

## **Meeting Report**

European Commission

Webinars on innovation in the construction sector

19 October 2022, 09:30 – 12:30 CET

20 October 2022, 14:00 – 16:30 CET

Technical Secretariat of the HLCF

DG GROW

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## **General overview**

On the 19 and 20 of October 2022, the High Level Construction Forum organised two webinars that aimed to identify technologies that have the potential to advance the digital and green transition of the construction ecosystem. It initiated an exchange on challenges and needs regarding research and innovation, the uptake of technologies and the transfer of technology from research to market. The first session on new ways of building was attended by 125 participants, while the second session on new ways of collecting and using data for construction had 103 participants.

The following key messages were raised during the sessions:

- **Europe needs to ensure sufficient R&I funding** is allocated for construction technologies, which are crucial for the digital and green transitions and the resilience of the ecosystem.
- A new website has been launched supporting the digitalisation of construction SMEs.
- The European Innovation Council supports bridging the gap between scientific excellence and market adoption by providing **dedicated support for architecture, engineering and construction innovators** through the EIC Pathfinder, EIC Transition, and EIC Accelerator programmes.
- **3D** printing can increase resource efficiency and Europe is at the forefront of this technology. However, challenges such as the use of different materials, regulatory barriers (e.g. building codes), lack of awareness, lack of standardisation and education and insurability remain. Those could be addressed notably by research and innovation, updated regulations and standards, technical approval testing and certification.
- **Robotics**, automation and digitalisation could help address challenges such as low productivity, lack of safety, lack of skilled labour and complex coordination. Robotics can be used in several applications, such as logistics as well as construction and demolition work.
- **Prefabrication** and off-site production processes offer numerous benefits. They can improve material efficiency and reduce waste, reduce health and safety risks, and facilitate uptake of technologies such as robots.
- Huge benefits could be garnered from digitalising building permits and compliance checks. For example, saving on physical resources, more efficient processes by saving time and automating repetitive tasks as well as allowing more time for more complex analysis and the reuse of data. In the long term, it is possible to use the structured data generated for the circular economy, LCA and renovation purposes. Furthermore, it can provide the first step to digitalising construction.
- **Earth Observation** can support construction and infrastructure by addressing challenges such as timely maintenance, monitoring the construction process, and climate and weather resilience. It could support remote planning of urban development as well as improve work oversight.
- Improved data collection and reality modelling can support construction by providing a global and accurate perspective of the job site, monitoring and evaluating the progress and performance of a given job versus design, allowing the calculation of cut/fill quantities, improving safety and lowering the cost of inspection survey and as-built survey.
- Overall, connecting different parts of the value chain as well as different technologies will be key to breaking silos and ensuring productivity by engaging the whole value chain, creating economies of scale and increasing the overall integration of the sector as well as supporting SMEs in the uptake of innovation.

The **recording** of the first session can be found <u>here</u> and of the second <u>here</u>.



## Session 1: New ways of building (19 October 2022)

## **Opening of the meeting**

*Ms llektra PAPADAKI*, Team Leader at the European Commission (DG GROW H.1), opened the first session on new ways of building. She stressed that **the two webinars aim to identify technologies that have the potential to advance the digital and green transition of the construction ecosystem**. The webinars focus in particular on the productivity of construction companies, quality and resource efficiency as well as opportunities for new business models. She explained that the findings of these webinars will feed into the development of the transition pathway towards a green, digital and resilient construction ecosystem. In particular, inputs will help define future work programmes, policies and support actions in the areas of research and innovation. They will also help foster solutions and opportunities for the better transfer of technologies from innovation to the market.

Before handing the floor to the first speaker, Ms Papadaki informed participants about **a new website**<sup>1</sup> **supporting the digitalisation of construction SMEs**. The website features a digital maturity scan, a handbook on digital business models and technologies, best practices from companies, and most importantly a training calendar outlining upcoming training opportunities for SMEs.

## Technology scouting and venture building for the construction sector

*Mr Franc MOUWEN*, Programme Manager for AEC technologies at the European Innovation Council (EIC), gave an opening presentation on technology scouting and venture building for the construction sector. He pointed out that the EIC was launched in response to a paradox quoting Ursula von der Leyen: "We, Europeans, are excellent in making sciences with money. But we are not so good at making money out of science. And the new European Innovation Council is here to help." He highlighted that **the EIC supports bridging the gap between scientific excellence and market adoption**. He outlined three main funding schemes of the EIC, namely the EIC Pathfinder, EIC Transition, and EIC Accelerator.<sup>2</sup> The EIC tries to connect research and science with commercial reality. These main funding schemes should increase technology readiness and commercial readiness. With proactive management, the EIC aims to maximise its support for the success of the entrepreneurial journey.

Mr Mouwen stressed that the EU faces a monumental task to decarbonise and modernise the construction sector by 2050 as it accounts for 5-12% of EU total emissions, 50% of EU extracted materials and 35% of EU's waste. He also highlighted that contrasting other sectors, the construction sector faces lagging productivity due to, for example, low digitisation. He also highlighted that we should differentiate between embedded carbon and operational carbon with the former being a hidden challenge for climate change mitigation within our buildings. For example, while cement is an important and good material for construction, the calcination of limestone at high temperatures during its production is a major source of embodied carbon emissions. According to Mr Mouwen, there are several solutions, such as the use of alternative materials, reuse of materials, use of electric kilns or carbon capture. Another way to think about innovation is how nature can use a few materials endlessly and in complex ways, contrasting with humans' simple and wasteful use of many materials. He believes we should follow the example of nature, and argues this is a nice dimension to think about a future paradigm shift in construction. He also argued that deep digitalization of the way we imagine, design and make our buildings is key to fully opening such pathways into the future. Beyond nature, we should also remember our historical architectural legacy. In fact, many innovative and efficient solutions came about when we had fewer materials and tools to use. He concluded by stating that the decisions and regulations we make now, will be affecting people far in the future considering the long life cycle of buildings. Closing his presentation he emphasised the "European

<sup>&</sup>lt;sup>1</sup> See: https://digital-construction.ec.europa.eu/.

<sup>&</sup>lt;sup>2</sup> See: https://eic.ec.europa.eu/eic-funding-opportunities\_en.

Green Deal" and the "New European Bauhaus" as important for the guidance and innovation of the future of AEC.

Figure 1 EIC: the entrepreneurial journey from pathfinder, over transition, to accelerator with increasing readiness levels



## Panel #1: 3D printing

Moderator: *Mr Philippe MOSELEY*, Policy Officer for Sustainable Industrial Policy and Construction at the European Commission (DG GROW, H.1).

## **Opening statements from the panellists**

## Mr Mikkel BRICH, Founder and CEO of 3DCP Group

*Mr Mikkel BRICH*, founder and CEO of 3DCP group, started by highlighting how labour productivity in construction has declined since 1968 in contrast to rising productivity in other sectors. He pointed out that the construction sector is extremely conservative and there is a need for radical change in the sector to remain competitive. **He stressed the potential of 3D printing. First, it can increase efficiency significantly and could make construction socially, economically and environmentally sustainable.** Second, for the 3DCP group, the heavy repetitive lifting is done by a robot and no longer workers. 3D printing also enables freedom of form-giving and detailing at little to no extra cost. Lastly, it is repeatable and scalable outside traditional geographical limitations allowing companies to email someone a house.

Figure 2 : 3DCP pictures of a 3D Printer and 3D printed houses





Mr Brich also dived into the challenges facing 3D printing. **They mainly are general regulatory challenges, meaning that technology evolves faster than bureaucracy**. There is also a lack of general knowledge about this technology which results in distorted risk perception. Finally, there is a lack of standardisation and sufficient education on the subject in relevant educational institutions.

## Ms Sandra LUCAS, Assistant Professor of 3D Printing at Eindhoven University of Technology

*Ms Sandra LUCAS*, Assistant Professor of 3D Printing at the Eindhoven University of Technology, presented **her main focus to introduce new materials for 3D printing to decrease the need for cement.** She started by explaining that the current materials used are mostly with a high content of cement. Thus, her work partly focuses on developing materials with new functionalities through 3D printing. According to her, to do that, we also need to rethink the printing system to increase our control over the printing process. To take on those challenges, she recently started working with a group from software engineering on a project<sup>3</sup>. It uses machine learning and deep learning to both improve the printing process and work on material discovery for 3D printing in construction.

Ms Lucas introduced another aspect of her work: sustainability and circularity. **Not only should we use more environmentally friendly materials but also ensure circularity in 3D printed buildings**. She is working with several companies on another project<sup>4</sup> as 3D Printing should work towards the netzero target and a circular printing system is a tool towards this goal.

#### Mr Jean-Daniel KUHN, Co-founder and Managing Director of XtreeE presenting Wool2Loop

*Mr Jean-Daniel KUHN*, Co-founder and Managing Director of XtreeE introduced his company pointing out that it was born from a university R&D project. XtreeE pursues two objectives: Firstly, to radically decrease the carbon footprint of construction and secondly, to increase productivity. He strongly believes that these issues should be addressed simultaneously as otherwise neither will be achieved and because the low margins in the construction sector make it difficult for companies to take up the investment costs of new technologies.

Mr Kuhn underlined that XtreeE is not a 3D printing company, but a technology-enabling company. If traditionally, construction has been done on-site, he argued that productivity gains were achieved in other sectors thanks to the concentration and use of advanced techniques in a specific location. Thus, **productivity gains in construction should also come from the industrialisation of the sector**. It explains why XtreeE decided to take on an industrial approach, contributing to a switch from on-site to off-site activities. However, to avoid having to transport heavy building elements over long distances, Mr Kuhn proposed **a vision for the future with many small factories close to sites that will enable industrialisation while reducing the carbon footprint.** 

#### Moderated discussion on 3D Printing

Mr Philippe MOSELEY started the discussion with a question on *how Europe compares with third countries and competitors abroad when it comes to 3D printing*. **All three panellists agreed that Europe and the USA are at the forefront of 3D-printing technology and drive innovation**. Ms Lucas added some other examples such as Latin America and South Africa, even if these countries do lack behind compared to Europe and the US. Mr Kuhn emphasised also the importance of Japan and China in 3D printing, explaining the different approaches to this innovative technology. In Europe, the focus is more on open innovation, whereas in Japan it is more internal. Meanwhile, in China, there is a large amount of research being done on 3D printing. China should not be underestimated as a player in 3D printing even if this is not always obvious since we have different networks of communication.

Another question that was raised in the discussion from the Architect's Council of Europe was addressed to Mr Brich. The question *concerned whether there is any post-occupancy evaluation in* 

<sup>&</sup>lt;sup>4</sup> See: https://research.tue.nl/en/prizes/additive-manufacturing-of-sustainable-concrete-for-zero-energy-bu.



<sup>&</sup>lt;sup>3</sup> See: https://research.tue.nl/en/prizes/additive-manufacturing-of-functional-construction-materials-on-de.

place to monitor the indoor condition of the 3D-printing house. Mr Brich responded that his presentation covered a prototype. It was a requirement for a larger project and it was used for measurements. These measurements showed good quality in terms of acoustics and thermal conditions.

DG CLIMA followed up on *whether there are examples of 3D printing that have been applied to the renovation of buildings as well as to new construction.* **Mr Kuhn responded that 3D printing is a good tool for renovation since it is a way to materialise complex shapes and nonstandard shapes.** A traditional approach would be much more cumbersome as it would require creating formworks for a limited number of pieces. An example he raised was a French construction company that built structural elements to uplift a building so they could add floors on top of existing ones using 3D printing.

The next question asked whether there are barriers when it comes to policy regulations regarding 3D printing and whether there are any updates to building regulations needed. Mr Brich argued that this is **one of the biggest factors working against the 3D-printing technology currently**. For example, when looking at load-bearing structures in building codes there are options for cast concrete such as precast elements as well as a stacked structure like brick and mortar. However, 3D printing falls in between both options making it difficult to know which building code to follow. For that reason, for their prototype, 3DCP Group had to print extra columns, which took a lot of time. Currently, the group is working together with its competitors to figure out how to address this issue.

Ms Lucas was asked whether there is any research ongoing in materials for structural safety, durability, acoustic properties and aesthetics. According to her, it is still not a priority in many research groups in this area. However, one of her PhD students is working on the topic of thermal properties. In this field, many improvements are still needed if we want to achieve similar levels of thermal efficiency and soundproofing that we have now in traditional buildings. Regarding durability, she believes that there are no concerns to be had. Finally, in the projects she presented, they had to overdesign the structures of the printed prototypes of bridges and a house, to make sure that there was no question asked on structural safety. However, she highlighted that it generated an inefficient use of materials. Therefore, **regulations may need to be revised to allow other materials to be used especially for residential houses**.

Mr Moseley finished the discussion by asking the panellists to reflect on *how they foresee the 3D-printing market evolving*. Mr Brich qualified 3D printing in the phase of very early adoption and pointed out the current lack of standardisation as many activities realised by the 3DCP group have no prior examples. He also said being hopeful as he sees an increasing number of projects coming up that should change the distorted risk perception. **Mr Kuhn confirmed that insurability is indeed a key issue**. As the technology is very new and a house is a huge investment for people, the expressed uncertainty about the durability should be addressed. It could be done through **technical approval testing and certification**. It would accelerate the growth in 3D-printing technology. Mr Kuhn also highlighted that another trend, already observed, the "imitation effect", may help to further accelerate the uptake of 3D printing. Lastly, he also talked about the money flowing into technology, accelerating its growth. This trend, however, is much more prevalent in the USA than in Europe which poses a risk for Europe. From a material scientist's perspective, Ms Lucas argued that a major step will be to move from printing with mortars to printing with actual concrete. She believes that more needs to be done when it comes to material development and also to have better control of the system and the material to make it a large-scale solution.

## Panel #2: Robotics

Moderator: *Mr Philippe MOSELEY*, Policy Officer for Sustainable Industrial Policy and Construction at the European Commission (DG GROW, H.1).



## **Opening statements from the panellists**

### Mr Artem KUCHUKOV, Co-founder and CEO of Kewazo

*Mr Artem KUCHUKOV*, Co-founder and CEO of Kewazo introduced his company, which focuses on construction robotics. Its main goal is to automate construction with the help of robotics and data. The reason for this is that they believe humanity has much bigger goals in terms of what needs to be built and can be built. **Construction, as of now, is expensive, unsafe and difficult to coordinate. But Kewazo believes it could be solved by bringing more automation and digitalisation into the industry**. Automation would help improve the processes on-site requiring fewer resources and labour, while digitalisation would help to structure activities on-site and improve transparency on what is happening. He explained that they approached it by looking at the different activities happening on-site and put the focus solely on on-site transport to understand how the materials are being moved from point A to B, and, in turn, aimed to optimise this process through automation and digitalisation.

Kewazo broke down this process of on-site transport into different steps and **decided to first focus only on vertical transport**. According to Mr Kuchukov, this is where **most efficiency** can be gained as much is still done manually. He provided the example of scaffolding assembly, where 10 to 12 people stand above each other, transporting materials just with their hands, which is both time-consuming and dangerous. A solution they posed was to introduce a lifting robot that would automate the process and significantly improve safety as people would get tired less. Additionally, this would save up to \$2500 a day and 70% of man hours, which would simultaneously address the issue of labour shortage. They aim to expand their company to other countries but also other application areas, such as insulation material transport, equipment transport, general transport and more.

## Mr Kepa ITURRALDE, Research Associate at the Technical University of Munich, presenting the Hephaestus Project

*Mr* Kepa *ITURRALDE*, Research Associate at the Technical University of Munich, presented the Hephaestus project<sup>5</sup>. Hephaestus is a research project funded by the European Commission, focused on the cable-driven parallel robot for the installation of curtain wall modules. He started by stressing that construction robotics is not a new idea pointing to examples such as the EU Rocco project which was implemented 30 years ago and a joint and anchor installing robot developed by Lindner and Hilti. He emphasised that the materials and design of different elements that participate in the construction process, need to be adapted for robots. It should be taken into consideration before considering robots in construction as it is very difficult to apply robotics in construction.

Mr Iturralde introduced how the BERTIM project<sup>6</sup>d to the Hephaestus project. The BERTIM project focused on the installation of timber-based prefabricated panels with insulation for existing buildings. He explained that throughout the project they ran into some difficulties. For instance, when there was wind it was difficult for the operators to install the prefabricated panels on top of the existing façades. **This led the team to think of different applications of robotics in construction to renovate buildings and install prefabricated elements**. They applied for a research grant at the European Commission under Horizon 2020, which they obtained for the Hephaestus project. As part of the Hephaestus project, they developed technologies and a prototype which enabled the full instalment of four curtain walls and which could also be used for building renovation. Concluding his presentation, he pointed out that they are also now working on using other typologies of robots, like Unmanned Aerial Vehicles for placing connectors on top of the building facades.

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<sup>&</sup>lt;sup>5</sup> See: https://www.hephaestus-project.eu/.

<sup>&</sup>lt;sup>6</sup> See: https://cordis.europa.eu/project/id/636984.

# Mr Ethan KERBER, Researcher at RWTH Aachen University, CEO of Robots in Architecture and editor for the Springer journal on construction robotics

Mr Ethan KERBER, a researcher at RWTH Aachen University, started by introducing the Chair of Individualized Production<sup>7</sup>, which looks into automation and mass customisation of robotic processes, including concrete. He highlighted that they are an interdisciplinary research group with partnerships across countries, disciplines, and universities. Additionally, he is the editor of the Springer journal Construction Robotics<sup>8</sup>. Finally, Mr Kerber is the CEO of Robots in Architecture<sup>9</sup>, the commercial side of the Association for Robots in Architecture. He also highlighted the upcoming Rob | Arch conference, where they aim to celebrate achievements and come up with new ideas for what the future of automation in construction and engineering has in store for us.

He explained that during the pandemic, he and his colleagues faced the challenge of being locked out of their labs, which **sparked the idea of bringing automation online**. They started developing an extension to KUKA|PRC, which had already made great strides in making robots accessible. The next step was to make these robots accessible from KUKA|PRC also in online meetings. It would allow anyone to control a robot from anywhere in the world, thanks to Cloud Remote Control. **Another focus was on digitising construction processes.** Mr Kerber presented the example of the Centre Construction Robotics, a consortium of industry and academia, which looked at how we can bring together the challenges from industry and discover new digitalised solutions in innovation. They used the reference construction site of the Centre Construction Robotics as a living lab to test new ideas, improve them and build on a larger scale. **They focused on practical applications and on how to bring robotics onto a construction site, where the environments are dynamic. The current research focuses on sensors, tracking technologies and new forms of working in mobile environments with robots.** 





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Mr Kerber also touched upon the **topic of reusing concrete**. The ROBETON research project<sup>10</sup> considers how the existing stock of concrete can be used and cut up into building blocks for reuse. Thus, he stressed that not only are they working towards making robots accessible, but they are also looking at heavy-duty machines, which are more common in the construction industry, and turning them into robots as well. The ROBETON project is looking at existing concrete structures, and how these can be chopped up into new "Lego bricks" for future construction. He argued that it requires mobile robotics, a secondary robotics system, and the integration of digital modelling with early design decision assistance tools.



<sup>&</sup>lt;sup>7</sup> See: https://www.ip.rwth-aachen.de/.

<sup>&</sup>lt;sup>8</sup> See: https://www.springer.com/journal/41693.

<sup>&</sup>lt;sup>9</sup> See: https://www.robotsinarchitecture.org/.

<sup>&</sup>lt;sup>10</sup> See: https://www.youtube.com/watch?v=qy5B9hQfIpo.



Figure 4 RWTH Aachen University: picture of a robotic heavy-duty machine from the ROBETON Project

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Closing his presentation, he explained that **one of their main innovations regards IoT connectivity since when bringing robotics into construction sites, the problem of interconnecting robots arises.** Thus, the interconnecting robots in IoT networks enabled diverse factories of machines to work together through online communications and, in this way, have an extendable framework where machines can talk to end effectors without hard-wired connections.

## Moderated discussion on robotics

Mr Philippe Moseley started the discussion with a question on *how Europe compares with third countries and competitors abroad when it comes to robotics*.

Mr Kuchukov responded that in general construction robotics is in its early days, explaining that they started their company four years ago and most other companies are start-ups that started around the same time. In Europe, there are only a few examples of companies that came out in recent years. However, on a positive note, he added that established companies entering the field can be observed, pointing to the example of a larger German company recently acquiring a Start-up from Austria.

Mr Iturralde added that the first generation of construction robots was developed in Japan in the 80s because there was a huge real estate market that could afford the development, however, this disappeared after the real estate crash in Japan. Europe has taken over that position at the beginning of the 2000s. In regards to research, he thinks that Europe is well positioned as universities like Aachen and Zurich are doing remarkable work. **He added that for on-site robotics, one of the biggest challenges is positioning accuracy.** 

Mr Kerber explained that Europe in comparison to the USA benefits from a closer integration between academia and industry. Most of his colleagues that are interested in Start-ups are doing their research while working in close cooperation with Start-up incubators. Because of this integration, there is also more openness. A lot of the construction companies in America would be more closed about their innovations, while here in Europe companies are more ready to share their innovation, challenges and



processes with researchers. Europe is also unique in its internationality and interdisciplinarity with people being able to easily cross borders and collaborate on research within Europe but also globally.

Mr Moseley followed this up with a question directed at Mr Kerber asking about his views as the editor of a journal on robotics regarding *future research needs*. Mr Kerber referred back to the earlier point made on sensing and positioning arguing that **there is a greater need for adaptivity, meaning system loops that integrate not only mass customisation of robots but robots that can sense deviations between digital and physical and adjust accordingly**. In addition, there is much interest in humanrobot collaboration as well as safety when it comes to closer collaboration.

## Panel #3: Prefabrication of new construction

Moderator: *Mr Philippe MOSELEY*, Policy Officer for Sustainable Industrial Policy and Construction at the European Commission (DG GROW, H.1).

## **Opening statements from the panellists**

## Ms Sonia SARACINO, Project Manager at CETMA, presenting the RE4 Project

*Ms Sonia SARACINO,* started by presenting CETMA, which is a research and technology organisation founded in 1994 and located in the Apulia region of Italy. CETMA is organised into two departments on advanced materials and processes and ICT technology. Both operate in various sectors including construction. CETMA's main activity is devoted to R&D projects at the national and European levels. In parallel, the organisation supports SMEs and large companies in the innovation processes and technology transfer providing advanced services.

Ms Saracino then introduced the European RE4 project<sup>11</sup>, led by a consortium of 13 partners from 7 different countries and managed by CETMA. Funded by the European Commission under the Horizon 2020 programme, it got selected as a success story in the field of circular economy in construction. The project started in 2016 and ended in February 2020. The project aimed to develop a fully prefabricated energy efficient, easily dismountable and reusable building made mainly of concrete and timber components and containing up to 65% by weight of construction & demolition waste (CDW) materials and structures.

Among the achievements of the project, Ms Saracino highlighted the production of CDW-based elements and components with a full replacement of virgin material with CDW-derived elements. She underlined that the CDW recycling potential was demonstrated with the development testing and upscaling from laboratory to the prefabrication scale of different kinds of materials components and elements. For the project, five new concrete-based materials with different properties were produced. They also produced four new components (block, tiles, timber components and insulating panels) and developed four new prefabricated elements (concrete and timber façade panels, loadbearing concrete elements, and internal partition walls). The materials, components and prefabricated elements in the range of 50 to 85%.

Finally, Ms Saracino showcased the demonstration cases they used to validate the solutions. For instance, in the Acciona Demopark in Madrid, a two-story building made of prefabricated concrete and timber components was built as well as a reference demo building with the same geometry but with traditional components, materials and construction techniques. For the prefabricated building, all the elements were tied together using a dry connection to facilitate disassembly. At the end of the project, the two buildings were disassembled and demolished to compare the construction and disassembly phases. The overall timing of construction of the prefabricated building in the RE4 project



<sup>&</sup>lt;sup>11</sup> See: http://www.re4.eu/.

in the different locations was 14 days against 36 days spent on the reference building. Other demo buildings were constructed in the UK, Italy and Taiwan.

## Ms Kelsea CRAWFORD, Co-founder and CEO of Cutwork, presenting PolyRoom

*Ms Kelsea CRAWFORD* introduced Cutwork, an architecture and design studio based in Paris and Amsterdam founded in 2016. Since its foundation, the motivation of the company has been to address the mismatch between the way existing cities are built and the emerging lifestyles and communities of the 21st century. More specifically, **Cutwork was founded in response to three major shifts: the decline of the nuclear family, the rise of freelance employment and the proliferation of the sharing economy.** Outlined by Ms Crawford, Cutwork focuses on architecture, furniture and manufacturing. Cutwork aspires to design new ways to live and work which can expand the elasticity of our built environment and integrate them better into our ecosystems. She briefly presented Cutwork's initial entry into manufacturing: a patented design for metallic tubes scored by laser cutting. Designed for furniture and lightweight architecture, these tubes can be shipped flat and then manually shaped into the correct design by the end-user, giving greater design control from concept to production, and reducing the climate impact of transportation.

After this introduction, Ms Crawford presented Cutwork's pioneering prefabrication concept, the PolyRoom<sup>12</sup>, designed in collaboration with Bouygues Immobilier. The concept presented was a scaleone prototype of a residential, co-living space assembled on-site from modular units. **An off-site production process can have many benefits since traditional construction sites are only productive approximately a third of the time.** They may also suffer from additional inefficiencies such as the repeated moving of materials and high levels of waste and there may be issues with material deliveries or a lack of local qualified labour. Ms Crawford suggested these risks are easier to control by moving production inside a factory, in addition to ambient benefits such as reduced local pollution and noise levels from reducing the footprint of construction sites.

Figure 5 Cutwork's slide presenting the PolyRoom designed in collaboration with Bouygues Immobilier



Finally, Ms Crawford outlined how Cutwork is now exploring how the PolyRoom can be applied across multiple contexts. Each unit is designed to integrate with other units. This could allow for the entire construction process to be completed off-site, with full units being delivered and assembled into buildings of varying sizes and designs. Ms Crawford outlined that this broadens the scope of the



<sup>&</sup>lt;sup>12</sup> See: https://cutworkstudio.com/polyroom-by-bouygues-immobilier.

PolyRoom concept to a wider range of urban and rural topologies. One particular example was an ongoing project with the German government investigating how the civil infrastructure of Ukraine could be rebuilt off-site.

# Mr Thomas BOCK, Professor of Advanced Construction and Building Technology, Automation and Robotics, at Technical University of Munich

*Mr Thomas BOCK* presented on the concept of 'instant delivery, 2050 and beyond', and the potential impact of online configuration, automated prefabrication and robotic installation for the construction sector. He initially outlined the current context. For citizens, good quality housing is becoming less affordable and accessible in large metropolitan areas. This then has subsequent impacts on increasing rents and mortgages, which is becoming even more significant in the ongoing cost of living crisis, where residents are spending a significant proportion of their income on financing their homes. **This contrasts with the potential for robotics to improve the productivity and scale of prefabrication by addressing issues such as time and cost overruns, interface problems and lack of skilled labour.** 

Nevertheless, conceptual applications of automated prefabrication existed since the late 1960s and on-site robotics since the late 1970s. Mr Bock outlined an example in Japan where heavy influence from the chemical and automotive industry allowed a construction firm to reduce the time of construction to just six hours. However, while these concepts have been proven in principle, their impacts have rarely trickled down widely into the market as we did not focus on making it affordable for customers. We need to reorient our needs to what the people can afford and increase the availability to guarantee a high and immediate ROI (return on investment) due to the huge financial investment.

Mr Bock then outlined the concept of instant delivery. While this has been pioneered by digital companies such as Amazon, **he believes there is significant potential for this model to be applied to the construction industry to reduce the time and cost overruns often found in construction**. Another potential would be to allow for greater customisation to the needs of the consumer for the project giving them greater control over their order. Mr Bock outlined how this concept has been applied in a construction site in Madrid. Fitting new insulation to historical buildings had been delayed due to high levels of variation in the joints of old buildings. To address this, 3D printing was used to efficiently print the required joints with fast delivery to the construction site. In his conclusion, Mr Bock emphasised that all the systems of robotics, 3D printing and prefabrication need to be integrated into a complete system, and then orientated towards the needs and budgets of the customer to be successful.

## Moderated discussion on prefabrication of new construction

Opening the discussion, Mr Philippe Moseley asked a question to all three panellists on *how they expect the European market for prefabrication to develop over the next years*. Ms Saracino responded by saying that there are many demonstration projects for prefabrication and the use of recycled materials in Europe. However, **there are many barriers to reaching the market such as price but also culture as, in particular, SMEs have difficulties in accepting secondary raw materials as a good option.** It is necessary to continue with demonstration projects to provide examples to companies and show that this is possible. Meanwhile, she added, **SMEs will need support in including in their processes these technologies**. For example, through Test before invest programmes or circular labs. Currently, there are not many places where companies can test a new solution.

Responding to the same question, Ms Crawford added that the technology is there to be used, but from a business perspective, she sees a lot of hesitancy in exploring these solutions due to the traditional nature of the construction and real estate industry. Moreover, the problem is that prefabrication uses a different logic than the traditional one where an architect designs a project, and then hands it over to a manufacturer who might then implement it in a modular system. However, we need a paradigm shift where we start with modular from the beginning and think about it as a



**product.** This requires a close link between the architect, industry and the customer. An architect cannot design a building for modular easily or effectively without working hand in hand with the industry which has its own software, technologies and techniques for production.

Mr Bock agreed that the technology is there, but added **cheap labour costs as another barrier to its uptake**. He argued that if labour is cheap, then there is less need for innovation and the introduction of new technologies. He shared an example from a company in Texas that used prefabrication in the 70s. In the 80s the company had stopped investing in new machinery and prefabrication due to the influx of cheap labour from Mexico making such investments unnecessary. **He argued that there is a need for a common strategy in Europe to make use of the good technology we have and provide orientation based on what people can afford and what they need to then develop and apply the technology in the best-suited mix. Prefabrication can not only be applied in building construction, but also for infrastructure. If you have this flexible customised robotised prefabrication, then you can do a lot of things and adjust to the condition that the customer wants.** 

Mr Moseley brought up a question from the audience on *the expected lifetime of prefabricated buildings and if there are any differences between their durability with traditional buildings*. Ms Crawford responded by saying that they do not see any difference as in prefabrication one can work with many different materials such as concrete, cross-laminated timber, and steel frames, Thus, the lifespan would depend on these choices similar to traditional houses. She highlighted also one of their earlier projects which used concrete textiles and used their metallic tube system to create a refugee housing system that could be prefabricated in a factory-shipped flat in 2D and installed on-site using all local materials and labour. The system had a 30-year lifespan.

# Presentation of the European Research Area (ERA) Preview of the Roadmap for construction

*Mr* Adrian MARICA, DG RTD, presented a preview of the ERA Industrial Technology Roadmap for Circular Technologies and Business Models. This roadmap is being developed by DG RTD following the European Research Area communication<sup>13</sup>. **The main focus of this roadmap exercise is to create bridges between research and industry to identify and create ways for better cooperation and bring technology faster to the market.** The roadmap targets three industrial ecosystems, one of which is construction. Based on consultations, firstly the roadmap maps key relevant technologies and business models for the circularity of the targeted industrial ecosystems. Secondly, it assesses them in terms of TLR, circularity potential, economic performance, contribution to zero pollution and potential rebound effects. Mr Marica further explained that they made projections of R&I investment needs for circularity to the market. This was complemented by a review of framework conditions and potential barriers based on which key actions were developed.

Among their findings, **they have seen great circularity potential when it comes to technologies that facilitate the recycling and sourcing of circular materials such as modular design, design for disassembly, urban mining, off-site construction and so on.** From an environmental perspective, the use of circular materials is expected to contribute to reducing GHG emissions and environmental objectives. Mr Marica added however that circular technologies need to be integrated with other types of technologies as we need a systemic approach. For example, digital technologies can reduce costs and lead to better economic performance, and minimise waste. Then, he presented some of the other preliminary findings from the roadmap exercise (see Figure 6).

<sup>&</sup>lt;sup>13</sup> See: https://ec.europa.eu/commission/presscorner/detail/en/ip\_20\_1749.

Mr Marica concluded his presentation by showcasing a preview of investment needs for different technological and non-technological solutions, which is based on the Built4People Partnership's Strategic Research and Innovation Agenda<sup>14</sup>. This he complemented by the results of a Delphi exercise conducted as part of the roadmap, which estimated investment needs per project. For instance, EUR 5-10 million are estimated to be needed per project to invest in recycled raw material sourcing technologies to reach TRL 9 by 2020. The final roadmap will be published by end of 2022.

*Figure 6* Intermediate takeaways of the technology assessment (ERA Industrial Technology Roadmap for Circular Technologies and Business Models)

Q	Relevant circular technologies for the construction sector are <b>generally at medium technology readiness</b> levels.
Q	Some technologies <b>score highly</b> in terms of <b>circularity potential</b> , <b>economic performance</b> and other criteria: urban mining, BIM-based applications, modular design, off-site construction, big data and analytics, as well as digital material passport.
Q	With further maturity and concrete applications, <b>digital technologies</b> are expected to form the backbone for greater circularity. They address important gaps such as enabling material tracking, improved optimisation of processes, better understanding of construction needs and better planning.
Q	None of the technologies can be dealt with in isolation. Only the technologies themselves, without proper integration into the wider ecosystem (combined use of recycling, alternative materials, clean production, circular business models), are considered to be ineffective.

## **Open moderated discussion on technology transfer**

The final part of the first innovation in construction session focused on a discussion on technology transfer in the construction sector moderated by Mr Mouwen, European Innovation Council. He introduced the topic by asking participants to think about two interconnected questions, not only focusing on the what but also on the why. An entrepreneurial journey starts with the technology, the 'what'. However, it is critical to understand the 'why' and in particular the 'why' for the customer, meaning their needs and how the technology could be transformed into a product addressing these needs. Mr Mouwen stressed that product development should always start with answering the 'why question' before making the prototype.

To underpin this point, he then brought up the example of Tesla, a company that while not inventing the electric car, understood how to convert people into adopting this new technology. In contrast, the Segway, while being a fantastic technology that integrated gyroscopes, failed nonetheless because it did not solve a problem while pushing too much technology. Bringing the focus back to construction, he then raised the example of the dream of moving the assembly of raw materials in construction offsite into a controlled environment. Stanford Business School did a case study on Katerra, which raised huge amounts of money for making factories for buildings off-site and witness an initial uptake before failing. They had failed because they lacked taking into account one of the particularities of the construction industry with one of the main barriers being logistics. In fact, the modules they were making were suffering from logistic capabilities. Nevertheless, experimentation and failure are part of entrepreneurship and today there are still various modular construction companies.

Another challenge raised by Mr Mouwen is the need to decarbonise within 30 years. He showed an aerial view of a cement factory highlighting this issue for companies that will need to innovate and will need support to do so for reaching these targets. Carbon capture is sometimes seen as a solution,



<sup>&</sup>lt;sup>14</sup> See: https://www.kowi.de/Portaldata/2/Resources/heu/coop/he-built4people-sria-2022-27.pdf.

but despite a lot of research, it is still difficult to store underground especially. He also recommended a book<sup>15</sup> about a robotics company trying to solve the problem of developing a bricklaying robot and the difficulties not just of the technology but also entrepreneurship.

In the discussion about innovation in the construction industry, one hears often as reasons for the lack of innovation that the industry is sluggish and fully regulated and that margins are only 1%. However, pointing to the example of Velux, a market leader in the area of roof windows, Mr Mouwen highlighted that it is possible to innovate in construction as they opened up an unused real estate volume in the attics of houses. This is a simple example of a standardised product solving a customer problem in construction and real estate. Closing his introduction to the discussion, Mr Mouwen highlighted one of the companies that the EIC is supporting, a Swedish company name Modvion which uses timber to construct wind turbine towers.

After his opening remarks, Mr Mouwen collected inputs from participants about barriers, needs, solutions and technologies in and for the construction sector. These comments are highlighted in Figure 7.





## **Closing remarks**

Following the discussion, Mr Philippe Mosely closed the webinar by thanking the speakers, panellists and participants for the fascinating presentations and discussions as well as inviting everyone to join for the second session.



<sup>&</sup>lt;sup>15</sup> Jonathan Waldman, SAM: One Robot, a Dozen Engineers, and the Race to Revolutionize the Way We Build.

## Session 2: New ways of collecting and using data (20 October 2022)

## **Opening of the meeting and key messages from session 1**

*Mr Philippe MOSELEY*, Policy Officer for Sustainable Industrial Policy and Construction at DG GROW, H.1, opened the session. **He reiterated the main points from the first session, where technologies such as 3D printing and the possibilities of e-mailing someone a building on the other side of the world, robotics and prefabrication were discussed.** These technologies can lead to productivity improvements while also improving resource efficiency and reducing waste in construction. However, they should not be discussed in isolation but combined and integrated into a systemic approach. Beyond these opportunities, barriers to uptake, and potential policy actions for addressing these barriers were discussed. Participants also talked about the need for research on these technologies and the fact that labour costs can have a big influence on the uptake of innovative solutions in construction.

Mr Moseley then highlighted that these meetings not only offer the chance to exchange knowledge but they also represent a way for the European Commission to hear about the needs and challenges of the industry. These discussions will in turn have an impact on the way policies are drafted. For instance, at the moment the European Commission is in the final stages of drafting the transition pathway of the construction ecosystem. The discussion in these sessions will be taken into account in the making of the document, which will be published at the beginning of next year.

# New EU research projects supporting the deployment and use of digital building permits and logbooks

*Mr Eleftherios BOURDAKIS*, Project Adviser at the European Health and Digital Executive Agency (HaDEA) presented on new EU research projects that have received or are about to receive grant funding. He started by highlighting both the relevance of the construction ecosystem (9% of the EU GDP, 18 million direct jobs) and the challenges it faces: fragmentation and a large share of SMEs, labour shortages, low degree of digitalisation and industrialisation, voluminous waste steam and prone to labour accidents. He then presented two relevant calls from the firs Work Programme of Horizon Europe: 'Digital permits and compliance checks for building and infrastructure' and 'Demonstrate the use of Digital Logbook for buildings'.

The scope of the first topic is to develop, connect and align new technologies and digital tools for construction, including improved and automated methods of designing, building and authorising construction works. The expected outcomes are: efficiency and productivity gains in design and construction processes; fewer errors in planning, design and construction processes; automated, faster, more accurate and more efficient permitting and compliance for construction works; improved build quality and resource efficiency in construction, in line with the aims of the New European Bauhaus initiative.

The scope of the second topic was to demonstrate and realise the potential benefits of using digital repositories of information that will accompany buildings throughout their lifecycle. The expected outcomes are: Improved resource efficiency and decarbonisation of buildings during their construction or renovation; improved linkages of existing databases, tools and sources for digital building logbooks; improved usability of digital building logbooks through user experience; new or improved tools for collection and update of relevant data; demonstrate other benefits of using digital building logbooks e.g. safety.



## Panel #1: Digitalisation and automation of building permits

Moderator: Mr Eleftherios BOURDAKIS, Project Adviser, HaDEA.

## **Opening statements from the panellists**

## CHEK – Change toolkit for digital building permit

*Ms Francesca NOARDO*, Open Geospatial Consortium, presented both the European Network for Digital Building Permits (EUnet4DBP)<sup>16</sup> and the recently awarded Horizon Europe project: Change Toolkit For Digital Building Permit (CHEK) project<sup>17</sup>.

- EUnet4DBP: Ms Noardo introduced the network as an informal initiative, started at the beginning of 2020, due to the increased need for multidisciplinary collaboration regarding digital building permits. The people behind EUNet4DBP see intersectoral collaboration as crucial to support the exchange of information among people (researchers, policymakers) working in this field. To support this aim, the EUNet4DBP carries out outreach actions to raise awareness of the relevance of digital building permits and to grow the network, which currently includes partners within and beyond Europe. Their actions include joint research paper publications, informative media content (e.g. the EUnet4DBP talks<sup>18</sup>) and the organisation of knowledge exchange events. Ms Noardo highlighted that the next event, on 4<sup>th</sup> November, will host, among others, the three new Horizon projects to facilitate knowledge exchange among them.
- CHEK: This project arises from the need to support the transition from the traditional building permit processes which are difficult to change at a municipality level. As matter of fact, there is a big knowledge and skills gap, as well as a need for digital skills which are not available in everyday work practices. A diversity of municipalities is included in CHEK (not just from different nation-states, but a diversity of municipalities within nation-states). Additionally, training and education will be crucial in CHEK. An iterative approach will be developed, to provide flexibility, especially in terms of being able to meet requirements in municipalities. The project will start with a series of pilot municipalities to kick off the process. The aim is to produce solutions allowing standard-based interoperable information (both GIS and BIM based); software that should be modular, interoperable and scalable for anyone interested; and tools supporting building authorities in the change. A larger community of stakeholders will be involved, to provide feedback on their developments and foster scalability. Lastly, Ms Noardo summarised the contents of the CHEK toolkit: process digitalisation; data interoperability; upskilling/reskilling; interoperable modular technology; and scalability.

## ACCORD – Automated Compliance Checks for Construction, Renovation or Demolition Works

*Ms Rita LAVIKKA*, Senior Scientist at VTT Technical Research Centre of Finland, presented the ACCORD project<sup>19</sup>. **ACCORD is about digitalising and automating building permit processes**. **The project supports the twin transition of green and digital by developing mechanisms for automating the compliance checking of environmental rules**. This will be done following a maturity roadmap from manual checking to digital (openBIM, reuse of public data, 3D for visualisation, BIM-based analysis) and further to automatic (integrated, interoperable data exchange, machine-readable and interpretable regulations).



<sup>&</sup>lt;sup>16</sup> See: https://eu4dbp.net/.

<sup>&</sup>lt;sup>17</sup> See: https://chekdbp.eu/.

<sup>&</sup>lt;sup>18</sup> See: https://www.youtube.com/channel/UCAIL0VKYrdYi7Zu4IhHAAmg.

<sup>&</sup>lt;sup>19</sup> See: https://accordproject.eu/.

Ms Lavikka explained that ACCORD's vision is that **digitalised building permit processes are humancentred, transparent and cost-effective for both building permit applicants and authorities**. In addition, she raised the importance of how building permit processes should help advance climate neutrality. ACCORD will develop a semantic framework to transfer information between organisations and avoid a loss of meaning of this information. This semantic framework for European digital building permitting processes will allow driving rule formalisation and integration of existing compliance tools as microservices. Closing her presentation, she highlighted that project results will be validated in reallife construction projects. These include automatic checking of environmental compliance in Finland and Estonia; structural integrity in the UK; land use permitting, green building certification, and industrialised timber housing in Germany; and urban regulations in Spain.

# DigiChecks – Digital environment for management of permits and compliance in building and construction

*Mr Ignacio RINCON*, FCC Construction and *Mr Mark MOERMAN*, Data-Driven Construction presented the project DigiChecks. It creates a new framework that allows for interoperability and communication between different platforms initiatives to facilitate the management of construction permits, including compliance checks. In their recent kick-off meeting they outlined their four principles for this framework:

- (1) a federated ecosystem, as opposed to a centralised application;
- (2) a modular and scalable approach;
- (3) the use of a shared set of conceptual information models (ontologies), that align with existing domain ontologies; and,
- (4) Data that is generated within the framework is formalised based on open and widely-accepted standards, including W3C Linked Data standards.

To achieve this, DigiChecks follows four steps:

- (1) Permit ontology: developing a standardised permit ontology, i.e. a shared language for permitting that allows to move away from centralisation of data;
- (2) Permit processes: developing a tool allowing authorities to model their permit processes into DigiChecks thereby creating a flexible approach;
- (3) Permit rules: based on this modelled process, authorities will be able to use one of the modules developed allowing authorities to build their own 'rules'; and finally,
- (4) the integration of the previous steps into a Permit Service (API).

Once these steps have been implemented, they will test the DigiChecks modules across three pilot projects: an infrastructure project by FCC in the UK, a project by Realia in Spain and a prefabrication project by CREE in Austria.



## Moderated discussions on digitalisation and automation of building permits.

Mr Bourdakis opened the panel discussion with a question to all three panellists on *what they see as the major benefit of digitalising permits and compliance checks*. In her response, **Ms Noardo explained firstly that while it would allow saving on physical resources such as paper, its main benefit would** 



be to make processes more efficient by saving time and by automating repetitive tasks. Manual and human resources can therefore be dedicated to solving more complex cases. This will also lead to a higher quality of checks and better processes that will not only benefit the building industry, but also the municipalities. Secondly, the development team will be able to use more complex analysis supporting the possible introduction of new regulations in the future. The third advantage is that we could reuse the data which is part of the process when relevant to feed other data sets. For example, cadastre, construction-related data, or digital building logbooks. Ms Lavikka agreed that there would already be short-term efficiency gains from the Horizon projects, but in the long term, we can design buildings and use structured data which we can reuse for the circular economy, LCA and renovation purposes. The building permit phase is where one needs to start that process, and these frameworks create the bases for structured data.

**Mr** Moerman argued that digitising permitting is actually at the core of digitalising construction. To his sense, needing to deliver a permit that requires some form of digital information will nudge the entire supply chain to slowly but steadily adapt. This, hopefully, will allow us to slowly move away from a linear supply chain in construction and work much more towards an ecosystem and life cycle approach. Mr Rincon agreed that digitalising building permits could give an impetus for a more digitalised sector without having to change the way of working as it digitises what is already there.

A participant from a construction materials company raised the question of *how the three projects aim to address the current interoperability issues when using IFC formats*. Mr Moerman explained that IFC is already becoming an open standard. However, they are not only dealing with the current technology but looking towards the future beyond IFC. There are more data sources, which is notably why they are working on developing semantic ontologies and towards a singular language for permitting. This will allow dealing with interoperability, whether the data that resides is in IFC, in Excel or PDF.

Regarding BIM, one participant from a company providing software solutions for the construction sector asked what challenges the panellists foresee in connecting BIM models to the mostly paperbased construction permit-related regulations. Mr Moerman responded by explaining that they look at BIM models as a type of data source. BIM models are just one single part and while the sector comes from a traditional paper-based business, this is not a trade-off. Both BIM models and paper-based construction information can be hosted. Certainly, soon enough paper-based information will not be used anymore. For PDFs it will take a while before they meet the same fate, however here they are applying different technologies to read and transform the data on these documents from unstructured to structured machine-readable data. Ms Lavikka added that this will be problematic and that Finland is now reforming its land use and building act. If everything goes well, starting in 2024, Finland will have a BIM-based building permit process as part of the law which help create the basis for structured building data. Connecting it to the previous question, Ms Noardo explained that the plan for CHEK is to start with the current regulations and data requirements. Starting from the analysis of regulations and their data requirements, they can then move to BIM and GIS structures so that these can be defined and controlled by using the open BIM tools provided also by buildingSMART and other associations. The intention is to have a pragmatic approach providing also exporters and validators of data which in turn would allow controlling the data. They expect to extract from BIM or other kinds of information sources the data needed for paper-based regulations, which will probably in turn evolve in the future. Finally, as outlined by Ms Lavikka, regulations will likely be machine-readable in the future, so opportunities for using 3D data will increase.

## Panel #2: Earth observation

Moderator: Mr Eleftherios BOURDAKIS, Project Adviser, HaDEA.



## **Opening statements from the panellists**

## European Forum for Earth Observation (FIRE Forum): Ms Lucy KENNEDY, CEO of Spottitt

*Ms Lucy KENNEDY* took part in the panel as the CEO and Co-founder of a satellite-based infrastructure monitoring service provider called Spottitt, and her role as Earth Observation (EO) evangelist for infrastructure attributed by the FIRE Forum. In her role as evangelist, she promotes the awareness and uptake of EO technology and provides feedback to the EO community on what the sector needs to address gaps in the use of EO as a relatively new technology.

In particular, EO can support construction and infrastructure by addressing some of its challenges, such as:

- Maintenance efficiency: to move from schedule-based maintenance to risk-based maintenance where some areas get checked more frequently, and other areas that do not have a lot of issues get checked less frequently.
- Costly and lengthy construction: projects run longer and are more costly than anticipated, EO can help monitor construction sites.
- Climate and weather resilience: our need for reliable infrastructure is increasing as extreme weather events increase.

Infrastructure owners can look to EO to help them understand where they could best invest. **EO can help address these challenges for existing infrastructure**. It enables accurate remote asset monitoring that is timely and cost-efficient. It also reduces the risks associated with hazardous work. Improving maintenance operations, especially for large and secluded areas. Additionally, EO-powered monitoring can help ensure built infrastructures resilience, mitigating the risk of failure.

## Our Watch Leads<sup>20</sup>: Mr Pedro RESENDE, Founder and CEO

*Mr Pedro RESENDE*, Founder and CEO of Our Watch Leads (OWL), introduced OWL as a start-up based in Coimbra Portugal. OWL participates in the European Space Agency Business Integration Centre in Portugal. In his presentation, he showcased how OWL is integrating satellite technology with BIM and AI. The company's mission is to democratise access to EO as a technology. An online store was set up so that professionals such as architects, engineers, builders or developers can access the information. In addition, mobile apps are being developed to facilitate access for citizens. This is complemented by dashboards created for municipal governments to facilitate a more optimised management of our cities.

OWL combined the tools that architects and engineers use with EO by using for instance the digital surface model 'Good2build'. It helps to determine different building zones ranging from best, and reasonable to worst while highlighting areas that are high in vegetation and water and therefore protected. 'Good2Build' is a diagnostic tool which can be used to create a project design for example to propose a new green neighbourhood with collective spaces for users, while protecting vegetation and water.

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<sup>&</sup>lt;sup>20</sup>Our Watch Leads (OWL) | LinkedIn



Figure 8 Imageries obtained via EO, subsequently Topography Isolines, Digital Surface Model and "Good2Build"

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OWL also developed machines with deep learning algorithms that can help classify the soil use covering several kilometres in its overview map of existing structures. Summarising his intervention, Mr Resende said that **EO can support the remote planning of urban development as well as improve work oversight, observation of vegetation growth and oversight of site cleaning.** This information is merged with BIM and 3D formats so that professionals can get a detailed diagnosis with more parameters than the traditional topographic and geotechnical surveys would provide.

## Eurisy: Mr Corneel BOGAERT, Project Officer

*Mr Corneel BOGAERT*, Project Officer at Eurisy, introduced the non-profit association representing space agencies across Europe. Eurisy facilitates exchange and raises awareness by creating a network for space and non-space communities. In addition, they also take an advisory role and provide feedback to decision-makers to ensure a widespread adoption of satellite data. Eurisy works across thematic areas such as Space4Cities, Space4Health, Space4Rural, etc. The thematic area Space4Cities provides:

- success stories of cities relying on innovative satellite-based services;
- exchange of expertise among city managers, SMEs and stakeholders;
- identification of challenges;
- assessment of the needs of the local administrators; and
- recommendations to service providers.

Eurisy holds the largest European database of user cases of satellite-based solution to help newcomers to build the case and to better understand the benefits stemming from the integration of satelliteborne data among other sources. Mr. Bogaert illustrated some of these cases relevant for the construction industry. He also invited all the audience to visit the website to have a better understanding of the possibilities offered by this technology.

**EO** applications could be well used also in the construction sector for instance in the field of preventive monitoring. For example, by updating monitoring tools that could help plan and prioritise inspections of buildings and structures. And also, for instance, monitoring water turbidity during port extension to avoid damage to natural areas. It could also be used for urban planning. For example, by creating a heat map where the heat island effect is mapped for a city. This way hot spots can be identified and mitigating measures for the community can be taken. This tool can also be used to plan where to build, and where to place a body of water and green spaces.



## Moderated discussions on earth observation

Opening the panel discussion, Mr Bourdakis raised a question to all three panellists on *how they see Europe compare with other third countries when it comes to EO technology*. All panellists agreed that Europe is very well placed. Ms Kennedy remarked that Europe has a very active sector in terms of data providers and downstream services providers. Europe has a healthy and growing ecosystem. Therefore, Europe is probably ahead compared to other parts of the world. Ms Kennedy also expects to see more streamlining in the coming years as smaller companies come together in partnerships, mergers and acquisitions. Europe is a great place to look for specific services for specific sectors, including EO in construction.

Mr Resende added that European EO companies not only use the imagery provided by the Sentinels from the Copernicus system, but they also have a lot of private data suppliers in Europe. There are also a lot of SMEs using this satellite data and treating this data in their services. The technology will continue to be democratised and if the demand continues to grow, then the images will get cheaper while the precision and resolution will get better. Europe is ahead in Geo location. The Galileo system is the most advanced together with EGNOS.

Mr Bogaert agreed with the previous speakers, he highlighted that in Europe we have one of the most advanced EO constellations: Copernicus, which thanks also to its free data policy, is a global leader in terms of EO data provision. On top of the current suite of services gathered under broad domains including: Land, Marine, Atmosphere, Climate Change, Emergency and Security, offered by the European Commission and based on the images and data collected by the 5 missions in orbit, will be soon complemented by the Sentinel Expansion Missions. **The main objective of the new family of satellites to be launched in the future is to expand the current capabilities of Copernicus as well as to better address EU policy and gaps in user needs.** To conclude Mr. Bogaert stressed to harness synergies between EO but also communications and positioning services. Exploiting these synergies can benefit the European economy at large.

A question raised by an audience member referred to *the possibility of using EO data for public land registries and whether the data would be precise enough for such a task*. Ms Kennedy responded by saying that the answer is both yes and no. **It depends on the resolution of the satellite imagery as well as on the number of ground control points that would allow controlling the accuracy of where the satellite image is and how it matches the exact precise location on the Earth. This is happening from about 600 kilometres above and the current accuracy of high-resolution satellite imagery ranges from one to two meters difference. So for an individual plot of land, this might not be sufficient accuracy, however, in larger settings, e.g. a city, this would be different. Ms Kennedy added that one should not compare EO to our existing terrestrial-based tools in terms of accuracy and resolution as it is a brilliant tool for operating at scale and remotely, but we need to get used to subtle differences in the accuracies than what we are used to.** 

Mr Resende reinforced the same point saying **that it depends on the objective**. If the objective is for example to update the municipal plan of the built environment, EO is the solution, since it is looking at the metric detail and even if there is a small margin of error of one meter, the results are good enough because they can be updated weekly. However, if we need to look at the centimetric detail, it is different and EO would not be the right solution.

Mr Bogaert complemented the other two panellists by adding that **EO** is often just a part of the puzzle. It is very effective, but it should also be used as a complementary tool and there are of course still other tools that are more precise and can be used in other situations as well.

However, he shared the case of the Belgian region of Wallonia where the Geomatic department of the Public service Wallonia, the primary interface between the regional institutions and the local administrations and citizens of the region. To comply with the EU Inspire Directive, the Team needed to acquire precise, accurate and easily updatable information, including data on land cover (LC) and



land use (LU). The project WALOUS<sup>21</sup> was established soon after and its maps integrate the latest georeferenced data on the whole Walloon territory.

## Panel #3: Drones, 3D scanning & other ways to collect data from buildings Moderator: *Mr Eleftherios BOURDAKIS*, Project Adviser, HaDEA.

## **Opening statements from the panellists**

## Bentley Systems: Mr Jerard MARSH, Manager of iTwin Context

*Mr Jerard MARSH*, Bentley Systems, presented on reality modelling in construction. He first introduced Bentley Systems, a European-based software company with the mission to provide innovative applications and services for enterprises and professionals who design, build, and operate the world's infrastructures. He then introduced **reality modelling**, **explaining that time-based reality data is a key component for creating a digital twin**, which can be anything from point clouds, reality meshes, 360 images or oblique images. With the use of mobile mapping systems such as drones, this reality data is becoming much more common. **Owners and operators of infrastructure need to deal with this fast-growing quantity of data, captured at always higher precision, scale and pace.** 

Figure 9 Bentley Systems: Introduction to reality modelling technologies



Mr Marsh then explained that reality modelling can support construction by providing a global and accurate perspective of the job site, monitoring and evaluating the progress and performance of a given job versus design, allowing the calculation of cut/fill quantities, improving safety, and lowering the cost of inspection survey and as-built survey. Using a past project, Mr Marsh showcased how they kept track of their sites and get a visual update on a weekly or monthly basis. They could very quickly assess progress and overlay the mismatches with the design thanks to their data. The project, a railway line in Kuala Lumpur, used UAVs to capture high-quality images, which were then captured with Bentley Systems' software Context Capture to generate the 3D reality meshes. As an outcome, the company experienced increased productivity estimated to be 30 to 50 times higher than with traditional surveys saving over 1 000 resource hours for surveyors, project managers and engineers.

## Evercam: Mr Marco HERBST, CEO

*Mr Marco HERBST*, CEO of Evercam, presented his company, a visualisation & collaboration platform. Evercam is a partner company of Bentley Systems. The company aims to address the productivity issue within construction linked to delays, disputes, reworks and the typical headlines on overruns in large construction projects. Combining the various reality capture opportunities (cameras, mobile phones, drones), Evercam creates 4D models, and turns them into actionable insights for different people on the construction site, for example by comparing the BIM schedule to where the construction site is or providing footage of an incident to a health and safety manager. There are two main interests to



<sup>&</sup>lt;sup>21</sup> See: https://www.eurisy.eu/stories/the-public-service-of-wallonia/.

Evercam's work: the assessment of the gap between what is happening on site and what should be happening with the ambition to close this gap, and also learning lessons which can be applied to other projects making these more efficient.

Mr Herbst then provided a visual example of one of their project tools showcasing a project in Dublin. He showcased different views on the site, jumping between cameras and different functionalities, e.g. an X-ray tool providing a view of the structural supports underneath the first layer, a viewer that showcases completed parts of the structure versus planned parts, and a real-time view. The data that is being collected on these sites, for example on the delivery times of materials, is then converted by algorithms into actionable data. Closing his presentation, he stressed the power of having all these relevant tools under one roof and being able to seamlessly jump between them.

## Moderated discussions on data collection from buildings and construction sites

After thanking both speakers, Mr Bourdakis asked them *who they think should be the owner of the data*. Mr Marsh responded that this is a common question. Generally, it is owned by the project owner or operator. However, **he believes that openness is key and that data should be shared and open source when possible so others can use it as well to assist in their construction workflows.** Mr Herbst agreed, saying that ultimately the project owner takes ownership or in some cases, they are selling the data to the main contractor. However, **the most successful projects are those where the owner and contractor are working very collaboratively and take shared risks as then there is a strong incentive for information sharing.** These are often also the more complicated and mission-critical projects, e.g. data centres, semiconductor production, and oil or gas infrastructure, where the owner cannot completely de-risk the project.

A follow-up question from the audience asked *whether the owner-operator of such drones would have any intellectual property rights on the pictures/ films they produce*. Mr Marsh replied that he would guess not as the operator supplies a service to a client and these intellectual property rights should therefore pass on to the client. Mr Herbst agreed that **the ultimate data owner is the paying client**.

Mr Bourdakis then asked both speakers *what they see as the main challenges or barriers to the collection of data*. Mr Marsh highlighted that **the main current barrier is people**, as there is some **doubt in how accurate the information from reality data is as it is taken from simple mobile phones and drones**. Another barrier when it comes to drones is the **use of drones in terms of line of sight as for some contracts it is a requirement to have a line of sight for your drones when your drone is flying.** Especially for construction monitoring, it would be beneficial if one could have their drone take off autonomously, capture the site, come back and update their model regularly without the intervention of someone. Mr Herbst added that **a construction site is an ever-changing, dangerous and messy environment, which makes it challenging to get cameras installed, ensure power supply and avoid day-to-day damage.** Still, technology is improving with for example solar batteries and autonomous data collection. With collaborative projects being still the minority, trust is another issue. The average contractor is generally not delighted when they see cameras being put up by the owner.

## **Bringing innovation to the market: Discussing solutions, barriers and support** Moderator: *Mr Eleftherios BOURDAKIS*, Project Adviser, HaDEA.

## DG CNECT on supporting innovation and technology readiness: the Innovation Radar

*Ms Carmen IANOSI*, DG CNECT, European Commission, presented the topic of EU-funded research as a source of deal flow with a focus on the Innovation Radar. She highlighted that EU funding can derisk technology and research. Especially, Horizon Europe as the world's largest public-funded R&I programme can provide this support. However, **once innovations are made the question of bringing them to the market arises.** To address this, the **Innovation Radar**<sup>22</sup> was set up to make it **easier to discover innovations and identify investment opportunities**. Innovations are scored by their Market



<sup>&</sup>lt;sup>22</sup> See: http://www.innoradar.eu/.

Creation Potential as well as their Market Maturity, highlighting both the potential to disrupt and create markets as well as the market readiness. In addition, innovators can highlight their needs (e.g. advice on intellectual property, business plan development, internationalisation, etc.). Ms Ianosi highlighted that a sizeable amount of EU-funded innovations (35%) have disruptive potential in the market and that about 200 innovations are added every month.

Once added to the Innovation Radar, innovations are also added to Dealflow<sup>23</sup>, a matchmaking platform that connects these EU-funded innovations with investors and companies. When adding innovators to this platform, their information is merged with data from another company called Dealroom on the amounts of money raised by start-ups and the companies, other related intellectual property, and other information. Finally, 'go to market' support is also provided to innovators through conversations about their actual needs before adding them to the Innovation Radar. Ms lanosi highlighted that one of the biggest added values is this conversation between innovators and market experts on their needs and where they are in their journey from lab to the market, which helps them to better understand what their next steps should be. Closing her presentations, Ms lanosi stressed that the goal of the European Commission is to enrich deal flow through market-ready, disruptive innovators from the EU's R&I programme.

# Built4People Partnership on bringing innovation in the construction value chain to the market

*Mr Stephen RICHARDSON*, World Green Building Council presented the Built4People partnership and how it aims to support bringing innovation in the construction value chain to the market. First, he highlighted a series of barriers that Built4People is trying to address. Those include the low level of digitisation, low R&D spending, and high fragmentation of the construction sector with 99.9% of companies being SMEs and about 94% micro-enterprises. To address these barriers, Built4People has set itself three general objectives: (1) Generate holistic innovation in the built environment towards sustainability; (2) Revitalise the sector through decarbonisation and sustainability transition; (3) Induce lasting behavioural change towards sustainable living.

Concerning these objectives, **Mr Richardson stressed that connecting different parts of the value chain will be key to breaking silos, engaging the whole value chain, creating economies of scale and increasing the overall integration of the sector.** Built4People will achieve this by channelling both public and private funding into R&I projects in the construction and real estate sectors. However, beyond this, there is also a need to support these projects further for market uptake and scale-up. Built4People aims to bridge that gap by setting up a network of Innovation Clusters and fostering a connection between these often already-existing clusters. This will allow these clusters to interact better, but also enable Horizon projects to connect to this network and give them new opportunities to scale up. An EU-funded project, NEBULA<sup>24</sup>, was set up to support the setup of this innovation cluster network. In doing so, they align with the New European Bauhaus initiative. NEBULA will be working towards the steps in Figure 5. The consortium started this work by mapping the venture capital and investor landscape in the built environment as well as by building on existing actions by Green Building Councils and the European Cluster Collaboration Platform.

Closing his presentation, Mr Richardson highlighted that Horizon Europe's **biggest challenge for SMEs** is its bureaucracy, which makes it difficult for small companies and new players to access its funding.

<sup>23</sup> See: https://dealflow.eu/.



<sup>&</sup>lt;sup>24</sup> New European Bauhaus Unlocked through Built4People-endorsed Local Actions.

Figure 10 Steps and work ongoing under the EU-funded NEBULA project



## Discussion on innovation drivers and barriers

Taking the question on barriers raised by Mr Richardson, Mr Bourdakis asked Ms Ianosi *what she thinks are the main bottlenecks when it comes to funding*. Ms Ianosi explained that while funding comes up often, it is not the only barrier. European funding is there to support this aspect, but it is indeed not always easy to navigate as the process of putting together proposals can be quite complex while technology moves on, which makes the timing of EU funding also a challenge. Apart from EU funding, there are regional funds and a whole array of public funds. However, from her experience with the Innovation Radar, there is also a lot of private money and venture capital that can be accessed. She shared the example of a Norwegian start-up called Material Mapper as well as of a spin-off from Delft University that were able to raise capital. **Funding that might otherwise be a bottleneck could be bridged through the Innovation Radar**.

Mr Bourdakis then asked about the *direction the Built4People partnership is going towards in the coming years in terms of research*. Mr Richardson responded by first highlighting that the partnership has a Strategic R&I Agenda (SRIA)<sup>25</sup>, which maps out the direction the partnership will take in the coming years. The SRIA on the one hand puts people (e.g. users, and workers) at the heart of the green transition. On the other hand, it takes a holistic view of what a sustainable built environment means. This is why the vision of the New European Bauhaus is key. **Not only the energy efficiency of buildings but other aspects should be considered, such as embodied carbon, biodiversity, resource depletion, etc. This more holistic way of thinking is already being embodied in key policy frameworks.** 

Ms lanosi responding to a question about *whether the Innovation Radar only covers Horizon funding or also other projects funded via EU Member State funds*, explained that the Innovation Radar only covers European-funded projects. Member State grant funding is not included. Beyond this, she stressed, that project officers need to be aware of the Innovation Radar and need to use the Innovation Radar questionnaire as well as invite innovation experts to the midterm reviews to see if there is a relevance for the Innovation Radar. Mr Bourdakis agreed that also for his colleagues it is a common practice to invite experts to the final review once all outcomes of a project are finalised to assess the innovation.



<sup>&</sup>lt;sup>25</sup> See: https://www.kowi.de/Portaldata/2/Resources/heu/coop/he-built4people-sria-2022-27.pdf.

## **Closing remarks**

Mr Philippe Moseley closed the 2<sup>nd</sup> webinar on innovation in construction by thanking the moderator, the speakers, the panellists and the participants for the interesting presentations and discussions. He particularly highlighted how interesting it was to hear from different innovative companies. Hearing about the challenges and barriers is also very valuable as it will be relevant input for the transition pathway for a resilient, greener and more digital construction ecosystem.

The transition pathway will feature research and innovation, but also various related aspects of such as skills, the circular economy, the renovation wave and more. A key aspect, the European Commission Is also looking into are the current high prices for energy but also construction materials that are affecting the sector. Ways to reduce our reliance on raw materials and imports for example through the circular economy supported by better data collection will form an important part of the way forward. This also highlights that aspects such as green, digital and resilience are interconnected.

Mr Moseley then closed the session, inviting participants to take part in future events of the High Level Construction Forum.





## Annex – List of participating organisations

#SustainablePublicAffairs	Dow Italia
APMGS	ECO Platform AISBL
Architects' Council of Europe	European Federation of Engineering Consultancy
Architecture and Building Foundation	Associations (EFCA)
Arcology System	Eindhoven University of Technology
Arkance Systems Finland Oy	Energy Managers Association
Associação Técnica da Indústria de Cimento (ATIC)	European Organisation for Technical Approvals (EOTA)
ASTM / Wohlers Associates	Estonian Ministry of Economic Affairs & Communications
Astron	EU BIM Task Group
Autodesk	European Plastics Converters (EuPC)
BEAM CUBE	Eurocities
Belgian Luxembourg Romanian Moldovan Chamber of	Eurogypsum
Commerce	European Association of Remote Sensing Companies
Bentley Systems	(EARSC)
Betotrace / IN2-CONCRETE	European Builders Confederation (EBC)
BIBM - Federation of the European Precast Concrete	European Calcium Silicate Producers Association (ECSPA)
Industry	European Climate, Environment and Infrastructure
Birmingham City University	Executive Agency (CINEA)
Bouwend Nederland.	European Commission - DG CLIMA
Buildings Performance Institute Europe (BPIE)	European Commission - DG GROW
Building information foundation RTS	European Commission - Office for Infrastructure and
buildingSMART Germany	Logistics in Brussels (OIB)
BUILT COLAB	European Commission, Joint Research Centre (JRC)
Bulgarian Ministry of Regional Development and Public	European Construction Industry Federation (FIEC)
Works	European Environmental Bureau
CASAIS Engenharia e Construção	European Federation of Parquet (FEP)
CEMEX	European Floorcoverings Association
CEN/TC442	European Panel Federation
CERIS - Instituto Superior Técnico, University of Lisbon	European Ready-Mixed Concrete Organization (ERMCO)
	EU Agency for the Space Programme (EUSPA)
CERTIF - Associação para a Certificação	Evenflow
Chalmers University of Technology	Faculty of Civil Engineering, University of Belgrade
Circle Economy	FCC Construcción
Civil Engineer	German Federal Ministry for Digital and Transport
Cobaty International	Belgian Federal Public Service of Health
Confederation of Finnish Construction Industries	FEUP – Faculty of Engineering, University of Porto
Committee of the Regions (European CoR)	Fincons
Construction Products Association (CPA)	Finish Ministry of the Environment
Centre Technique Industriel de la Construction Métallique	Fédération Internationale du Recyclage (FIR)
(CTICM)	Fire Safe Europe
Cypriot Ministry of Interior	FNV Bouwen & Wonen
Czech Ministry of Industry and Trade	Fédération des Promoteurs Immobiliers (FPI)
Danish Agency og leving and planing	Federației Patronatelor Societăților din Construcții (FPSC)
Danish Housing and Planning Authority	Romania
Deutsches Institut für Bautechnik (DIBt)	Fraunhofer IBP
Dlubal Software	



	French Ministry for Housing	RINA Consulting
	GEO DATA CONSULT	Ruppert
l	GKH GmbH	S.C. GENERAL GAME S.R.L.
	Grupo CINTAC	SAIDEL Engineering
l	GS1 Global Office	SIA.architectes
	Hauptverband der deutschen Bauindustrie	Siemens Smart Infrastructure
l	Hellenic Open Universiry, School of Science and	Sika Services AG
	Technology, Greece	Sika Sweden
	IC-Instituto da Construção	Sixense
1	Institut luxembourgeois de la normalisation, de	Small Business Standards
	l'accréditation, de la sécurité et qualité des produits	Smith Innovation
	et services (ILNAS)	SOROCAM
	Industrial Minerals Europe (IMA-Europe)	Soudal NV
Ì	Istanbul Medipol Umiversity (IMU)	Spanish Association for Standardisation UNE
	Institute for Federal Real Estate (Germany)	Spottitt Ltd.
l	Institute Superior Tecnico, University of Lisbon	Strabag
	Just Bim it	Sudop Praha
l	Knauf Gips KG	Synthesia Technology
	La Salle Campus Barcelona - Ramon Llull University	Tallinn University of Technology
l	Laval University	Taltech
	Loop Operations	Technical Chamber of Greece
	Loughborough University	Technical University of applied sciences Rosenheim
l	MBB Group	TECNALIA
	Metropolia UAS	Teneo
	Modern Building Alliance	Teneo Brussels
	MPO	Technische Universität Munich (TUM)
	Muncie Design Construction Technology Conten (CTCON)	Ulrich Paetzold EU-Consulting
ì	Nutria Region Construction Technology Center (CTCON)	Ultratech Cement Itd
	National Centre for Construction 4.0, Czech Technical	University of Brescia (UniBs)
	University in Prague	Universidad de La Laguna
ì	National Standards Authority of Ireland	Universidad de Sevilla
		Université Libre de Bruxelles
ì	Ontotext	University College London
	Magnes University	University of Minho
	Nidores University	University of Strathclyde
ì		University of Zaragoza
	PLIXXENT A/S	Vastuu Group
ì	Politik Ministry of Feenemic Development and Technology	VITO - Flemish Institute for Technological Research
	Polish Ministry of Economic Development and Technology	VTT - Technical Research Centre of Finland
į	Policecnico di Milano	Wacker Chemie AG
	Project 500 AEC COnsultants	WR Logic
į		ZWEI
	UEIIUS D2M Solution	
	KZIVI SUIUTION	

Disclaimer: The list of participating organisations is based on the registrations.

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