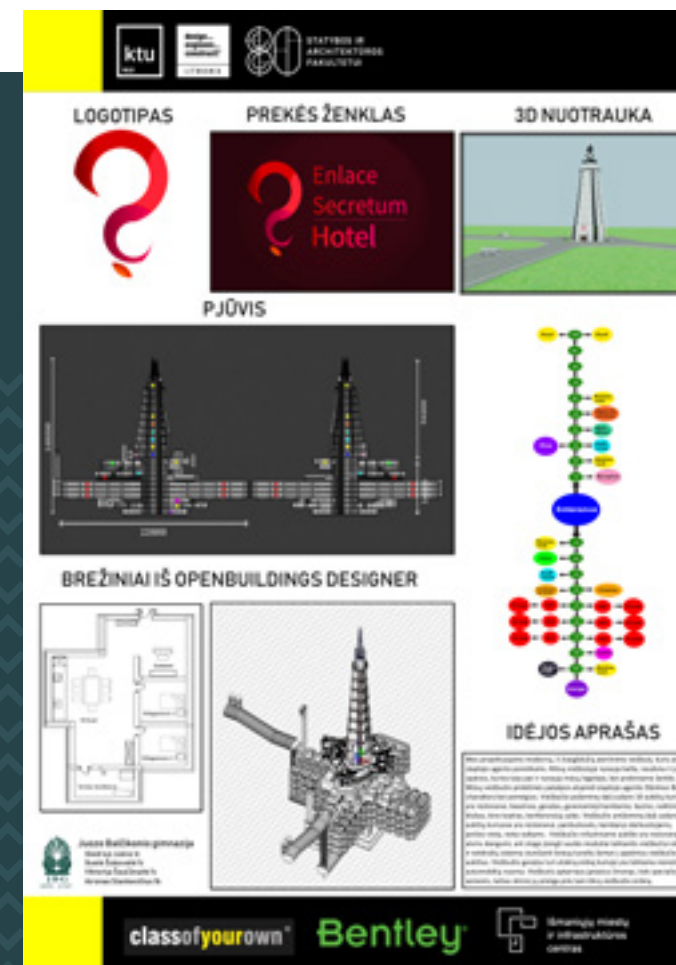
One of our centre's focus areas is changing the image of civil engineering in young pupils' eyes and showing them how much innovation and digitalization this field encompasses. We want to encourage them to choose Civil Engineering or Architecture fields and to acquire knowledge and skills of how to design processes work from scratch.

In September of 2019, we started with the first year of the project Design. Engineer. Construct! in Lithuania. The project was organised with partners from Great Britain "Class of your own" and supported by "Bentley systems". In the school year of 2019–2020, teams from 3 schools (KTU Engineering Lyceum, Vilnius Žemynos and Panevėžys J. Balčikonis Gymnasiums) created James Bond Hotel in London.

In 9 months, they created projects from first vision, brand, architecture sketches, plans, 3D models and planning various engineering parts. More than 15 experts from various fields consulted young architects and engineers.

Just look at these projects:

More about the projects of 2019 and 2020:
https://fcea.ktu.edu/news/learning-differently-students-built-hotels-all-year-round-in-dec-lt-project

In 2020, we started working on a new task, namely Music House in Kaunas!

The project attracted one more school (Kaunas Saulės gymnasium) and we started with 12 teams. We also had LRT OPUS radio as our new parter.

Students had the opportunity to "get" inside LRT radio recording areas and learn from LRT experts Tomas Lukaševičius and Marius Dundulis. In a pre-recorded presentation of the task Freaks on the Floor, vocalist Justinas Jarutis, drummer Rokas Beliukevičius, Biplan vocalist Maksas Melmanas and comedian Mantas Bartuševičius spoke about what they expect from concert halls and recording studios. Marijus Adomaitis and Tautvydas Gaudėšius showed record studios in which they create music.

Justinas Jarutis • **Freaks on Floor**

Maksas Melmanas • **Biplan**

Gintaras Balčytis, a well-known architect who was also recognized as an artist of the year and a lecturer of the KTU architecture study programme, advised on architectural ideas and how to come up with your own project. He was followed by Ben Burgess, a British acoustics engineer, who spoke about the importance of acoustics and his experience in designing the BBC Maida Vale Centre.

In first half of the year, teams created visions, architecture sketches, plans and other parts of projects. In the second part, they will be making civil engineering related decisions.

Gintaras Balčytis • architect, artist of the year and a lecturer of the KTU architecture study programme

Mantas Bartuševičius • comedian

In 2020, CSCI conducted 2 non-formal educational programs, Building Information Management and Data Analytics and Applied Machine Learning for construction industry stakeholders. Next year, we are going to move forward in this field and create a brand new programme related to the application of the National Construction Classification System. In the case of BIM obligation in Lithuania, we are sure about the necessity of such kind of upskilling programme for the construction industry.

But we are not limited to official courses. The establishment of the Centre in the Faculty gives a push for Digital opportunities to the whole community of the Faculty.

The activities carried out by CSCI provide me with clear information about the possibilities of BIM and demonstrate how to systemize as much information as possible. Such structured data offers new ideas and stimulate my creativity as a teacher. It is very important that CSCI staff always explains and consults in a simple way when there are any questions related to the digitization of the construction sector.

Aūnas Navickas

Working in the BIM-LT project helped to gain invaluable experience of participating in European Union-funded projects and skills of working in a large interdisciplinary team. There are opportunities to improve qualifications and share experience in trainings and meetings with partners from Lithuania and other countries. The acquisition of knowledge provides an opportunity to participate in and lead activities in the projects D2EPC and PRECEPT funded by the European Union Horizon programme.

Eglė Klumbytė

Science:

> The development of Kaunas digital twin by upgrading it with possibilities of IoT, remote sensing and AI technologies.

> Collaboration in EU H2020 projects:

Next-generation Dynamic Digital EPCs for Enhanced Quality and User Awareness;

Novel decentralized edge-enabled **PRE**s**C**riptiv**E** and **P**roac**T**ive framework for increased energy efficiency and well-being in residential buildings;

Development of Utilities Management Platform for the case of Quarantine and Lockdown.

> KTU Smart Campus project. Development of digital twins for the Faculty of Civil Engineering and Architecture palace and M-Lab building.

> BIM-LT. Piloting the results and preparation of the final methodological documents.

> Cooperation in the project with Šančiai community.

Studies:

> Integration of Kaunas digital twin with the study process (placement of students' works, visualization in Lumen RT, sharing know-how, etc.);

> New non-formal education programme National Classification of Construction Information;

> Implementation of master's and doctoral theses on topics relevant to CSCI strategic partners.
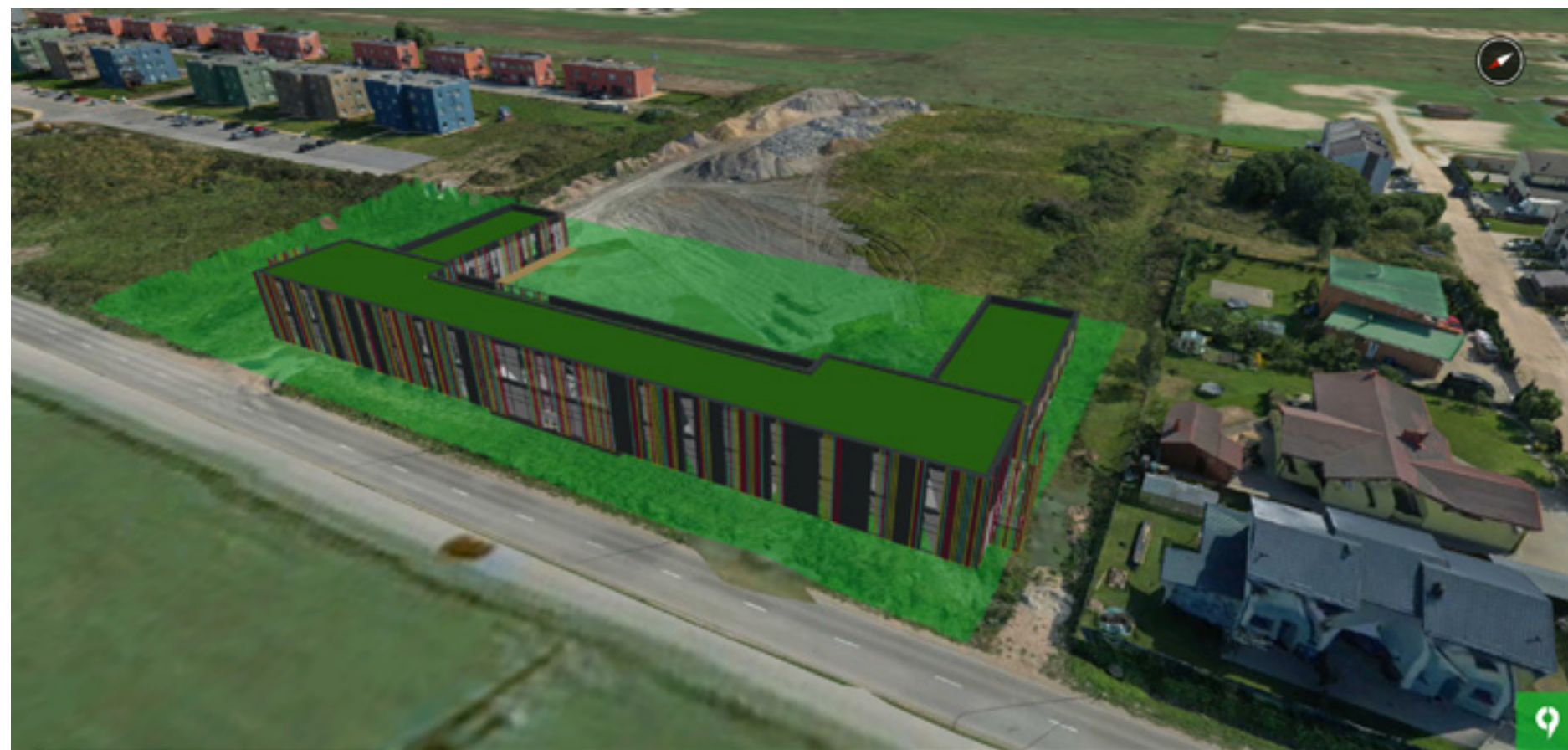
Cooperation, Publicity, Soc. projects:

> DEC-LT - 2nd season