MOLIO MAGAZINE

# Digital transformation in the construction industry

26

**MORE INNOVATION AND FEWER STANDARD SOLUTIONS**

A number of the technologies that once seemed futuristic are becoming part of the construction industry's reality. But how do you as a company figure out where to invest? And what technologies do you need to master?

Get the answer from some of the top leaders in the construction industry.

# DIGITAL TRENDS 2020





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**SUSTAINABLE CONSTRUCTION CAN BOOST DIGITAL WORK**

At By & Havn and Rambøll, they have big ambitions when it comes to sustainable construction. This requires documentation of materials, and this is where the digital systems are necessary.

46

4

WELCOME
TO MOLIO MAGAZINE

# Contents



12

WHEN ARTIFICIAL INTELLIGENCE HELPS CREATIVE MINDS

As many living rooms and balconies as possible should have natural light, shelter, and good views. This is the plan for the new Fælledby development on Amager nature reserve. In order to explore the various possibilities, the consultants use generative design.

# About Molio

Molio ensures independent, qualified and relevant dissemination of knowledge across the construction industry's players and processes. It is our vision to make a significant contribution to the development and digitalization of construction, facilities and operations to benefit the industry and society. Our mission is to be the key player who, through involvement, development and dissemination, makes the relevant knowledge available at the right time for construction companies.

That is why Molio supplies digital tools to the industry, each of which helps to make the phases and processes of construction more efficient and thereby strengthen the productivity and quality of construction. Molio is also actively helping to disseminate international standards and thus help companies in the construction industry to a more competitive everyday life.

On 1 January 2020, buildingSMART Denmark was established as a subsidiary of Molio. buildingSMART Denmark is an independent chapter of buildingSMART International and takes special care of Danish interests in connection with the development and dissemination of international standards.

Molio is also in charge of a new project funded by The Danish Industry Foundation and Realdania – Project ConTech. The starting point is to strengthen the construction industry's productivity and sustainability through increased use of technology in all parts of construction.

Molio is one of the industry's largest suppliers of both textbooks, courses and training programs for the entire construction value chain. We provide new competencies at all levels of the construction industry to tackle new challenges and technologies. The courses are often conducted at our own course center, HUSET Middelfart, with an associated 28,000 m2 of indoor and outdoor building exhibition.

Read more at molio.dk

**Molio's digital tools**

- Price data
- Construction data
- Fire data
- Molio BR18
- Descriptions
- Agreement and communication (ICT tools)
- CAD and building model

**"I know that in the construction industry we have the ability to improve, rethink and create great things together."**

**CHRISTINA HVID**
CEO, Molio

# Welcome to Molio Magazine

**In many ways, the construction industry is developing rapidly. In February 2020, the number of employees in the construction industry broke records. Sustainability has really come into focus and new climate partnerships are leading the way. The construction industry faces a future where competences, collaboration, sustainability, data, and digitalization will be the most important success factors. This applies both to the individual company and to the construction industry as a whole.**

As the CEO of Molio, I have had the pleasure of visiting companies throughout the construction value chain. I have gained insight into the experiences and perspectives that the digital development is based on, and it is my experience that digitalization is extremely high on the agenda across the industry. And there are many good reasons for that.

Digitalization is a means of achieving increased efficiency, productivity, and quality – both for the individual company and for the construction industry as a whole. Digital tools can help us to collaborate better and more efficiently across the industry. They can help us minimize downtime, make faster decisions, ensure better management, and develop new products. But digitalization is also about sustainability. I see sustainability and digitalization as mutually lifting each other up. Because if we are to live up to our common green ambition to build sustainably, then it places high demands on our ability to exchange data and document materials, processes, durability, and maintenance.

I therefore believe that in the coming years, we will see an industry that will collaborate even more to reap the benefits of digitalization. And collaboration is what it will take. We need to benefit from each other's experiences and gain insight into each other's knowledge and desires across the construction industry. Molio is working extremely hard to help drive that process. Most recently, we have joined forces with Realdania and the Danish Industry Foundation on the ConTech project, which, precisely through the involvement of the industry, will pave the way for a more sustainable and productive future through digitalization and effective collaboration in all parts of the construction industry.

To gain more knowledge about the digital transformation, Molio has, in collaboration with the consulting company Seismonaut, researched how far we are with digitalization, as well as what drivers and barriers the companies themselves experience. The results of this nationwide survey have been published in the form of the Digital Barometer of the Construction Industry 2020, and insights from this have been incorporated into the Molio Magazine.

Now is the time to sit back and let yourself be inspired. Molio Magazine brings you across the most important digital trends and gives you the opportunity to 'listen in' when some of the industry's pioneers willingly share their experiences and reflections. This applies to the CEO of By & Havn, Anne Skovbro, CEO of Rambøll, Ib Enevoldsen, CEO of Henning Larsen Group, Mette Kynne Frandsen, CEO of Sund & Bælt Holding A/S, Mikkel Hemmingsen and many more. In a series of interview articles, they describe some of their successes and some of the things that did not go as well as they might have wished. And then we bring up operational experience, so we can all be inspired and become wiser.

I know that in the construction industry we have the ability to lift, create new things and think big together for the benefit of the individual company, the industry, and our society.

Happy Reading!

**Christina Hvid**
CEO, Molio

# The Digital Barometer of the Construction Industry 2020

The Digital Barometer of the Construction Industry 2020 provides a current picture of how digital the construction industry is, and which areas of digitalization are moving the fastest. Across the construction value chain, the barometer highlights challenges, drivers, and barriers companies face when working digitally.

**MOLIO MEASURED THE** pulse of digital development for the first time in 2018.

The 2020 barometer is based on a survey with 506 respondents across the construction industry. Overall, the barometer shows that the digital development of the construction industry has been stagnant since 2018. Although the industry agrees that digitalization makes construction more efficient – and an increasing number of small businesses have discovered digitalization – it is difficult to implement the digital working methods.

In the management corridors, digital tools are welcomed, but in reality, we see that they are difficult to implement when it comes to the actual execution. The companies respond that, from a management perspective, they see great potential in working digitally. But when it comes to using digital tools across the entire construction process or rethinking and automating processes, there is still a long way to go.

Generally the level of digitalization is similar across the different actors in the construction value chain. However, contractors stand out as a little less digital than the rest.

## Stay tuned at molio.dk

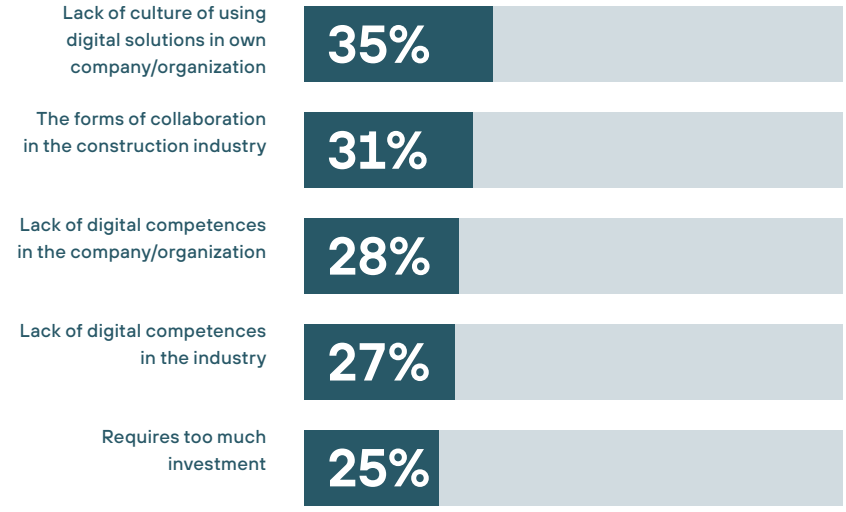
The Digital Barometer of the Construction Industry is based on a survey conducted in August 2020. Molio performs ongoing measurements of the barometer to follow the digital development of the construction industry.

**Find the entire Digital Barometer of the Construction Industry for 2020 here: molio.dk/byggeriets-digitale-barometer**

## The top five barriers to digitalization

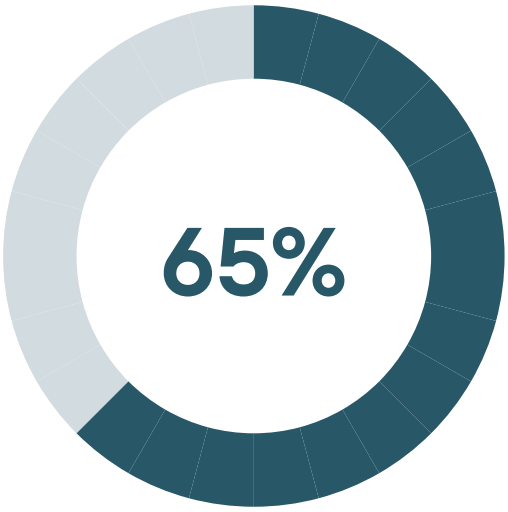
Source: The Digital Barometer of the Construction Industry 2020

Although the majority of the industry is aware of the great benefits of digitalization, many barriers are in the way of the realization.

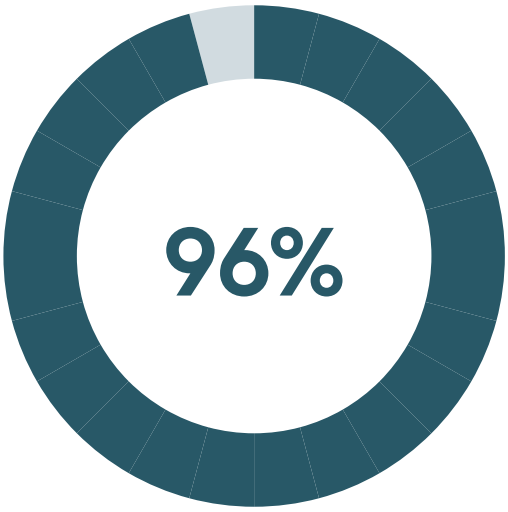



The percentage indicates the proportion of respondents who have selected the barrier in question. Each respondent was able to select up to three barriers.

## The Digital Barometer of the Construction Industry shows that:




65% believe that increased quality and fewer errors are the biggest gain from digitalization.




96% experience that there is a benefit to be gained from digitalization.

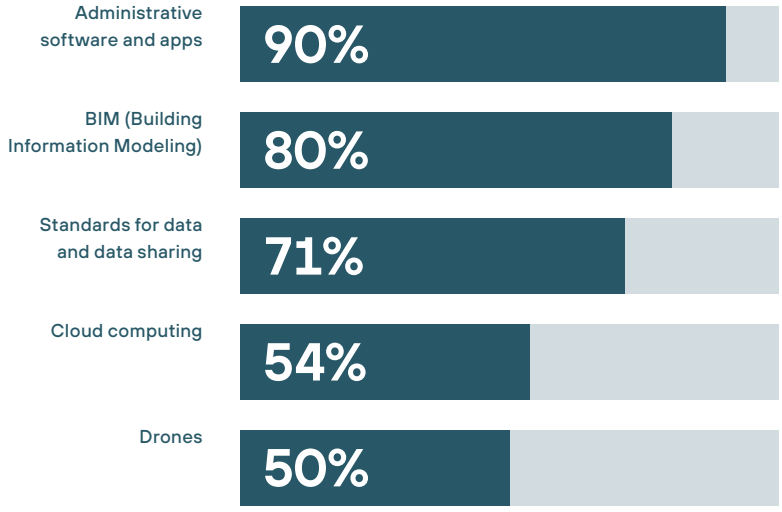
Source: The Digital Barometer of the Construction Industry 2020

## The top five on technologies

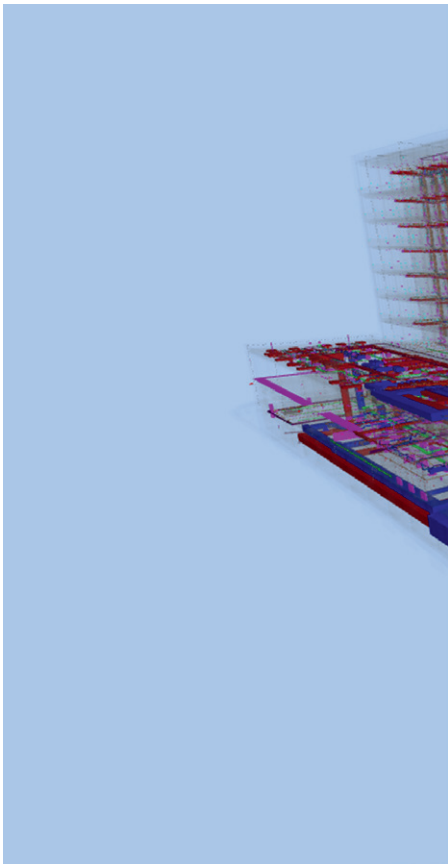
Source: The Digital Barometer of the Construction Industry 2020

There is a wide range of work with BIM, administrative software and standards for data and data sharing. The largest companies are generally the most digital. The industry is in general lagging behind in the use of the more data-driven technologies such as IoT, machine learning, artificial intelligence and blockchain. The data-driven technologies are most prevalent among engineering firms.

The percentage indicates the proportion of respondents who use the technologies to either a high degree or to some degree today.



Nordea's former headquarters in Christianshavn, is undergoing a renovation and will be converted into a luxury hotel. The project is a digital pioneer project that puts all of the parties involved to the test. Because how do you build in a way that has never been tried before?



# Digital ambitions are spreading within the industry

Demolishers remove old concrete columns and prepare for the new seventh floor to be built on top of the existing building.
Photo: NCC

**THIS RENOVATION PROJECT**, with a beautiful view of the Copenhagen Canals, is different. All parties of this renovation have joined forces on a digital pioneer project. Physical blueprints are scarce, and all information must be available within one minute. The project is expected to work as a digital flagship project and strengthen the digital culture in future projects.

**The developer demands BIM**

— We've turned everything upside down. We did a clean cut and said no more blueprints and traditional descriptions. Normally, the digital BIM model complements the drawings and descriptions. But here, it is the other way around, and BIM is the main source of information. We have never done anything like this before, says Mikkel Nygaard Rønne from NCC.

Although NCC's VDC Managers Lone Sand and Mikkel Nygaard Rønne are experienced builders with 28 and 13 years of experience, respectively, it is the first time for both of them that the digital BIM model is the starting point for the entire digital set-up and the process throughout the value chain.

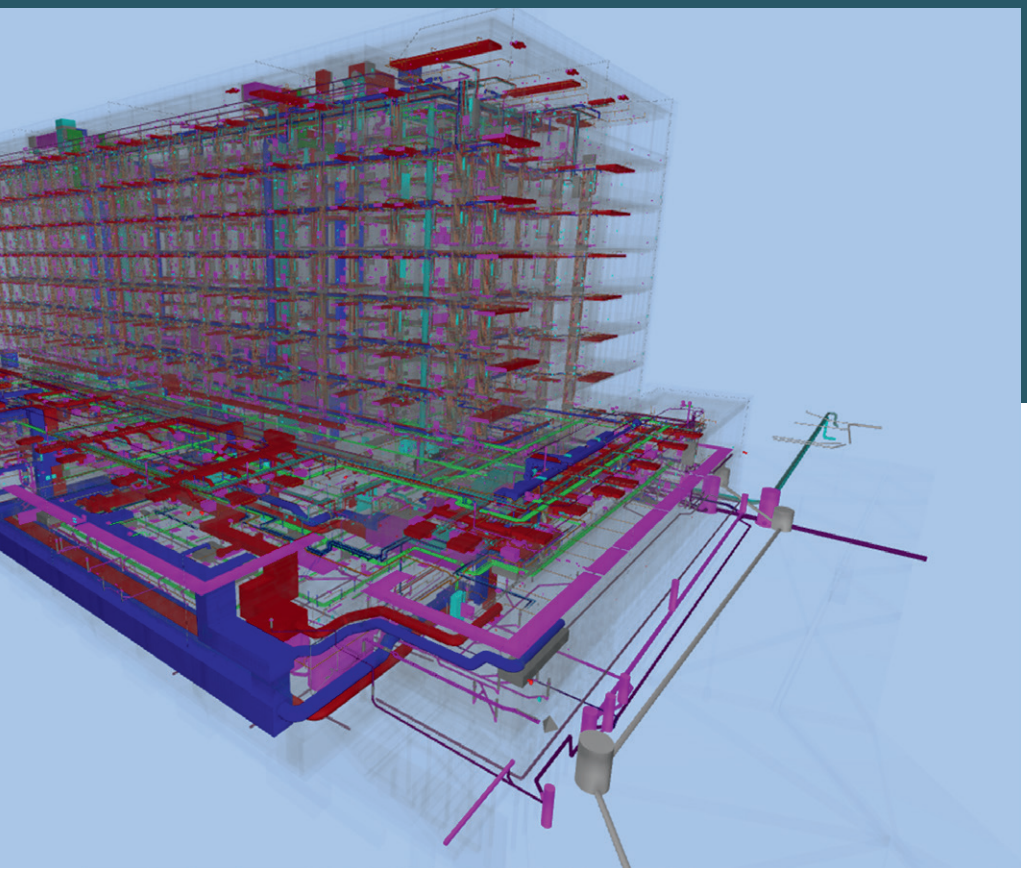
Even in the trailer on the construction site, the BIM models have replaced physical drawings. Construction management now uses BIM models on PCs and tablets instead of paper. Developers are also demanding BIM models instead of the physical drawings they usually use. From the beginning of the project, it has been clearly stated that it had to be 100% digital.

— It used to be that you were lucky if you had a BIM model that was taken seriously by all parties involved. But here, the BIM model is the project material that counts and it is absolutely key to everyone's work. It's quite a crazy experience, says Mikkel Nygaard Rønne about the digital investment.

**Developer prepping for the future**

Christian Hartmann, former Director of Property Management at ATP Real Estate, believes that the digital path is a necessary investment in the future for developers like them. It can attract customers, ensure quality, future operation, and maintenance as well as strengthen the sustainable profile of projects.

— As developers, we normally use 2D



The digital twin of the future hotel. All professional groups have actively participated in the creation of the comprehensive BIM model, which can now provide information in 60 seconds.
Illustration: NCC

drawings, but now we will also be switching to BIM and 3D. We must be ready for the future, and that is why we are ready for BIM. We can no longer deviate from the evolutionary leap. Now, we are going to dive into the digital ocean with the others, he says excitedly.

**Digital flagship project**

The renovation of Strandgade 7, popularly referred to as the Ørkenfortet, is one of ATP Real Estate's projects in connection with their major digital investment. The plan is for the real estate company to have digitalized most of their properties in the coming years. And with the hotel renovation, their ambitions are being seriously tested.

— We have plans to digitalize 700,000 floor m2 in the near future. Our portfolio totals 1.6 million m2, which is scheduled to be digitalized over time. And this will require testing some things before we get started with all that, adds Christian Hartmann.

The digital ambition at ATP Real Estate is initially associated with large expenses, which are expected to generate profits later on. One of ATP Real Estate's major digital investments has been to acquire the most up-to-date knowledge within digital construction and operations. They have now developed a strategy that they are very happy with. ATP uses the BIM model from NCC for the actual renovation work and then switches to Dalux FM in connection with the subsequent operation. And precisely this balance in the handover from planning and execution to the operating system is a discipline that ATP Real Estate has worked hard to get ready for.

"It used to be that you were lucky if you had a BIM model that was taken seriously by all parties involved. But here, the BIM model is the project material that counts and it is absolutely key to everyone's work. It's quite a crazy experience."

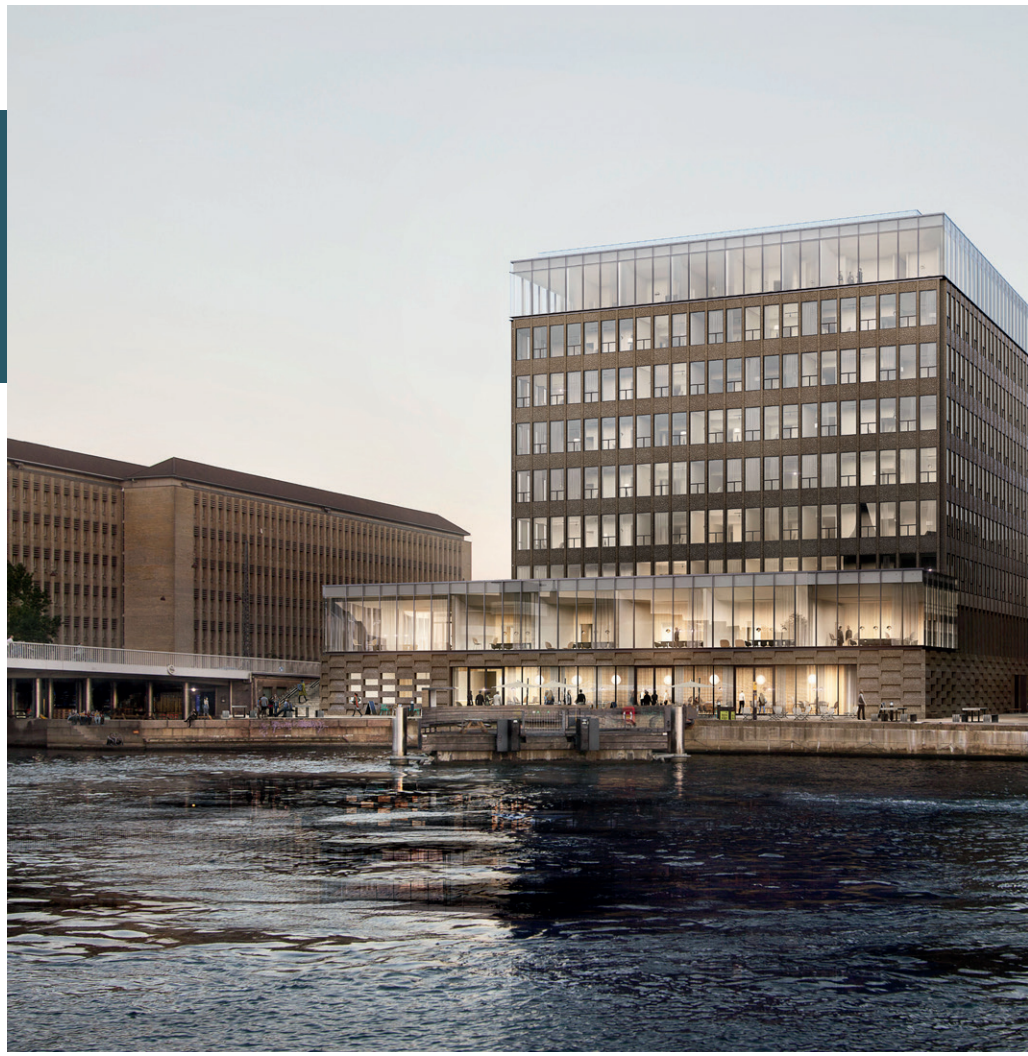
**MIKKEL NYGAARD RØNNE**
Development Manager, NCC

**Digitalization or market loss**

Christian Hartmann explains that it is necessary for ATP Real Estate as developers that, like contractors and consultants, they are involved in the digital aspect and have developed an independent strategy in the area. It enables them to make demands as to how the construction should proceed and gives them a better position toward their customers. Christian Hartmann points out the importance of making precise demands on the ICT agreement as a developer. ICT forms the basis of digital work and defines which digital initiatives create value for the developer.

One area where Christian Hartmann anticipates major financial gains from going digital is in the transition to using project web (the database that keeps track of all documents related to a project and makes it easy to share them). He says that ATP Real Estate, therefore, expects to make use of Dalux FM in the subsequent operations portion.

— We become better at making demands because we ourselves gain better insight. I think the use of the Dalux platform could save us a great deal of money. ►



With new digital collaboration tools, Nordea's old headquarters in the Christianshavn neighbourhood will be transformed into a hotel.
Illustration: Arkitema Architects

We hear that the entire consulting portion becomes more agile by using Dalux. I have heard from consultants that you can save 15-20% by using Dalux Field in connection with supervision and delivery to the developer. In fact, it will cost a lot of money if we don't make the conversion. That would mean market losses. It would be difficult to collaborate with consultants and contractors because they are digitalized.

Hartmann and ATP also have expectations that their new digital approach in the future will make projects less fragile and person-dependent because all of the information is located in the building model and is, therefore, accessible to everyone.

— If we are not digital, we cannot ensure data security. We cannot ensure that our knowledge is located in models and not individuals. And we depend too much on who is specifically assigned to the task. If, on the other hand, we are digital, then knowledge is not personal – and that is a huge advantage, says Hartmann.

**BIM instead of Netflix**

One of the key advantages of the digital building models is that you can visualize the project to the customer before it is built. This is emphasized by all parties, and ATP Real Estate believes it is an important tool in a customer context.

— We simply must be able to offer digital solutions to our customers and be able to illustrate the project to them before it is built. There is an abundance of insight that requires BIS. It is crucial in order for us to have a strong position in the future, says Hartmann from ATP Real Estate.

With digital building models, you can present both form and function during the design process as well as when the building is finished so that everyone understands it. That is a great advantage for all of the parties involved – and that is difficult to give up once you have had a taste of it. Lone Sand from NCC elaborates:

— Hopefully, in the future, many parties will unknowingly have a digital dependency. NCC has made a conscious decision that all parties of the project must turn digital in order to succeed. Because the BIM model provides completely new visual and communicative opportunities for each party, and we are absolutely convinced that if the digital ambition succeeds, all the good people who have contributed to the project will each have developed a new set of competencies. It will have a positive effect on new projects and lead to a higher digital ambition in the future! she says.

**"Hopefully, in the future, many parties will unknowingly have a digital dependency."**

**LONE SAND**
IKT Leader, NCC

"One of the big time wasters is waiting for information and/or getting misinformation. During the project, we try to boil it down to the fact that they only need to search in one location."

**KIM RYTTER**
BIM-Coordinator, Arkitema

**60 seconds for information**
Many perspectives and experiences can be drawn from the renovation project at Copenhagen's canals. One of the most spectacular initiatives is that all of the information across the construction project must be retrievable in just 60 seconds. One of the digital tools being used to ensure data consistency is the Projectspine cloud solution. With this solution, NCC can easily ensure the quality of the large amounts of data and also enrich the BIM model with all relevant information and make physical drawings redundant. Data has often been hidden away in technically heavy BIM software, but will, in the long run, be easily accessible to the relevant parties through Projectspine. Mikkel Nygaard Rønne from NCC explains:

— One of the big time wasters is waiting for information and/or getting misinformation. During the project, we try to boil it down to the fact that they only need to search in one location. With the digital mindset and 60 seconds for information, we have tried to make it easy for everyone to obtain information rather than wait for others to find the information for them. Basically, the execution has been our most important focus and a well-coordinated project and product-specific building parts have been absolutely essential.

**Flawless in the first take**
The ambitious renovation project is associated with many new experiences and challenges. Arkitema's BIM coordinator, Kim Rytter, describes the challenges from a consulting perspective:

— To begin with, it was difficult to do without the physical drawings. But we expect that, in the long run, it will save time, ensure quality, and mean that each architect will have more time for their core services.

According to Kim Rytter, there is a potential advantage in running 100% digitally because you get an overview of all the phases of the construction right from the beginning and you can thus tackle any error before it is too late. It is a challenge having to deal with a digital model where pencil lines have been replaced by digital objects consisting of property data, but in the longer term Kim Rytter expects that this is an approach that will pay off financially.

— We believe that it is an advantage when you gain much greater awareness of what is going to happen technically when you draw the models. This also puts demands on those who model with BIM because if they are modeled incorrectly, they will also be built incorrectly. The fact that we can directly see what the building will ultimately look like with precise measurements means that we can save a lot of time in the long run. We can build everything right in the first take, he says.

**Digital formation**Although there are still many rookie challenges associated with the digital renovation project, and tracking time savings or financial gains is not yet clear, NCC is convinced that there is plenty of indirect value to be gained from the project. Consultants, tradespeople, site managers, contractors, and developers come out on the other side with a digital mindset and great commitment. And this is crucial in order for ATP Real Estate's ambitious goal of implementing a digitalization of their 1.6 million m2 from the property portfolio. For this to be possible, it is necessary that some dare to take the lead, such as with the Ørkenfortet. Mikkel Nygaard Rønne finishes by saying that:

— It is too soon to conclude anything about any huge economic benefits, but the project will give rise to a digital culture on future projects. The project team will be trained in digitalization, and this will create the foundation for the next major digital gains, including for supplier collaboration, sustainability, and operations. In other words, we are working on digital formation. ◆

DIGITAL TREND

Generative design

# When artificial intelligence helps creative minds

During the design and planning of a construction project, you must be able to take many different factors into account. Ensuring the best possible inflow of light, taking wind into consideration, achieving the best possible utilization of a sparse area, or making the best possible use of resources are some of the factors that a construction project must consider.

Illustration: Henning Larsen

**IN THE PAST,** this required many iterations with comprehensive calculations for architects, engineers, and other construction professionals to be able to take such factors into account. Today, development has been boosted using generative design.

**What is generative design?**

Generative design is one of the ways artificial intelligence is used in construction. In short, generative design allows you to automatically generate a wide range of design suggestions in minutes. With generative design, you can design, plan, and develop across many factors.

You utilize the power of the computer to generate hundreds of building designs or simulations of a structure across the most important factors. The result can be analyzed based on the most important parameters, such as the amount of light, area size, material consumption or construction time, based on which the architect or the planner can subsequently make their decisions.

↑ Generative design has helped to ensure as much daylight as possible for most homes, combined with three other important factors: view, density, and wind.

Illustration: HD Lab

## Artificial intelligence at Henning Larsen

Henning Larsen Architects are collaborating with the engineering companies MOE and HD Lab on the Fælledby development, which will be constructed in a windy corner of Amager Fælled nature reserve. Fælledby will be the first (newly built) district built exclusively out of wood as a sustainable project. During the design and planning of the development, the consultants have leaned on artificial intelligence, more specifically, generative design. The aim has been to develop the best possible concept based on several significant factors.

In addition to sunlight and comfort in relation to wind, views and density between the buildings were important factors. The goal is for as many living rooms and balconies as possible across the apartments in the village to be able to enjoy light, shelter, and views.

The use of generative design has helped the consultants to quickly explore a host of alternatives within a design. Rather than manually exploring and calculating the many alternatives, they are able to spend their time on key professional tasks.

Illustration: Henning Larsen

In many places, the COVID-19 pandemic has meant that digital solutions in the construction industry have been realized at full throttle. Solutions that were thought to take several years to implement are ready in a matter of days.

# The crisis that put a turbo on digitalization

**IN ADDITION TO** the mandatory, new experiences within digital meeting culture, parts of the industry have undergone a digital transformation within industry-specific tools that are here to stay. The use of VR and cloud technology has reached new heights, and innovation work and the digital approach has gained importance.
Here, top executives from the construction industry talk about the surprises and business opportunities that they have encountered during the global crisis.

## COVID-19 has boosted VR communication

**FREDRIK ÖSTBYE**
Group Vice President and
Head of FutureLab at Grundfos

**What has COVID-19 meant for the digital work at Grundfos?**
COVID-19 has had a positive impact on digitalization, even though we have had some production challenges. In many ways, we work more efficiently with online meetings, and the physical limitations have prompted a lot of development projects. Because we cannot physically meet our customers, we have invited them into our virtual world instead. We have sent them VR headsets and shown the products in virtual reality. We have received really good feedback on this.

**What products are your customers increasingly demanding?**
In general, there has been a demand for digital products during the COVID-19 pandemic. For example, our IoT sensors, which are mounted on pumps, are in demand. Using artificial intelligence, you can see if the pump needs service.

That type of tool is becoming more important to our customers. Because you do not have to travel to the pump – you can visit it on demand. We also have a product that helps the water distribution system for the water supply. If there is a leak or an overload, then we can visualize it and repair it. And then we have a digital service to reduce energy consumption in buildings, which is also an area of interest during this pandemic.

When only a handful of people go to work, you need to be able to adjust the energy consumption of the buildings on demand. Although COVID-19 has been around for a relatively short period of time, we can already see that there is generally an increased focus on how to regulate temperature and energy consumption from a distance.

**What new norms do you expect as a result of COVID-19?**
The great progress of online meetings is a positive thing that is here to stay. It creates equality between the meeting participants. Everyone sees the same thing and has the same information. You can easily jump from one meeting to another. And then you are at home with your family immediately without having wasted $CO_2$.

We try to see it as a positive thing. A large amount of work will probably be done from home in the future. Tech giants like Google and Facebook predict that 50% of their employees will be working from home within 5-10 years.

**What does COVID-19 mean for your FutureLab department?**
While COVID-19 was taking over the world, we were in the process of establishing FutureLab's new, radical innovation unit in Bjerringbro. We only had a few days together before we were forced to go home. So, we created FutureLab

> "Tech-giganter som Google og Facebook spår, at 50% af deres medarbejdere kommer til at arbejde hjemmefra inden for 5-10 år."

online. It has been a great way to work together. Although there are social benefits of being physically together in an office, there are also benefits of meeting online, and we will continue to work on reaching out to customers instead of everyone sitting in one central location. We need to be closer to customers, who are literally all over the world. We need to talk to people from Asia, Africa, and America. And online meetings work perfectly.

One positive thing about COVID-19 is that, as humans, we are learning to be more accepting of online and digital tools. We have reduced our carbon footprint during this time, and that is positive. We will not have to travel as much in the future as we did before the pandemic.

## Covid-19 has accelerated the use of industry-specific digital tools

APRIL **20%** → AUGUST **35%**

**At the beginning of the pandemic, about 20% of companies used industry-specific tools. By August 2020, this number had increased to approximately 35%. The share had thus almost doubled.**

Source: The Digital Barometer of the Construction Industry 2020

## We continued our work in Australia when the world shut down

**METTE KYNNE FRANDSEN**
CEO and Partner at Henning Larsen

**What has COVID-19 meant for your way of working digitally?**
COVID-19 came like lightning from a clear sky. Suddenly, all of our projects had to be set up to run efficiently from home. Systems and speeds have worked, and everyone quickly found great ways to collaborate both internally and externally. I was incredibly surprised that we were able to do it so quickly. What saved us was the fact that we were already well on our way because we could not have done it just three years ago. Last year, we invested in mobile and flexible workplaces, so that all the employees now have a powerful laptop. In addition, we already had internal competences related to digital collaboration platforms, although this was not generally widespread.

**How have you maintained your international collaboration?**
Sixty percent of all of our work at the design studio in Copenhagen are projects that are taking place outside of Denmark. In the past, most of our travel activity was related to projects involving partners abroad. And now we have been forced to make it work via Teams and Skype. We have had idea development and workshops without being physically present. COVID-19 has forced us to develop new ways of communicating. We have worked with online presentations that are relevant even though we are not physically present.

Post- COVID-19 might mean that we will not have to travel nearly as much. We have realized that some of the tasks can be completed online. But we are also really looking forward to being able to travel again and quote on new assignments!

**What are you particularly proud of that you have accomplished during this COVID-19 pandemic?**
I am really proud that we won a major assignment in Australia, just before the whole world shut down. We have managed to run a complicated start-up and design process at all hours of the day with the client in Australia and consultants on several continents – a process that was intended to involve a high degree of physical presence.

> "COVID-19 forced us into a situation where digital competences became a matter of survival. It has really pushed our innovation work and digital approach."

**What new work processes has COVID-19 opened up for?**
COVID-19 forced us into a situation where digital competences became a matter of survival. It has really pushed our innovation work and digital approach. In just a few months, we have taken quantum leaps in our workflows and, as a bonus, it has opened up new opportunities for using our data. We have been forced to develop methods of running the business when we cannot meet physically.

We have worked together to meet this challenge at Henning Larsen. Many employees have come up with great ideas and solutions for how to do best practice, and the discussions have mainly been based on digital challenges. The internal collaboration has become much better because we have stuck together and used each other's professional skills in new ways. ►

## Better cloud technology and new digital solutions

**LARS BORK HANSEN**
Director of Construction, Sweco

**How has COVID-19 affected your work?**
COVID-19 has meant that we have evolved to a certain degree. Fortunately, the construction industry has been running all the time, but under completely different circumstances, which we have adapted to. We have, therefore, accelerated both our collaboration and the use of digital tools with Skype and Teams, for example. New, digital approaches have been crucial for our daily work to be able to function, and in several cases the quality has increased.

> I think COVID-19 is an example of how external factors can strengthen the digital aspect.

**What new, digital initiatives have you launched?**
COVID-19 has had a positive effect on our business. We have become better at automating our processes and have created new services. Within digital renovation, we have created tender packages that do not require us to be physically present. With a camera fitted on the helmet of a person filming the building to be renovated, you can consult from home while not bothering those who use the building. There are already technologies that can scan automatically, but with a camera on a helmet, the images get better. This is a brand-new approach and clearly something that we will continue to do.

During COVID-19, we have also seen that we are increasingly using digital, industry-specific tools such as 3D models. After all, we only act through our digital models when we cannot be together physically. Furthermore, we have become more cloud based. All of our data is now stored in the cloud, and this gives us flexibility and agility because we are collaborating across the country, and people from third-world countries make models for us. To act agilely, it is, therefore, extremely important that we have access to the same projects at the same time.

**What has the increased digitalization meant for your employees?**
Digitalization has accelerated and given everyone a positive boost – even those who were not on board before. Everyone has gone digital because, otherwise, it would not have worked.
The fact that people have worked from home has in some cases had a positive effect because it has given them peace to work, even though others have had to homeschool and act as a daycare. But in fact, in some places, we have seen productivity increase when people have worked from home.

**What surprised you about the restructure?**
For several months, we have had a world that has functioned without travel activity. It has been possible to do many things from home, although, of course, it has also proven to be necessary to have some physical meetings. But I think COVID-19 is an example of how external factors can strengthen the digital aspect. And that is what I'm most happy about: The fact that everyone has embraced digitalization.

## A new meeting culture and full production

**MARLENE HAUGAARD**
Director of Engineering, NCC

**What has COVID-19 meant for your digital work?**
At NCC, we already work a lot with industry-specific tools, such as 3D modeling and digital exchange. Therefore, that way, I don't think that COVID-19 has prompted anything new. But we have held a lot of digital meetings using Teams instead of having physical meetings and have really enjoyed the chat features. Our big leadership conference in the spring was also held via Teams instead of physically.

**What challenges has COVID-19 had for your digital work?**
What we have established is that it is a challenge for our technical designers to work from home. Because the 3D models are so big that they cannot run on a computer from home without lagging. We have a detailed model that embraces all professions and disciplines. That has given us some challenges.

**What surprised you about the new digital workflows?**

It has surprised me that our productivity has remained the same, even though people have worked from home and some have had to care for their children at the same time. Our working hours are more fluid now, and some have worked odd hours. It has made us aware that when we are part of a team, we need to clearly communicate how we structure our workday.

In the future, we will pay more attention to choosing a meeting style based on what type of meeting we are dealing with. The digital version will be used for brief meetings where we need to be informed and decide on things.

> "It has surprised me that, so far, our productivity has remained the same despite people facing some pressures at home rather than working in the office. "

**What is the most positive story about COVID-19?**

It has surprised me that, so far, our productivity has remained the same despite people facing some pressures at home rather than working in the office. We have had some challenges with a few deliveries, but then we have found other solutions. Our order book was quite full before the crisis, so we have done well. But I'm anxious to see whether we will experience the same activity in the future. There is a need for the public sector to speed up the process so that public construction projects can be initiated more quickly than is currently the case.

## The future demands new office communities

**RASMUS BRANDT LASSEN**
Director of the Danish Building and Property Agency

**How has COVID-19 affected digital work at the Danish Building and Property Agency?**

COVID-19 has been the litmus test of whether we are ready to work completely digitally. During COVID-19, all work processes were suddenly forced to be carried out in the digital world. Fortunately, it turned out that we were very well prepared to work digitally.

**What new business opportunities has COVID-19 opened up for?**

As you know, we deliver office solutions to public institutions. By now, many of us have been working from home for several months and, overall, it has worked very well.

As we build the offices of the future, we need to look at what people have missed when working from home. Because that is what offices must offer first and foremost.

There is no doubt that offices continue to play an important role in ensuring coordination and knowledge sharing, supporting social and professional networks and being a focal point for culture and values in companies. This requires that our offices be designed differently in the future. And maybe we can make do with far fewer square meters.

In the past, we said we supplied office buildings. Then, we also started providing facility management and then we said we were providing jobs. And with the experience we have gained working from home, it is to be expected that this will play an increasingly active role, even after the pandemic. We may need to look at whether we are in fact providing opportunities to work. This requires a close collaboration between those of us who provide the buildings and FM (facility management) services, and those who provide the IT infrastructure that makes the more fluid work life possible.

**How will your new focus unfold in practice?**

We are in the process of testing these thoughts in practice on ourselves. Our own offices in Skanderborg and Copenhagen have turned fully activity-based, where we share a number of facilities that support different tasks. The next step is to use our own experience in our work to ensure even better offices, and we are currently developing a new hub of 30,000 $m^2$ in Odense.

> "As we build the offices of the future, we need to look at what people have missed when working from home."

We will be looking at how the offices should take shape to support the way we will be working in the future as much as possible. This is a development that may have moved five years closer due to the experience that we have gained with the COVID-19 pandemic. ◆

DIGITAL TREND

Digital twins

# Digital twins for smarter building operations

With the digitalization of the construction industry, new opportunities have arisen to streamline both inspection and maintenance work in connection with large buildings and construction projects. Today, sensors can detect and deliver real-time data on almost every component of a building. Digital building models coupled with real-time data are the foundation of working with digital twins.

With the digital twin, Sund & Bælt will be able to access both the machine's operating history, maintenance and specifications – all digitally and in real time without the need to go down into the tunnel.

Illustration: Icono A/S

**THE DIGITAL TWIN** is a living digital model of a building that follows the building throughout its life. Using sensors that send real-time data to the model, the digital twin displays a current and updated image of a building's condition. A digital twin can provide knowledge about anything from when a light bulb needs replacement, or an exposed surface should be inspected, to when entire building parts need to be renovated.

The digital twin is often born already when a construction project is planned. Here, the goal is for BIM models to form the basis for design, calculations, and planning and to support fast and smooth construction.

Construction can thus grow and be created simultaneously in the physical and the virtual world.

With digital twins, it also becomes possible to simulate environmental scenarios and understand their impact.

**What can they be used for?**
When construction is complete, sensors will feed the twin real-time data. This allows you to monitor and perform inspection directly from a computer.

With digital twins, it also becomes possible to simulate environmental scenarios and understand their impact. If open, public data on weather conditions, water levels or soil conditions are linked to the model, you can simulate what a major hurricane would mean for a bridge, or what an elevated water level would mean for a subway tunnel.

## Sund & Bælt use digital twins

Sund & Bælt use digital twins to streamline the operation and maintenance of their bridges, tunnels, and ferry ports. In this connection, they have formed a partnership with CN3, IBM and KPMG.

Together, they are developing the digital twin for the upcoming Fehmarn Belt Link ahead of the physical construction. The goal is to be able to locate and remotely operate the individual technical parts.

With the digital twin, Sund & Bælt will be able to access the operating history, maintenance, and specifications – all digitally and in real time without the need to go down into the tunnel. Costly inspections and repairs are thereby kept to a minimum.

There are significant financial gains to be had by digitalizing construction, and a crucial key to reaping the full benefits is to use open standards such as IFC and BCF. This is shown by figures from Molio's Digital Barometer, where 37% of respondents answered that standards for data and data sharing are the technology that will have the greatest impact on their business over the next three years.

# Common standards create better and cheaper construction

"It is a clear advantage that competition is free with the common standards, so that the file format for the entire construction process is not determined by a single supplier. That way, they can get the best suppliers involved in a project rather than just the suppliers that can deliver in a particular format," says Mikkel Hemmingsen.

Foto: Sund og Bælt

**MORE AND MORE PARTIES** in the construction industry are leaning toward open formats these days. Others are already well under way. And while there are plenty of challenges associated with restructuring, there are great benefits to be gained. The formats make it easier to share data across projects and companies.

**Sund & Bælt uses common standards**
A good example is Sund & Bælt, which is the Danish state's owner, developer and operating organization for the country's largest bridges and tunnels. They benefit from working with open formats, among other things because it is easier to exchange data across companies and partners. When models and data in your own projects and those of others are based on common standards, it becomes possible to use them across companies. Especially the opportunity to compare across disciplines is of great importance for Sund & Bælt.

"There is great potential with common standards in being able to compare our processes with similar companies that we have not yet fulfilled."

**MIKKEL HEMMINGSEN**
CEO of Sund og Bælt Holding A/S

**Securing the future**
It is also important for Sund & Bælt that models and data are submitted in open formats, as opposed to the proprietary formats, as the building information models are thereby future-proof. The open formats mean that you can safely open the models with the new software versions, which will be current in 5-10 years – or more – and thereby make the operating part easier and cheaper.

**The whole industry must get involved**
According to Sund & Bælt, the application of common standards makes it easier to find opportunities to streamline and strengthen their projects and processes. At the same time, they feel that there would be even more benefits to be gained if the entire industry went along. CEO Mikkel Hemmingsen of Sund & Bælt Holding A/S explains:

— If we have a 3D model, it's nice to be able to share it with our suppliers. Instead of having to enter everything manually, we can share data with our suppliers so that everyone can use the data that best suits their system. The common standards also make it easier to disseminate algorithm-based solutions that we use when working with artificial intelligence. And then we can become better at benchmarking; if, for example, we want to benchmark the railway tunnel at the Great Belt Bridge with other bridges. There is great potential with common standards in being able to compare our processes with similar companies that we have not yet fulfilled.

Mikkel Hemmingsen points to the fact that the entire industry will need to follow suit so that the economic potential with common standards can be fully realized.

**Free competition**
One advantage of open formats is that you can decide for yourself which software you use, as long as you continuously export to open-file formats. This is a financial plus for both small and large businesses. The small businesses, which may otherwise be subject to the decisions of larger players in a project, avoid purchasing new programs and additional resources depending on the set-up in each construction project.

— Common standards help prevent small businesses from being moved around time and again from one project to another and from being forced to use a certain kind of software, says Architect and Owner of the software company Graphisoft Center Denmark, Thomas Graabæk, who is generally a proponent of common standards.

Sund & Bælt sees it as a clear advantage that competition is free with the common standards, so that the file format for the entire construction process is not determined by a single supplier. That way, they can get the best suppliers involved in a project rather than just the suppliers that can deliver in a particular format. Mikkel Hemmingsen says that it is an advantage for Sund & Bælt that the common standards prevent monopoly regarding the use of software packages. The free competition means that the quality of data will increase – and construction will be cheaper.

**The best rather than the biggest**
However, it can be a great challenge to get the whole industry involved in the common standards. Small and medium-sized businesses are already particularly hesitant. Because even though it can be expensive in the long run not to jump on the bandwagon, it requires consideration and takes a great effort to adapt to the new collaboration methods.

Architect Jakob Andreassen from Rørbæk and Møller believes there should be a greater focus on the potential of the open-file formats rather than dwelling on the challenges. ▸

## What are common standards?

Common standards are established structures, standardized data, and technical specifications for data that is publicly available and compatible across software. That way, those who follow the standards can use each other's models and data, no matter what software they use.

— When you can choose the file format and use the tools that are best suited for yourself and for the task you need to solve, you work faster and deliver higher quality. By running projects with common standards, small businesses – who might not have the resources to adapt to a specific file format – are also able to take on the task. You do not exclude the potentially most talented by requiring that the work be carried out in a specific program, says Jakob Andreassen, who sees it as a great advantage.

**Everyone must get on board for it to make sense**

Mikkel Hemmingsen from Sund & Bælt points out that the importance of working with common standards applies to all parties in the construction industry, as there is so much more to gain once you share data.

— For us, data sharing is a prerequisite for good collaboration. If our suppliers do not support the current standards in the market, it is difficult for us, he says.

In this context, Hemmingsen points out the fact that everyone must work together in common file formats for value to thrive for each company and organization. That is why, together, you must aim at a common, greater goal. A consideration that the proponent of common standards, Thomas Graabæk, agrees with.

— No matter where you look and ask where we can make big savings, common standards are part of the answer. And the Achilles heel is that it may be a bit more of a hassle for each individual in the project. In the short term, it would be easier if we all had the same software. It can be difficult to make changes in other people's files, but it is nice when you can share data without restrictions. You have to get used to that. It must trickle down throughout the construction industry that there is an overall goal. It is about creating better and cheaper construction – and common standards are essential, he explains.

**A question of cultural change**

As is the case with many new things, the transition to working with common standards is frustrating to some. The work requires that you have a good routine of constantly updating your work to the open format. Unfortunately, not everyone is disciplined with their transfers, which means that knowledge is wasted. Jakob Andreassen believes that the IFC format often ends up as a scapegoat in the heat of the battle but believes that the criticism is unjustified.

— I have seen IFC being mistaken for the lowest common denominator. Yes, it is a common denominator, but it is often used as a scapegoat and gets blamed if the hassle exceeds the benefits of the common standards. Quite often the challenge lies elsewhere – in the cultural difference between companies. It is often not the format but the tools from which they are to be generated that is the challenge. In reality, the workflows of exporting data are the issue, says Andreassen.

**It takes discipline**

By working with common standards you can make collaboration smoother across partis in the construction industry. But it requires that every party of the project has a plan for how often you update your files according to the common standards. In other words, working with common standards also requires new routines.

Thomas Graabæk gives an example as to why it is important that you are disciplined and have a common behavior for how often you update your model.

— Some people wait until the last minute to export to IFC, and then the content is not of the same quality. We often see that the software-specific files are located on these common project websites, e.g. Revit files that are constantly updated, but that the IFC files are updated sporadically. And then it doesn't work. If you end up locking all your knowledge into one platform, because "this collaboration platform is just so cool to use", then it can be difficult for the contractor to retrieve data. You must continuously convert to IFC. Even if you collaborate with parties that use the same file format. What if builders want to change consultants at some point? Then they shouldn't have to find someone who uses the same program.

## What is IFC?

IFC stands for Industry Foundation Classes and is an open data model that serves as a basis for data sharing and exchange. This is the common standard for BIM projects, which enables a project to be opened by almost any BIM-software, if the project is saved as an IFC-file.

"It must trickle down throughout the construction industry that there is an overall goal. It is about creating better and cheaper construction – and common standards are essential"

**THOMAS GRAABÆK**
Owner, GRAPHISOFT Center Danmark

**Three-step plan**

Thomas Graabæk proposes a three-step plan, so that the work related to common standards can be a success:

— Firstly, you must understand that there is an overall goal. Secondly, you must understand that there are also some limitations associated with working in this way – not everything is as usual in a different file format. Because the files will be used in a different way. That is why it is an advantage to join the project from the beginning. And then each employee must learn how to do it using their own software. How do I export IFC and how do I import other people's IFC files? You have to know some pretty specific things for it to work properly, he says.

**When are we at the finish line?**

Much has happened since the first digital 2D drawing programs were introduced in the 1980s. The construction value chain has improved with digitalization, and in order for the great potentials to be realized with digitalization, it is crucial that the entire industry gets better at working together. To take this quantum leap, common standards are the next big step.

Jakob Andreassen has implemented BIM workflows and BIM software into architectural firms since 2006. He talks about how much has happened since then.

— Today, we can live with the fact that information is not in a single file, but rather in a project environment. And that means more room for common standards. People used to think that everything could be available in a single file. We now know that everything must be accessible in a database context and be linked to each other. It has been demonstrated that a single format is not realistic when it comes to the huge amounts of data that are needed. Even producers are moving toward more database-based content rather than a single file. And more people have realized that the original goals set ten years ago have been revised. We have grown wiser along the way, he concludes. ◆

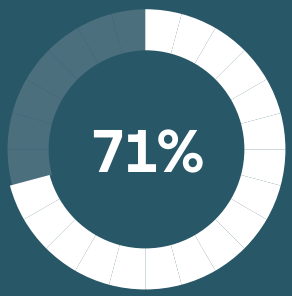
> "Today, we can live with the fact that information is not in a single file, but rather in a project environment. And that means more room for common standards."

**JAKOB ANDREASSEN**
IKT/BIM-Responsible, Rørbæk og Møller Arkitekter A/S

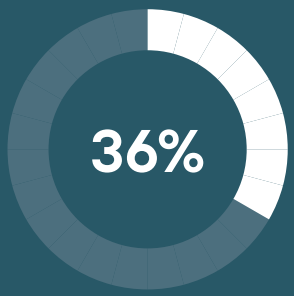
## What is BIM?

BIM stands for Building Information Modeling. It is an integrated method of digitalizing the construction process. Throughout the construction life cycle, from idea to demolition, digital data structures are the focal point of all the construction project's activities and the collaboration between the various parties. BIM is, therefore, both an information model and a working method.

## What the Digital Barometer of the Construction Industry shows:




Today, 71% of respondents use standards to either a high degree or to some degree.




36% of respondents consider standards as one of the most important digital technologies for the development of their business in the coming years (surpassed only by BIM with 62% and administrative software with 59%). [1]

[1] The respondents were able to select up to three technologies from a total of 14 options.

Source: The Digital Barometer of the Construction Industry 2020

DIGITAL TREND

Robots in the construction industry

# Robots finally get dirt on their hands

The construction industry has always been associated with heavy, manual labour. On the construction site, many tasks are repetitive, grueling, and time-consuming. Tradespeople performing the work even wear down the most important tool in the toolbox – their own body.

**THE INDUSTRY DISCOVERED** the ability of robots a long time ago and their ability to relieve and help factory workers around the world. However, the industrial robots that work side by side with factory workers today work best in relatively clean environments where they perform simple tasks.

However, the digital development within robotics technology is working hard on changing this. Now, robots are heading for the construction sites and act as the tradesperson's partner, a so-called cobot. A cobot is a robot that, rather than taking over entire tasks, works side by side with humans as a mechanical colleague. They can be brought out to the construction site and work side by side with the tradespeople.

## Exowear and Kobot's robots

**EXOWEAR'S COBOT**
The exoskeleton is one type of cobot that has great potential to help at construction sites. The company Exowear has developed exoskeletons that can relieve shoulders and arms, backs, and legs, e.g. during assembly and heavy lifting. While such cobots do not provide superhuman strength, they do relieve exposed muscle groups, protect the body from wear and tear from repetitive tasks, and significantly increase endurance.

**KOBOTS'S COBOT**
Another type of cobot is Amigo, which was developed by the company Kobots. Amigo provides the ability to automate repetitive and grueling cutting processes related to carpentry tasks. For example, when insulating and drywalling walls in large buildings, carpenters need to make many cuts in often crooked, back-breaking positions. A job that, in the long run, hurts the tradespeople performing this work.

With Amigo, the drywall can be placed within a frame, after which the desired dimensions are either entered into an app or dictated via voice recognition. The robot then cuts the drywall quickly and efficiently, saving both the employee the physical stress and materials for the building process. Because Amigo is not an unintelligent cobot. It helps to remember what remains from the cuttings made by the tradespeople. If a new task can be performed on a leftover piece from a previous cut, then Amigo remembers this and thus helps to minimize waste in the process.

The robot can also be separated into three parts and weighs only approx. 47 kg. The tradespeople can thus bring the robot, assemble it directly at the construction site in a few minutes and then start to work.

Photo: Kobots

Several technologies that previously seemed futuristic are becoming part of the reality of the construction industry. Artificial intelligence, digital twins, IoT, and robots are helping to drive digital development in the industry. But how do you as a company find out where to invest and what technologies to master?

# More innovation and fewer standard solutions

**THE ANSWER FROM** some of the construction industry's leading digital leaders is to increase curiosity and put innovation, rather than just technology, on the agenda.

"There is a really important exercise in sitting down and imagining what your company would look like if it were a technology company rather than a construction company."

**NIELS FALK**
Head of Consulting and Innovation, HD Lab

**New technologies are on the way**

A large part of the digital transformation so far has been about speeding up the processes. Gains in the form of quality and savings are ingrained in most companies that use BIM and VDC [ed: Virtual Design and Construction] to optimize their business and achieve greater productivity. According to the Digital Barometer of the Construction Industry, 81% already work with BIM, just as BIM is the technology and method that most companies expect to have a major impact on their business in the coming years.

However, new technologies that have matured in recent years are just around the corner. Artificial intelligence, IoT, sensors, and robots are no longer reserved for the few that are at the forefront of the industry. In just a short time, it has become both cheaper and easier to access and use the more advanced technologies. These are technologies that, according to the Digital Barometer of the Construction Industry, are not yet particularly widespread among companies. On the other hand, interest is on the rise.

— We are seeing an increasing interest in robots and automation. Some are construction site robots, and some are off-site. Then, there are also 3D printing and software assistants. At the same time, there has been an interest in the use of data, building passports, and data flow, says Niels Falk, Head of Consulting and Innovation at HD Lab, which houses technology consultants who specialize in the construction industry.

**You have to be curious**

In turn, the spread of these new technologies places demands on the boardroom. You have to be curios with regard to new technologies if you want to keep up. Like other industries, the otherwise practical construction industry is becoming a more technologically driven business. The transformation from an analog to a digital company means that you must be able to imagine the company from a completely new perspective. That is one of Niels Falk's points.

— There is a really important exercise in sitting down and imagining what your company would look like if it were a technology company rather than a construction company. It's about


Exoskeletons are one of the new technologies that CEO of HD Lab, Niels Falk, believes that more companies should experiment with.
Photo: Nina B. Fromm, Exowear / CG Jensen

techno-flexing your business and asking, "if Amazon ran our business, how would they do it?

**The technologies will prompt a quantum leap**

According to HD Lab, the new technologies can prompt a quantum leap in the construction industry, which will change the current structures. Therefore, it is important to focus on which technologies will impact your business areas.

The construction material supplier, Solar, has worked with this targeted approach. They have gone from being a classic suppliers to now earning more than 60% of their revenue through digital solutions. For them, technology has also played a significant role. From the beginning, they have focused on what technologies could soon affect their business. They mapped the technologies and linked them to features or applications that were either directly relevant to Solar or to the company's customers.

**Don't prolong the past with boards**

For Solar, running the company in a more technological direction was not straight forward. Their competences were in trade. Therefore, it was important from the start to collaborate with start-ups to get close to new technologies.

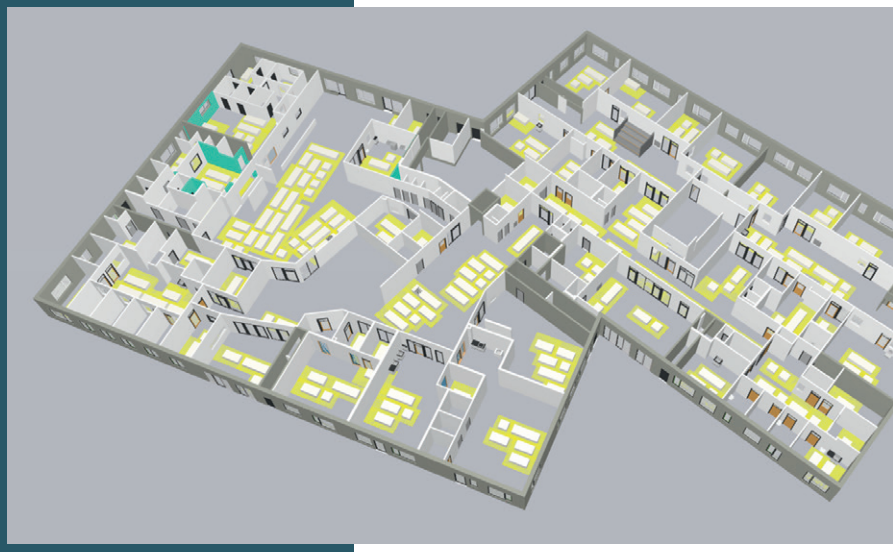
— Our IT department can maintain our SAP system and support our operations in a sensible way. But they don't have a chance to attract mobile app specialists or people who know usability or radio technology. If there is an area that is driven by some technologies, then you have to be close to those technologies to participate in it, says Hugo Dorph, Chief Commercial Officer.

"It is important to not just think about yourself. If you think that you have to come up with all of the solutions yourself, then you can end up building on the solutions of the past that are not suitable for the problems of the future."

**HUGO DORPH**
Chief Commercial Officer, Solar

Hugo Dorph believes it is important to not just think about yourself. If you think that you have to come up with all of the solutions yourself, then you can end up building on the solutions of the past that are not suitable for the problems of the future.

— There is a bit of a risk that you continue to build on what you have. This is not necessarily a problem for small businesses. But for medium-sized businesses, this can be a challenge. For them, IT generally started with finance when they needed to manage their finances, and then more data has just been added to the system over time. Today, there is a sensor in cars that provides the GPS position and workers have a computer in their hand. It offers new opportunities to be in close proximity to the business. So, you have to be careful not to just prolong the past, says Hugo Dorph. ▸



With digital services, Saint-Gobain helps installers at the construction site by planning and clearly marking where on the premises materials should be stored. Indicated with white boxes on a yellow tarp. A good example of how smart tools make logistics easier.
Illustration: Saint Gobain

"This is construction from reality. It includes drywallers who go on site to install the drywall. But we support it with smarter logistics, smarter tools, and socio-technical tools to agree on who does what."

**NICOLAJ HVID**
Digital Construction Director,
Saint-Gobain

Therefore, there are good reasons for thinking about the possibilities of technologies. Companies that are just waiting to see which technologies become the most prevalent may end up being overtaken without warning.

According to both Niels Falk from HD Lab and Hugo Dorph from Solar, it is important to use the technologies as leverage to see completely new opportunities in their business.

**A simpler approach**

In another part of the industry, materials supplier Saint-Gobain has run its digital development with a slightly different approach. For them, technology also plays a role, but not as a starting point. Nicolaj Hvid, Digital Construction Director, has set out to solve the practical problems on the construction site, which they see as an obstacle to a more productive construction industry.

— In my business, we focus a lot on the simple things. So, even though we use some very sophisticated tools, it is very simple. It's about how we can communicate better, and how we can ensure that there is a better correlation between what you want to build and what you actually build, says Nicolaj Hvid.

**Digitalization at the construction site**

In a pilot project with NCC Sweden, Nicolaj Hvid, therefore, chose to focus on problems and challenges at the construction site. When the processes at the construction site do not work, waiting time and a waste of materials occur. During the project, it specifically manifested itself by the construction manager constantly being stuck on the phone with issues or errors that needed to be corrected.

— Despite the fact that we started with VDC, [ed: Virtual Design and Construction], that was not what it was all about. We looked at the processes and at where things were failing. And the first thing NCC said was, "The logistics stinks!"

It is a mess at the construction sites. We get more material delivered than we expect because too many people are involved in the processes, says Nicolaj Hvid.

**Construction from reality**

The solution turned out to be simple. Procurement of materials is often coordinated through several offices and departments to keep prices down. The supplier is, therefore, far away from the actual construction site, while the construction manager and the workers at the construction site ultimately face the problems.

Custom-cut drywall is typically deselected because it is more expensive than buying in bulk. But the custom-cut solution has proven to be the very key to solving the problem. And the method of supporting a customized process was composed of several digital tools specifically selected for the purpose.

— This is construction from reality. It includes drywallers who go on site to install the drywall. But we support it with smarter logistics, smarter tools, and socio-technical tools to agree on who does what. As a material supplier, we get a completely different role. We become much more integrated into the construction process. Instead of being the last one in a role, we are right down to holding their hands, says Nicolaj Hvid.

And although the material itself became more expensive, the results were noticeable. According to Nicolaj Hvid, the project has managed to reduce the production time on the construction site by 30%-40%, while both material waste and extra work or rework have been reduced to almost zero. ▸

"When processes change with the use of technology, or when customers begin to collaborate in new ways, the roles in the value chain change."

## Project ConTech

Molio has joined forces with Realdania and the Danish Industry Foundation to increase productivity and sustainability through digitalization and effective collaboration across the construction industry. The initiative has the working title Project ConTech.

The vision is to support companies within the construction industry so that, together, they can test, develop and implement new innovative solutions that will pave the way for a more sustainable and productive future.

**Follow Project ConTech at molio.dk/contech.**

**New technologies prompt new roles**

Saint-Gobain's example holds two of the most important gains from digital construction; better processes and fewer errors. On the other hand, a by-product occurs in the wake of digitalization. When processes change with the use of technology, or when customers begin to collaborate in new ways, the roles in the value chain change.

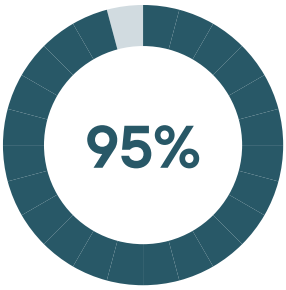
This is where, as a company, you need to find out what role you want to play – as was the case in the example from Saint-Gobain. This also applies to other parts of the value chain, including wholesalers.

— If our customers start designing solutions in BIM because their customers require them to do so, then what will happen? Will the decisions then move to someone else? And perhaps even closer to the contractors and the ways they run their business and customers in one system. Then, our goods must also be integrated into that context, says Hugo Dorph.

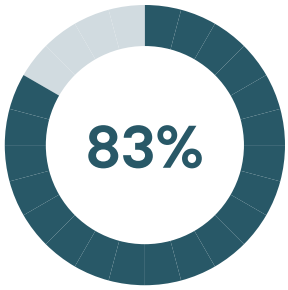
When customers pay more attention to solving their needs than to which specific product they are buying, the product, service, and platforms merge. This paves the way for new business models like servitization or platform-based businesses. In the example of Saint-Gobain, the company ended up taking on a different and more consulting role in the construction process.

— Traditional consulting for a materials supplier is upselling: Buy another product and earn a little more. But our approach is that we may not have to sell anything at all. These services are crystallizing as stand-alone services, where we get money for the work that we perform, says Nicolaj Hvid.

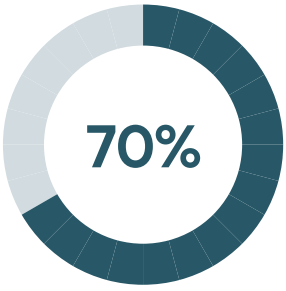
## What the Digital Barometer of the Construction Industry shows:



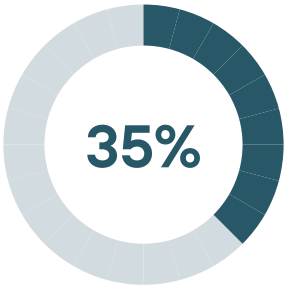

95% use process technology/ software (e.g. administrative software and standards).




83% use technology for design/modeling (e.g. BIM and VDC).




70% use physical technologies (e.g. drones, sensors, and robots).




35% use data-driven technology (e.g. IoT, artificial intelligence and blockchain).

The barometer indicates that the use of new technologies is not yet widespread within the construction industry. Today, companies mainly use administrative software (including software for quality, project, document, or financial management). Companies also use standards for data and data sharing (including e.g. IFC and CCS) and BIM (Building Information Modelling) to a great extent. Data-driven technologies such as machine learning, artificial intelligence, and blockchain are reserved for a limited portion and are especially seen in engineering companies and developer consultants.

Source: The Digital Barometer of the Construction Industry 2020

**Small steps and then combine**

But where do you start as a company when you want to take a quantum leap in your digital development? Nicolaj Hvid from Saint-Gobain, Niels Falk from HD Lab and Hugo Dorph from Solar all agree.

They believe that the construction industry has done well in working with common solutions. It has provided security and boosted productivity in companies and on construction sites. But it is also a lengthy process. The increasing speed of technological development makes it difficult to continue with that model – at least if, as a company, you want to be sure that your business keeps up.

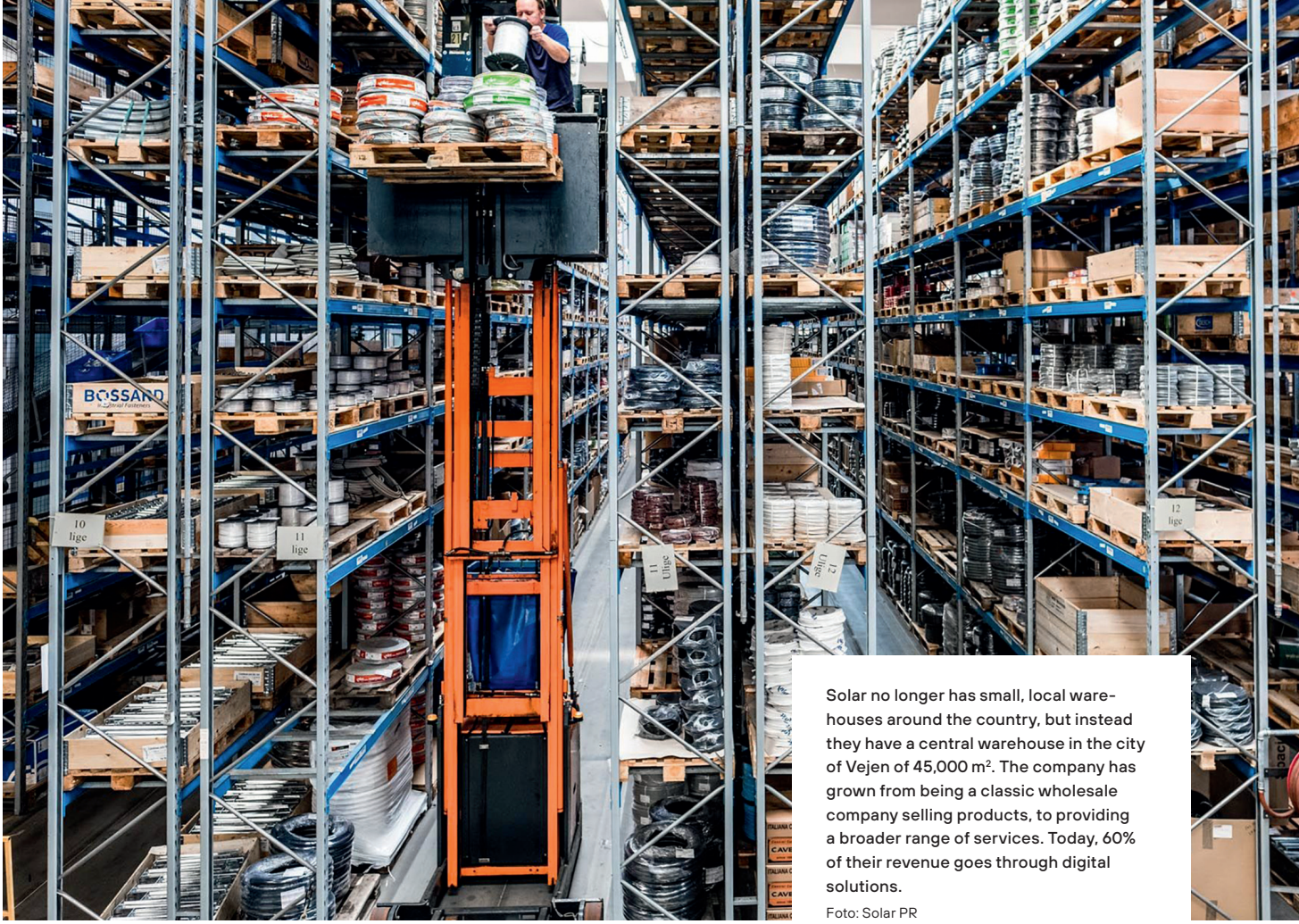
— One of the challenges in the construction industry is that we always see it as industrial solutions or business solutions that need to be in place. Then, we buy a solution and everyone uses it going forward. But that's not how we make cultural changes. Move the focus away from technology to the process and the result, says Niels Falk from HD Lab.

His perspective is backed up by Hugo Dorph, who has pursued a clear strategy of collaborating with small, innovative players and start-ups at Solar. One system cannot solve all of the problems. Therefore, it can be a disadvantage to think in big solutions alone.

— Forget your existing software for a moment and pursue the applications. The construction industry does not need much enterprise investment. We have to take the small steps, and then we need to build together, says Hugo Dorph from Solar.

**Experiment**

One way forward is to let experiments form a larger part of the toolbox when it comes to boosting digital development.




Solar no longer has small, local warehouses around the country, but instead they have a central warehouse in the city of Vejen of 45,000 m². The company has grown from being a classic wholesale company selling products, to providing a broader range of services. Today, 60% of their revenue goes through digital solutions.

Foto: Solar PR

Of course, it takes courage to experiment in 1:1 projects. And a perspective where you start by looking at your own processes to identify where technology can really create value.

— Start by forgetting everything about BIM. Forget about your tools. If we unite in different associations where we sanctify our tools, then it will never reach the construction site. You need to look at the processes. Is it really all that smart the way we are doing it right now? asks Nicolaj Hvid, who is backed up by Niels Falk from HD Lab, who emphasizes the importance of understanding what the technologies can do at the same time.

— Experimenting is a good way to do it. Companies understand it once they get into it. Many would be better off at both mid-level and management level if they became more familiar with the technology and what it can do. Try a VR set. Create an open BIM model, suggests Niels Falk.

**Test, test, and test again**

The innovation approach of working in short, fast iterations with a focus on constantly learning is something the construction industry can practice doing. And that method may prove to be the right solution for digitalization to reach the construction sites.

— This is where I think we are basically not good enough at accepting the innovation premises with build-measure-learn. We must experiment before we start buying tools or rolling them out. We must experiment and find out if it works, says Nicolaj Hvid and concludes by pointing out that Saint-Gobain's experiments provide pretty clear results when they succeed.

— We subsequently interviewed the site manager on the project. He was asked what the biggest advantage is for him by doing this. He takes his phone out of his pocket and says in a dry tone, "My phone doesn't ring!" Now, no one needs to constantly call and ask about something or complain that "something is not right." This means so much to him, and it has been a fantastic experience to be a part of delivering. ◆

> **"We must experiment before we start buying tools or rolling them out. We must experiment and find out if it works."**
>
> **NICOLAJ HVID**
> Digital Construction Director,
> Saint-Gobain

DIGITAL TREND

Virtual Reality

# VR helps minimize errors

One of the great benefits of digital construction is better tools and processes to prevent errors. Even minor errors early in the process can end up being costly or outright unsolvable once the concrete is cast, the windows installed, and the green areas planted.

**What is Virtual Reality?**
Virtual Reality, also referred to as VR, is a technology that creates a very lifelike virtual world in 3D using VR glasses. The lenses in the glasses have been replaced by a built-in screen that shows content from e.g. a computer. In recent years, more and more industries have discovered how VR can be used to simulate physical frameworks, where you can try things out and, among other things, involve users in a new way.

**How does the construction industry work with VR?**
VR makes it easy for everyone to understand what a building will look like and how it will function, even if it has not been built yet – or if you are not physically close to the building. This makes it easier to involve the non-construction end users. Through virtual reality, you can step into a 3D model in a 1: 1 ratio and experience the building in its actual size. Being able to move around in the actual building makes it easier for the user to understand what it will look like, and thus also easier to provide input, feedback, and ideas.

BørneRiget (Children's Hospital Copenhagen) is scheduled to be completed in 2025.
Illustration: 3XN

## VR at BørneRiget
(Children's Hospital Copenhagen)

The Capital Region of Denmark is currently working on building BørneRiget. An expansion of Rigshospitalet, which will become 'the world's best children's hospital'.

Working on creating BørneRiget, the focus has been on extensive and early user involvement. Despite the fact that construction is not scheduled to be completed until 2025, many doctors, nurses, midwives, patients, and parents have already moved around the long hallways and patient rooms. These visits are only made possible through a 1:1 VR model of the upcoming building. Professor Bent Ottesen, Project Director at BørneRiget, says about the VR solution,

— We get remarkably close to the reality we will have once the hospital is finished. It is crucial that we place the rooms next to each other, according to function and the continuity of care! In our case, we can actually start 'working' in the building six years before it is finished. That is far better than starting the day we cut the ribbon! Bent Ottesen explains.

By using an interactive VR studio, it has been possible to bring 200 professionals into the 'actual building' in just five days and thus test, validate and quality-assure the end users' experiences of the 58,000 $m^2$ hospital. According to Toke Laugesen, an architect working on the BørneRiget project, the VR model offers completely new and improved possibilities.

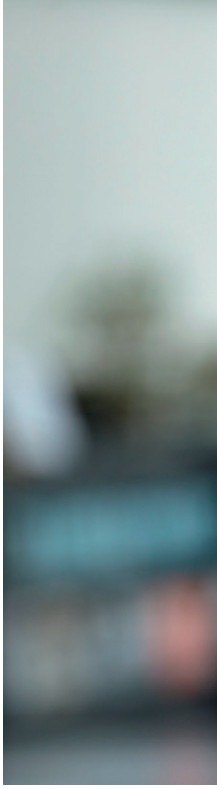
— Architects are used to reading floor plans, but it can be difficult to show doctors, nurses and midwives a floor plan and then expect them to understand the building. But it makes a difference when they experience it in a more intuitive way that lets them understand what they will be moving into, says Toke Laugesen.
He also points out that the conversations and inputs that result from being able to present a full-size 3D model are completely different – a conversation that does not happen in the same way when showing typical scaled floor plans and model drawings.

— It allows us architects to get feedback on the design from the patients', the relatives', and the staff's point of view. It opens up discussions about workflows among the staff, who begin to see the pros and cons of the hospital's design. Mind you, while it is still possible to modify the drawings, rather than after the walls have been erected.

"In our case, we can actually start 'working' in the building six years before it is finished. That is far better than starting the day we cut the ribbon!"

**BENT OTTESEN**
Project Director at Børneriget

The next level of digital development must occur through a mix of harmonization and community. And it must come from within. These are some of the experiences from the Norwegian and Finnish construction industry. Experiences that Denmark may benefit from in its work toward the next digital milestone and a stronger foothold in the European market.



# Trust and harmonization must go hand in hand

**– WE NEED TO** put the pedal to the metal when it comes to creating common standards and new forms of collaboration across value chains in the construction industry. Within Denmark's borders and certainly across other European countries as well. Because we have a huge market potential called Europe.

If you ask Elly Kjems Hove, Deputy Director at the Confederation of Danish Industry, it is crucial for the construction industry that there is confidence in the digital workflows and that there is a common, harmonized foundation for the new forms of collaboration. She finds that all European countries are currently facing challenges in this area, and that there is great potential in harmonizing workflows across European countries.

"We need to put the pedal to the metal when it comes to creating common standards and new forms of collaboration across value chains in the construction industry."

**ELLY KJEMS HOVE**
Deputy Director at the Confederation of Danish Industry

In the Nordic countries, we have generally been quick to kick-start digital development. Digitalization is not a goal but rather a means. The desire for more efficient processes, fewer errors, and an ever better and more ambitious construction industry makes it necessary to digitalize. This applies both in the Danish construction industry and among our Nordic sister industries in Norway and Finland.

However, there are differences in how people work digitally in the Nordic countries. Both at the level of digital development and at what drives the digital agenda.

### Early focus on common solutions in Norway

In Norway, the construction industry has long been a pioneer in working with BIM through open data formats and common standards. As in Denmark, large, public developers have demanded the use of open models, while good economic conditions have made it possible to maintain sustained pressure on digital development.

— Norway has benefited from a prolonged boom, a lot of risk-taking, and a desire to develop and digitalize, says Steen Sunesen, Chief Architect and Project Manager for BIM Requirements at Statsbygg, which is the developer and manager of public construction in Norway.

Already during the early 1990s, companies began using digital tools and considering common solutions. This is pointed out by Egil Skavang, who is the current CEO of the industry organization Arkitektbedriftene in Norway and who, at the time, was part of the development at the consulting company HolteProsjekt himself. For example, he remembers that their first experiences of sending building applications to authorities happened by email. Ten years later, the development really started to take off.

— Around the year 2000, we started working toward a common platform and a common place to develop BIM. BuildingSMART started at that time as well. We made a virtue of sharing knowledge and we involved everyone from the beginning. That was the reason why we came up with a model that worked for us, explains Egil Skavang.

### Major public projects have paved the way

After this, the public developers were among those who pushed for digital development. Large public buildings provided an opportunity to shape the development

"We have a huge market potential called Europe. If we approach those markets with a strong set of good digital habits and forms of collaboration, then we are in a good position," says Director at the Confederation of Danish Industry, Elly Kjems Hove.

Photo: Hans Søndergård
Copyright: Confederation of Danish Industry

of the industry through requirements for the use of digital solutions.

— From 2010, Statsbygg suddenly took off. They began to develop the framework for their own work with BIM. The industry moved extremely fast. From around 2010, all contracts with Statsbygg were to be based on BIM. It prompted a sudden jump in the development, continues Egil Skavang.

**Heading toward seamless digitalization**

The Norwegian industry propelled its development by focusing on common guidelines and standards from the outset. Today, the focus has shifted from being solely about the models to having a more holistic approach.

— I feel that we have reached a level where you don't just look at BIM. Naturally, BIM is crucial, but there is a lot of other information – trade information, sales information, product information, and logistics – that has nothing to do with the models. If we want to become digital and ensure that information moves seamlessly and without restrictions between us, then we must take a more holistic approach, says Steen Sunesen.

**Diversity has strengthened digital development**

In this context, it has been key that the use of BIM is so widespread in the industry. But Steen Sunesen also feels that increased diversity has led to a broader understanding of digital development.

More women have entered the industry. And when you see them at conferences as well, I think it's because we're starting to have discussions at a higher strategic level. The technical part is still under the hood, and it is still an important engine that does the pulling. But the user understanding and which direction we should be driving – that is where our industry is maturing at the moment, explains Steen Sunesen.

"We made a virtue of sharing knowledge and we involved everyone from the beginning. That was the reason why we came up with a model that worked for us."

**EGIL SKAVANG**
Administrerende Direktør, Arkitektbedriftene

**Finnish development based on a willingness to cooperate**

Finland started using BIM early on. They quickly reached a high level of general competence in the use of digital models.

— Already several years ago, many companies were using BIM in a smart way. And the majority worked according to the same methods and based on the same ideas, says Markku Hedman, Director General of Building Information Foundation RTS, a private non-profit organization that works to strengthen construction methods and practices.

Developments in the Finnish industry have particularly been propelled by the fact that each company has experimented with and tested technology. The broad work with models such as BIM has, therefore, provided a high general level of digital competences across the value chain.

— We have reached a level where knowledge and competences to work with BIM are widespread. This is especially true among architects and engineers, but also among contractors who are eager to use the models on construction sites to have access to better information, says Tomi Henttinen, Head of Innovation at Finnish BIM consultants Gravicon Oy. ►

**Development has reached a plateau**

While the approach of experimentation has led to a high level of competences, challenges have emerged as well. Just like in Norway, the construction industry in Finland has become more aware of the content of the digital models and the collaboration around them – not just the models themselves. However, to get the full potential out of digital data so that they can communicate with each other in applications, it requires both processes and data to be harmonized. And this is where the Finnish approach turns out to be falling short.

— Collecting and processing data is new to our construction industry. So, we have reached a transition to real digitalization and information management. This requires us to harmonize both data and processes. And we are not a country that is particularly used to standardizing, explains Tomi Henttinen.

– Because the companies have largely experimented from one project to another, Tomi Henttinen feels that many experiences have been left behind once a construction project has been completed. However, this is a challenge that we have started to rectify, points out Tomi Henttinen.

**A divided industry**

Harmonization is, therefore, crucial in order to unite the Finnish industry, which is currently divided. Some companies have been good at continuing the digital development and have really managed to become frontrunners in the industry. On the other hand, there is a need to get everyone on board.

We have the frontrunners. Companies and research groups that are quite far ahead and advanced in terms of digitalization. They are the pioneers who also reap the first rewards. But many in our industry are passive spectators. They look at what is happening and only innovate their own processes to a minimum. They are very careful about what they do and where they move to, says Markku Hedman.

**Joint efforts to bring the industry together**

This pattern has begun to change in a joint effort between the government, institutions, industry organizations and businesses. Through the investment program KIRA-digi, the Finnish government has raised more than DKK 100 million for projects that were to strengthen the industry's digital development. The projects have included work with both technology and guidelines, which were to harmonize the industry's digital development.

According to Tomi Henttinen, the program has brought about a common understanding in the industry that harmonization is needed to reach the next digital level.

— KIRA-digi has created good solutions, but the biggest effect has been that it has brought attention. The ministries, in particular, have discovered that they will need to get involved – that the next level of development does not necessarily happen by itself. All parties came together to guide and orchestrate the work of harmonizing, he says.

"The value of digitalization really depends how good we are at solving the problems we have and at creating a more sustainable development," says Markku Hedman, CEO of Building Information Foundation RTS.
Photo: Aki Rask

"We have reached a level where knowledge and competences to work with BIM are widespread."

**TOMI HENTTINEN**
Head of Innovation,
Gravicon Oy

**Common incentives are the way forward**

Despite differences between Norway and Finland, they have reached a common insight. It is difficult to move an overall industry in a common direction if the basic incentives do not help.

Although the industry in Norway has been good at harmonizing, there still have been challenges.

— I have been a BIM missionary for more than 20 years. I have personally been at a place where we thought that if we just use BIM, it will solve all of the problems. Well, it didn't! BIM does not solve basic issues such as sub-optimization within the projects, says Steen Sunesen.

The digital tools themselves do not solve the problems that can arise with collaboration in complex projects. It requires trust and a common foundation. To ensure better common incentives, the contract model Integrated Project Delivery has been tested.

— We have hardly found the solution that fits everything. But we have tested Integrated Project Delivery, which is an interaction and alliance contract. The idea is to create one company that is made up of contractors, architects, and consulting engineers, who share the risks and profits, says Steen Sunesen, but he goes on to say that:

– The same principle applies here. Those projects are only as good as the follow-up and as good as the management and how much top management believes in these principles.

"In Finland, the development has been driven by the fact that each company has experimented with technology," says Tomi Henttinen, Head of Innovation at Finnish BIM consultants Gravicon Oy.

Foto: Gravicon Oy

**A culture of community and experimenting**

In Finland, trust has also been a prerequisite for digital development. When you venture into new opportunities, challenges can arise along the way. The companies' trust in and support for each other has made it possible to experiment and learn about new technologies in projects.

— In Finland, the approach is that we act first, and then we think afterwards. This means that, sometimes, problems arise. But everyone understands that even if a problem arises, it does not immediately trigger an invoice from the counterparty. That makes it much easier to try out new technologies. Because everyone is of the understanding that it is a joint learning curve, says Tomi Henttinen.

**Denmark needs to step it up**

Elly Kjems Hove from the Confederation of Danish Industry finds the experiments from Finland very relevant when it comes to which direction the construction industry should be heading with digital work. At the national and European level.

— I am a supporter of the Finnish model. We must be brave enough to step it up. The important thing is for Denmark to start experimenting and dare to try out new project forms. And this is where a project like Trust [long-term strategic partnership across parties in the construction industry in the City of Copenhagen ed.] is very exciting. Trust shows that we can benefit more and become better at sharing knowledge when we enter into new forms of collaboration.

**Digitalization is just a tool**

Regardless of the approach, digitalization is not the goal in itself. It is only a means to achieve a stronger industry that can deliver better and more valuable buildings. A holistic perspective, competences, and an understanding of the process must precede the tools if it is to succeed.

— Digitalization is just a tool. You can either hit the nail or hit your hand. It really depends on who swings the hammer, says Steen Sunesen from Statsbygg in Norway.

A perspective which Markku Hedman in Finland supports:

— The need for digitalization and the value of it really depends on how good we are at solving the problems we have and how good we are at creating a more sustainable development.

**The European market must set the direction**

Elly Kjems Hove agrees on the importance of digital development not becoming an isolated phenomenon. You must take the customer's needs as a starting point and develop the necessary digital tools from there. The focus should be on the solutions.

— What provides value is what the customer demands. If you want value for your money, then you must go for what owners and builders demand and what provides value for them, she says.

Elly Kjems Hove believes that digital development must be driven by market demand.

— The market must choose the solutions. We should not be deciding centrally on which tools to use, she says.

She suggests that the Danish construction industry look beyond the Nordic countries to the experiences and potential markets that exist throughout Europe. Because there is a large market to pick up.

— In the Confederation of Danish Industry, we always look at all of Europe, and not only the Nordic countries. We have a huge market potential called Europe. That is why we are focused on what is happening in Europe. If we go to those markets with a strong set of good digital habits and forms of collaboration, then we will be in a good position. Trust and harmonization must go hand in hand, and it takes some getting used to as well as curiosity to get there, she concludes. ◆

"Digitalization is just a tool. You can either hit the nail or hit your hand. It really depends on who swings the hammer."

**STEEN SUNESEN**
Chief Architect at Statsbygg

DIGITAL TREND

building SMART

# buildingSMART will pave the way for data democracy

**The Danish involvement in buildingSMART gained new momentum at the turn of the year 2020, when Denmark formed an independent chapter, just like e.g. Norway has had for several years, and Sweden and Finland are not far behind.**

**What is buildingSMART?**
buildingSMART is the name of an international non-profit organization that works with open formats and common international standards for the construction industry. The goal is for data, in the form of e.g. 3D models, to be freely shareable during the construction process across the construction value chain, regardless of software and practice. buildingSMART Denmark is established as a subsidiary of Molio.

**What is the goal of buildingSMART?**
An increasing number of public and private builders and developers demand that work be done in open formats, which makes it possible to exchange e.g. 3D models across the industry. However, there is a lack of standards for what data the open formats should include, and this often gets in the way of good intentions. For a number of years, the BuildingSMART organization has offered tools and standards for the data to be included in the building model.

With its financial support for and the ongoing work in buildingSMART Denmark, Molio wants to create an active network and a platform for knowledge sharing for the benefit of the entire construction industry.

The aim is to achieve free competition and promote the democratization of data. It should be easier to share data for everyone involved, regardless of company size or place in the value chain. It also makes it possible to use the software that works best for each company. buildingSMART offers a common language for the construction industry for the exchange of data and 3D models, which can be "understood" by all software programs and thus allows free access to all data.

Photo: Leitorp + Vadskær

buildingSMART Danmark

# buildingSMART at Copenhagen Airport

Increased availability of data is one of the keys to higher fficiency. The ambitious expansion of Copenhagen Airport, Expanding CPH, is a good example. The project had three main focus areas:

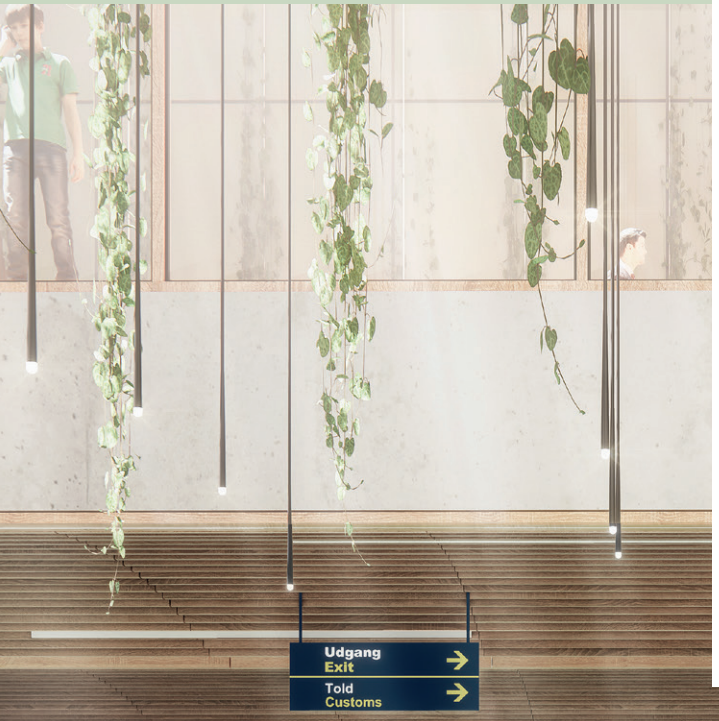
1) avoiding errors in the digital building models through all phases,
2) ensuring that everyone knew which errors they were each responsible for correcting,
3) helping the airport's partners to provide high-quality data to the airport's operators.

Strengthening the open exchange of data between the construction phases was key, as it provided a uniform and correctly structured exchange of data, which ensured quality and consistency.

By using the open IFC format, which serves as the basis for sharing and exchanging data, Copenhagen Airport also secured ownership of data in the longer term and thus also in relation to the long-term operation. With IFC, the airport is not bound by the use of a specific type of expensive software when they need to use their construction data in the future.

Internally, open-file formats are used, but proprietary ("locked") formats are also used if a consultant prefers this. It is Copenhagen Airport's ambition for IFC to be their primary exchange format in the long term.

The use of IFC opens up for new possibilities in connection with the use of new technology in a BIM model. At Copenhagen Airport, gamification has been used to give service personnel an understanding of escape routes and installations before arriving for their first shift in a finished building. In this context, IFC allows you to use a game engine or use the Solibri program to ensure customized integration.




The Circle House Lab project is made up of 70 companies from the Danish construction industry, who work together to make construction more circular. Pictured here is the exhibition building, Circle House, which is located in Valby. In Lisbjerg on the outskirts of Aarhus, the world's first social housing project is currently under construction and is being built according to circular principles. It is expected to be ready in 2023.

Photo: Tom Jersø

# Circle House – an unusual social housing project

Can you improve the operating costs by building sustainably? Yes, the people behind the Circle House project believe so. In many ways, good operations can be equated with sustainable construction. The key to this is digital solutions.

**CIRCLE HOUSE** is the first social housing project in the world that is built according to circular principles. The sustainable lighthouse construction project will result in 60 homes in Lisbjerg on the outskirts of Aarhus and is expected to be completed in 2023. As many as 70 companies have been involved in the development of the 60 homes. In addition to the actual construction of homes, the project acts as a demonstration project for how to build according to the "Design for Disassembly" principles. Components are not molded together but assembled mechanically, making them easy to reuse. The concrete elements must be dismantlable and reusable once the building is to be demolished at some point – without losing value.

— It makes good sense for Lejerbo to join a project like Circle House. In doing so, we help carry the great social responsibility in relation to environmental impact, optimize our own operational work and help build better, high-quality homes, says Project Manager at Lejerbo, Jesper Kort Andersen. .

This is what the interior of Circle House Lab's exhibition building in Valby looks like on the inside. The materials must be reusable afterwards.
Photo: Tom Jersø

### Longevity and digitalization are connected

It is definitely an advantage that knowledge about building materials is easily accessible in each building information model (BIM). Before construction begins, during operation, and when it is to be demolished someday. Nevertheless, there has been no tradition of keeping a log with adequate information. But the people behind Circle House want to change that.

Architectural firm Lendager Group, which is one of the consultants working with Circle House, is very aware of the enormous resource savings that can be achieved by recycling building materials. For several years, Lendager has prepared material analyses of older buildings and calculated the value of demolition fields, and they look forward to the day when all old buildings are digitally registered with the necessary data in the form of materials passports. Today, the work associated with calculating the history of materials is associated with many working hours and analog measurements. But with materials passports, this can become a thing of the past. With Circle House, the materials passport must be updated in the digital model from the beginning, and this will make sustainable construction cheaper and better in the future.

### Digital setting

Anders Lendager, Owner of Lendager Group, which together with 3XN/GXN Architects and Vandkunsten is behind the architectural development of Circle House, says that both in the design phase and in connection with the subsequent operation, a digital setting is crucial when working with sustainable construction.

— In order to calculate recycling percentages and collect information for materials passports, it is important to have a digital setting. For example, we use a digital script to describe how high of a recycling percentage we have. By using a digital tool, we can use what we draw for Circle House today to define the versions we will be using it for afterwards. If I want to recycle 70%, the program, for example Rhino or Revit, can interact with parametric programs like Grasshopper to structure data better and help calculate how we can recycle building forms most efficiently. From having to carry out analog measurements of materials, we can now handle them digitally, he says.

### Sustainable approach strengthens the operating economy

As the responsible for the subsequent operation, there are many interesting potentials associated with sustainable construction. Lejerbo expects the new sustainable lighthouse project to strengthen the operation of the building. Lejerbo Project Manager, Jesper Kort Andersen, equates the circular approach with good operation.

— Good operation and sustainable construction have a converging interest. A good sustainable building lasts as long as possible, and a good operating economy is an operation where the materials are kept alive throughout its life. The longer we can keep things running, the better, says Jesper Kort Andersen.

### Design for Disassembly

One focus area at Circle House is the Design for Disassembly concept. Anders Lendager explains the principles:

— With Circle House, you have to create a project that can be disassembled. How do we make sure that these concrete elements can be disassembled afterwards? This may not sound difficult, but it is. "The components must be assembled mechanically – without being casted, he explains.

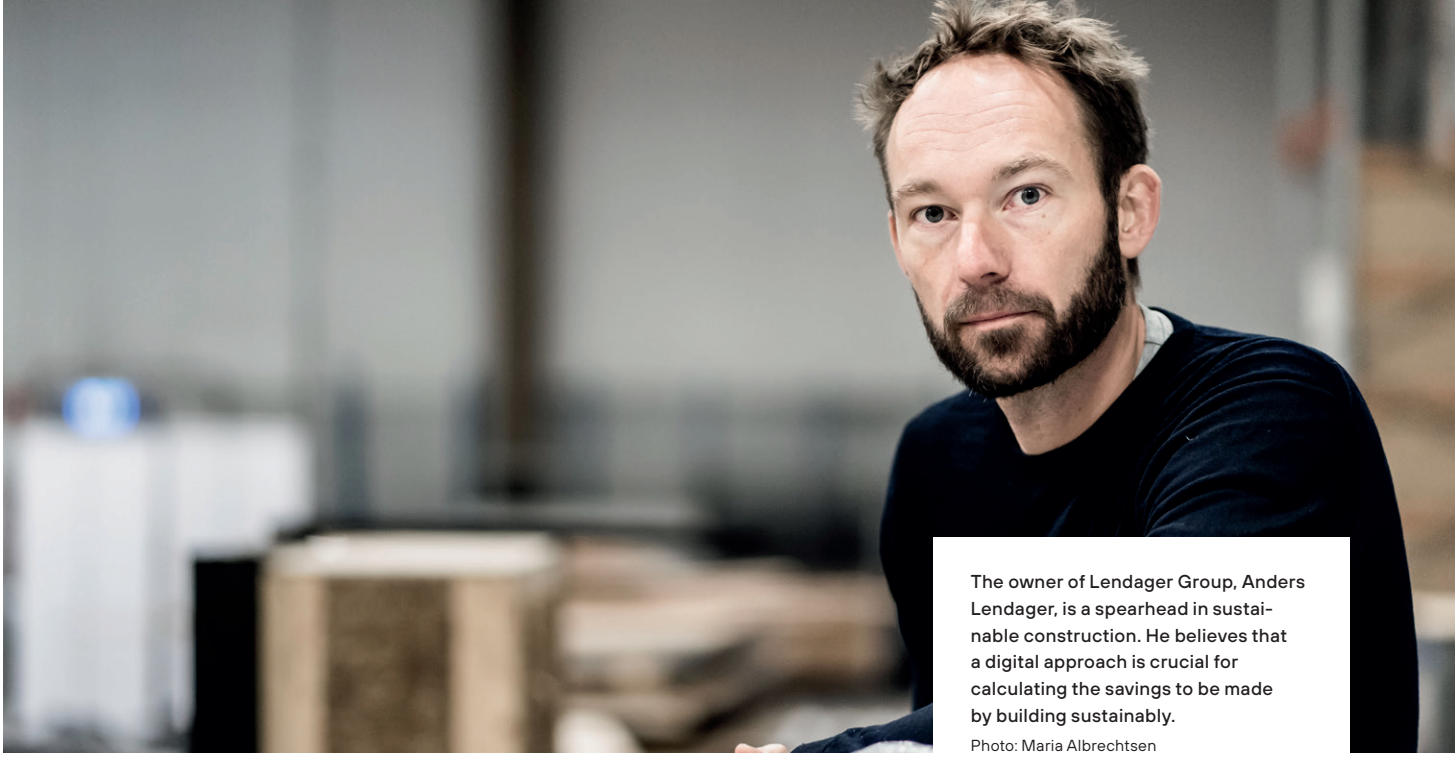
Jesper Kort Andersen from Lejerbo says that they had expected the design method to be a bigger challenge, but that they have been positively surprised at how simple it really is. Lejerbo finds the concept of Design for Disassembly

## Materials passport in 7D

**John Sommer, former Strategy and Business Development Director at MT Højgaard, who had the role of contractor in the development project Circle House.**

He sees great financial potential in sustainable construction. He explains how a combination of a sustainable approach and digitalization helps add economic value to construction. He sees great potential in 7D in BIM. That model has only been developed at the concept level so far in the project, but the idea is for it to be used in connection with the recycling of building parts when buildings are turned into material banks.

– In the book 'Building a Circular Future', we have described how the current 5D and 6D digital models can be expanded with a 7th dimension, which is a digital materials passport for all the materials used in the building. With this model, the owners control all of the materials that they have in the building – and their condition. This makes it easier to sell afterwards, says John Sommer.



The owner of Lendager Group, Anders Lendager, is a spearhead in sustainable construction. He believes that a digital approach is crucial for calculating the savings to be made by building sustainably.
Photo: Maria Albrechtsen

interesting, as it can make operation and demolition easier and more lucrative.

— If we look at Design for Disassembly, the BIM model holds a model for how to disassemble it again in the future so that our staff at that time can easily get in and see what is behind a facade panel. There is a description of what is behind the walls. We also expect that we will be more skilled at repairing so that it can be used directly for operational optimization, says Jesper Kort Andersen.

**From waste to financial resources**

John Sommer finds the pressure on the recycling of materials to be steadily increasing in the construction industry. Therefore, it is also necessary for the industry to better manage the materials that were used and how they were used. In order to support the management of the materials, the digitalization of materials passports is crucial, he believes.

— The construction industry is falling behind when it comes to the $CO_2$ numbers. We brag about being close to 90% in $CO_2$ neutrality, but we crush concrete, for example, and so we crush all of the energy that was spent making the concrete – and 7% of the world's $CO_2$ is used to make concrete. The industry must become better at conserving the energy that has already been spent, explains John Sommer.

Architect Anders Lendager is aware of the many possibilities that exist in the recycling of materials. He has learned that there are large sums of money to be saved by working sustainably.

— All of a sudden, this area no longer represents waste, but rather an economic resource, says Anders Lendager.

He talks about a project in Norway where an old business park was to be converted to 450,000 m2 of residential housing. Lendager prepared a material analysis of the entire area and found that many parts could be reused.

— Windows, doors, and so on. We calculated it all. It amounted to NOK 1.4 billion. And the builder saw it as an asset to the construction project that was about to be built. The parts were taken down and recycled, explains Anders Lendager.

**How are materials passports stored?**

There are many benefits of sustainable construction. However, to reap the huge benefits, it requires that the work associated with the building and materials passports is strengthened.

Jesper Kort Andersen from Lejerbo believes that it requires a digital approach to fully succeed and ensure future successful sustainable construction.

— When we are to operate our buildings and make sure to maintain their longevity, it is important that we have the right tools and there are a lot of things that point in the direction of digital tools. But which digital tools we should be using is hard to say at this time. If all of our materials need materials passports, where do we store all of these materials passports? We need to figure that out. In 30 years, for example, the windows will have to be replaced, and then the materials passports will have to be updated. Some are far ahead in making building passports and putting it all into the BIM model. We don't know exactly how to do it yet, but we will probably find a good solution, concludes Jesper Kort Andersen. ◆

"How do we make sure that these concrete elements can be disassembled afterwards? This may not sound difficult, but it is. The components must be assembled mechanically – without being casted."

**JESPER KORT ANDERSEN**
Project Manager at Lejerbo

DIGITAL TREND

Servitization

# From manufacturer to service provider

Digitalization provides an opportunity to focus on the customer and the customer's needs in completely new ways. The same applies to the construction industry, where suppliers and manufacturers must understand their customers' needs if they want to keep up with the development. The sale of services has become more important, and with the transition to servitization, manufacturers take on a new and more active role.

**What is servitization?**
Servitization is basically about offering services through a joint system connected to the physical product, thereby creating a smooth process and experience for all parties. For the manufacturer, it is also about being present as early in the customers' process as possible with a focus on following and meeting their needs from start to finish.

With ROCKWOOL's new venture, Rockzero, new services have come a long way. By using the customers' digital model, ROCKWOOL as a supplier can ensure that they follow the customer's guidelines and design.
Photo: Rockwool

Digitalization is essential for ROCKWOOL. Because the materials must be delivered in the right order, so that the trades-people's installation time is not wasted looking for the next piece.

Photo: Rockwool

## Rockwool and servitization

At ROCKWOOL, they work purposefully to develop services related to their insulation products. When an architect designs a building, he or she must allow room for insulation in the model. One of the first places to provide a service is to ensure that ROCKWOOL's products are available as digital objects that can be used directly in the 3D models. When the product exists digitally, architects avoid having to search up product specifications on their own and design the elements themselves.

One of the goals of the digital models is to collect and recycle information across the entire construction project, to streamline the process. This has not always been the case when it comes to purchasing materials. That is why ROCKWOOL has started to offer a new service to help architects and contractors join the process so that all work, starting from design to assembly, becomes more efficient.

Once the building is designed in a digital model, ROCKWOOL offers to receive the digital model, manufacture based on special measurements according to the model, and send the material directly to the site.

– We have had many discussions as to whether we should release software so that people can use it themselves. But we came to the conclusion that customers need to focus on what they are best at. So, instead, we developed this service where we receive the customer's digital model and adapt it to our wall types and products, says Hans Henrik Ter-Borch, Head of Product Management at ROCKWOOL.

By using the customers' digital model, ROCKWOOL as a supplier can ensure that they follow the customer's guidelines and designs, while also making the work easier for all parties.

However, the customized production also has a downside. When every little piece is a customized piece of the big puzzle, it places demands on the logistics.

— It is super important for logistics that things are available and that the tradespeople can find them. That is one of the challenges that we are currently facing. How do we ensure that knowledge from the drawing and the production drawings reaches as far as the construction site, becomes available to those who need to assemble them, and at the same time ensure that everything is placed in the right order so that the customer can actually find it? asks Hans Henrik Ter-Borch.

**"We have the technology. We just need to be put it together so that our overall offer creates value for the customer."**

**HANS HENRIK TER-BORCH**
Senior Project Manager,
Group Development, ROCKWOOL Group

A next step in ROCKWOOL's servitization is therefore to ensure that the pieces of the puzzle are delivered in the correct order so that the tradespeople's installation time is not wasted looking for the next piece. ROCKWOOL wants to use digitalization to offer new services associated with their product as well. The company is therefore working to connect GPS data from the trucks that deliver the materials with drawings of the construction sites and the production itself, thereby further enhancing the user experience.

— We know exactly where the vehicles are and where the building site is. We have the technology. We just need to be put it together so that our overall offer creates value for the customer – and becomes a positive experience that they feel like repeating, says Hans Henrik Ter-Borch.

An increasing number of builders and developers, contractors, and consultants have been investing in sustainable construction in recent years. However, many lack standards for how to document the sustainable materials. Anne Skovbro, CEO of By & Havn, Ib Enevoldsen, CEO of Rambøll, and Christina Collin, Rambøll's Sustainability Specialist, discuss how digital tools can meet the challenge.

# Sustainable construction can boost digital work

Director of By & Havn, Anne Skovbro, wants to increase sustainability within construction and within urban space. This places demands on digitalization.
Photo: Ricky John Molloy

**THE AMBITION** to build sustainably is growing in the construction industry. Decisions in the past were made solely based on esthetic and economic considerations, but now a frequent – and sometimes crucial – question is whether a building is sustainable. Today, the construction industry is responsible for one-third of national waste production, and more and more players are, therefore, working to push the industry in a more circular direction.
The trend is clear at Rambøll, which in just 3 years has expanded its sustainability department from 3 to approx. 40 employees, and at By & Havn, whose goal is for all of their construction and urban spaces to be sustainability certified.

**No sustainability without documentation**
In order for these great ambitions to succeed – and for even more sustainable construction to emerge – it will be important to have clear standards on how to document sustainable construction. This is the opinion of Anne Skovbro, CEO of By & Havn. She believes that it is important for sustainable construction projects that the building models are digital from the beginning and enriched with the necessary information about all the materials, including the production and capacity of these. If this information is missing, it is difficult to calculate the extent of sustainability of the finished construction.

> "If you need to start carrying out $CO_2$ calculations, the tools for doing so are lacking. I have personally seen various examples of how to do this, but they are not standardized."
>
> **ANNE SKOVBRO**
> CEO of By & Havn

— Throughout this movement toward sustainability within the construction industry, you will move closer to the choices you make. We are moving toward more documentation, which requires

digital support. You must be able to calculate based on your actual needs and the exact amount of $CO_2$ emissions, etc. they will produce, says Anne Skovbro.

**Concrete and organic vegetables**

In this connection, Anne Skovbro is demanding clear, common standards on how to document all materials. To put it into perspective, she compares the challenge to the one faced by organic food in the beginning.

— It's just like back when organic vegetables were introduced to the market. Back then, we also needed standards on what it took for vegetables to be called organic, she explains.

However, Anne Skovbro is aware that certifying concrete is a different matter than certifying bananas.

**Documentation standards mean digital acceleration**

By & Havn and Rambøll both use the DGNB sustainability certification. Both parties believe that there is a need for proper standards for the documentation of materials that consider the certification scheme.

— DGNB certification helps us enter the processes earlier on to have our calculations, documentation, and analyses carried out for us. This pertains to issues such as material selection. If you need to start carrying out $CO_2$ calculations, the tools for doing so are lacking. I have personally seen various examples of how to do this, but they are not standardized, says Anne Skovbro.

She welcomes the DGNB certification because it works with certification at the neighborhood level, on the construction project as a whole, and on the use of the building and the urban space afterwards. At the same time, however, she is demanding a standard for how to document each material if $CO_2$ calculations are to be made.

— There is a big difference regarding which concrete to use. Some can be extremely $CO_2$-emitting while others are close to being sustainable. Therefore, it is important to have common standards on how to document these materials. When you have a standard, it is easier to calculate which way is the best to go before starting the actual construction project, Anne Skovbro points out.

"Sustainability is deeply incorporated in our business processes and our strategy and goals, and in recent years, we have experienced tremendous growth in the area."

**IB ENEVOLDSEN**
CEO at Rambøll

**Rambøll is gearing up**

Rambøll's CEO, Ib Enevoldsen, says that sustainability is crucial to Rambøll's global business strategy. It is an important part of the company's value set, while at the same time being a good business.

— Sustainability is deeply incorporated in our business processes and our strategy and goals, and in recent years, we have experienced tremendous growth in the area. We have a minimum double-digit growth rate in sustainable construction and are growing enormously as regards our number of employees who work with sustainability. For us, it is important that sustainability is mainstream and not linked to pilot projects alone.

The small experts make the big difference. They are not part of an isolated unit but rather connected to a wide range of our work. The sustainability principles go beyond much of what we do, he says.

**Digitalization is a prerequisite**

Ib Enevoldsen points out the importance of keeping track of environmental product declarations, accounting, and building requirements to meet goals within the company's sustainability strategies. He believes that digitalization is a necessary tool for this.

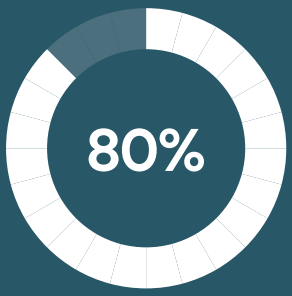
— Digitalization is a big part of our focus. That is a prerequisite for us to be able to do it. And if you need to keep track of your digitalization, you need to keep track of your computing systems and environmental product declarations. And then you can measure it against some requirements. The digital systems are a prerequisite for us to be able to do all this, he explains.

**Focus on the design phase**

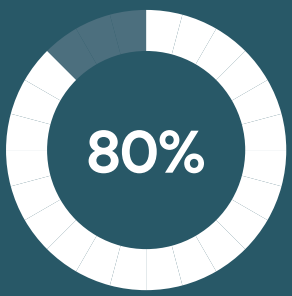
During the development phase, Rambøll has seen a need to connect more digital solutions to the documentation work. To do so, they have collaborated with SBi Byg and their development of the LCA tool LCA Byg. Sustainability Specialist at Rambøll, Christine Collin, says:

— We have done a lot of testing by extracting information and elements from the building models for DGNB certification, and it turns out that there are many errors. If we are to conduct sustainability analyses, it is crucial that the models are

## The construction industry's digital barometer shows that:




80% are experiencing an increasing demand for sustainable products and solutions




- 80% of companies see digitalization as a basic prerequisite for being able to document and support a sustainable construction with data

Source: The Digital Barometer of the Construction Industry 2020

based on a correct database and that we can trust them. That is why we are in the process of developing new methods for standardization of the information in the models, says Christine Collin.

Since fall 2018, Rambøll has run pilot projects, where the focus has been on the early design phase. In doing so, they have learned that there are great challenges associated with extracting information about the materials.

> "If we are to conduct sustainability analyses, it is crucial that the models are based on a correct database and that we can trust them."
>
> **CHRISTINE COLLIN**
> Sustainabilty Specialist, Rambøll

— It is important to have the specific information early on because it is crucial that we can perform the analysis early on. The earlier we can carry out $CO_2$ calculations, and the more variants we can test, the greater our opportunity to save $CO_2$, says the sustainability expert.

**Imported environmental product declarations save time**

According to Christine Collin, it is a challenge that Rambøll needs specific data, but that the environmental data in LCA Byg is primarily based on generic data. They have, therefore, created their own method and central database for importing environmental product declarations from well-known computer providers to LCA Byg. This way, they can continuously update their environmental product database and save time by not having to enter the information manually every time.

— With this method, we can continuously add environmental product declarations to our database. This can be from EPD-Norway, for example. It has saved us a lot of time, says Christine Collin optimistically.

**Global focus**

Another important area where digitalization is key to getting through with your sustainable strategy is within the development of building information models. At Rambøll, they are experiencing a need for better quality assurance of the building models because errors often occur during the design phase. Errors that can inadvertently increase $CO_2$ emissions – but are prevented if the models are adequately quality assured.

Ib Enevoldsen compares Denmark with the traditions for materials passports in Sweden and Finland, where he believes they are further ahead.

— In terms of system structure, Sweden and Finland have been at the forefront. Especially when it comes to environmental product declarations. We need to get on top of that as well. On the elements, systems, and requirements. Then we'll be up and running! he says.

Both By & Havn and Rambøll have ambitious plans. Plans that they share with many others. Rambøll's work with DGNB and LCA is part of their global strategy. Because it is key for all construction companies with a sustainable agenda to arrive at an optimal solution on how to calculate sustainability and most easily arrive at the best solutions. That is what Christine Collin at Rambøll experiences:

– It's a paradox, you know. When we need to do the calculations, we don't have time, but when we have time, it's too late. Therefore, our focus is: How can we use previous building models and, based on building areas, say something about the $CO_2$ emissions from the building? It's a global focus, she says. ▸

Rambøll's domicilein the Ørestaden neighbourhood follows the company's principles on sustainability.
Photo: Rambøll

**The Danish Technological Institute has created an overview**

There are no countries yet that have legislation stipulating exactly what information building and materials passports must contain. However, both in the Nordic countries and the EU, there are various initiatives underway that point in the direction of a consensus on what information should be shared. In Sweden, they have a voluntarily operated building product declaration, BVD, which declares the content of chemical components in the materials. In the EU, the BAMB development project has created a database for building and materials passports, which has the ambition to be the central platform in Europe for promoting circularity within construction.

In 2019, the Danish Technological Institute prepared an analysis of building and materials passports for the Danish Transport, Construction, and Housing Authority. In their analysis, they describe the different practices that exist in Denmark and countries such as Sweden and the Netherlands.

"To be able to use the materials passports for sustainable construction projects in the future, it must be defined as to what information is posted."

**KATRINE HAUGE SMITH**
Senior Consultant at the
Danish Technological Institute

**What is the purpose?**

Katrine Hauge Smith, Senior Consultant at the Danish Technological Institute, who is behind the study, believes that the standards for information in building and materials passports must be defined based on a clear, common purpose.

— There is a need for focus. You must know exactly what the passports are for. In our study, we focused on increased reuse and recycling as the purpose of the building and materials passports.

Through the analysis of the different approaches to building and materials passports in Denmark, Sweden, and the Netherlands, the department has observed approaches that are more or less complex.

— We can see that a consensus is relevant, Katrine Hauge Smith points out.

She recommends finding a common definition of the purpose of the building and materials passport, as the information about each material will otherwise point in too many different directions and thereby lose its value.

— There are huge differences in the kind of information that is needed, depending on whether you want a passport that promotes sustainability in general or more specifically reuse and recycling. Different schemes have been developed depending on what information is to be included – and the choices are often made based on different needs. To be able to use the materials passports for sustainable construction projects in the future, it must be defined as to what information is posted. There is a need for focus – and the focus depends on the purpose of the materials passports.

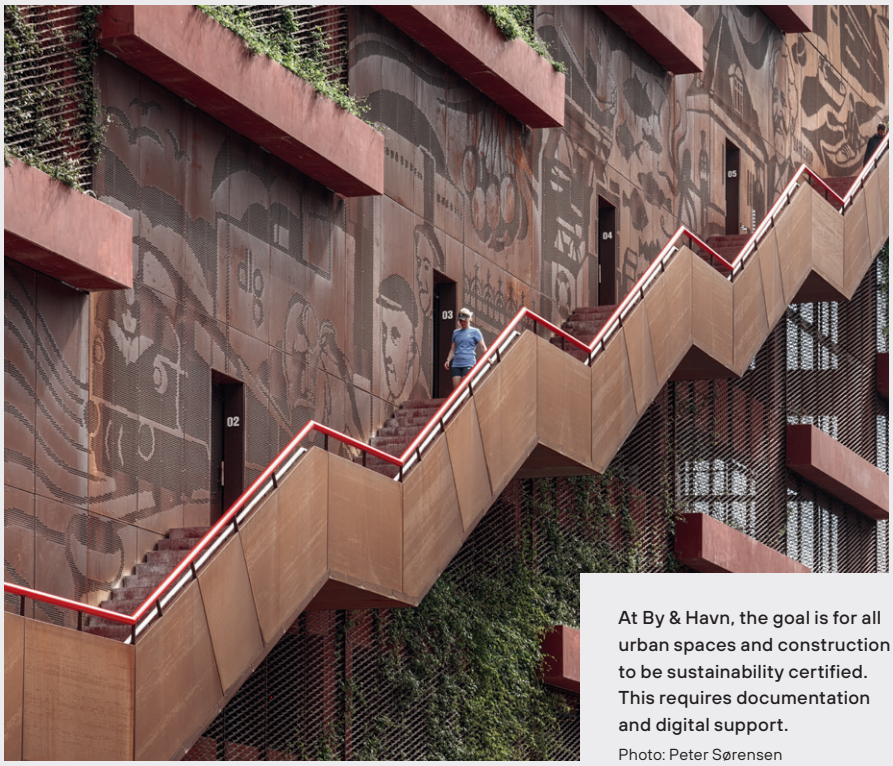
**Is a common standard on the way?**

There is an obvious need for information standards – and for building and materials passports to be digital in order for them to have actual value. But when can we expect to have a fixed standard for what data that a passport should contain? Katrine Hauge Smith does not know about the further plan for the area, but she knows that there is great interest in the subject both within the authorities and within the construction industry. She says that the study by the Danish Technological Institute is based on two key strategies from the Danish government: The Strategy for a Circular Economy and the Strategy for Digital Construction.

— The next step for the industry is now to determine what a materials and building passport should contain. What you want to do with it, she explains.

The focus is important. Furthermore, it is crucial for the system to become digitalized in order for it to succeed.

— If you want to make this advanced and enrich the passports with a lot of data, digitalization is crucial. You need to have one location where you store data instead of entering data in many locations. Rather than having a 2D checklist, it is obvious to use 3D models where you experience multidimensional materials – and ensure the preservation in the future, says Katrine Hauge Smith. ◆




**At By & Havn, the goal is for all urban spaces and construction to be sustainability certified. This requires documentation and digital support.**
Photo: Peter Sørensen

"There are huge differences in the kind of information that is needed, depending on whether you want a passport that promotes sustainability in general or more specifically reuse and recycling."

**About Molio Magazine**
In collaboration with the consulting company Seismonaut, Molio has prepared a comprehensive study of digitalization in the construction industry. The Digital Barometer of the Construction Industry. The barometer provides a snapshot of what the industry itself perceives as the biggest challenges, drivers and barriers in relation to the digital transformation. The Digital Barometer of the Construction Industry is incorporated into this Molio Magazine and put into perspective with a number of digital trends and interview articles with key players and decision makers from the industry.

**About Molio**
Molio supplies digital tools, standards, courses, training programs and textbooks to the entire value chain of the construction industry. buildingSMART Denmark, Project ConTech and HUSET Middelfart are part of Molio.

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