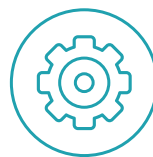


A buildingSMART Digital Twins Working Group Paper

Enabling an Ecosystem of Digital Twins – An Update



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Part 1:

Introduction and context

Societal challenges and the potential of technology

The built environment is undergoing transformative changes that will impact the industry for many years. Historically plagued by fragmentation, the construction sector has grappled with low productivity, performance issues, and interoperability challenges. Long-running concerns about the lack of technological adoption are well-documented; however, the industry's attention is now urgently turning to climate change and the applicability of technologies to help solve these various challenges. In the last few years alone, the extraction of raw materials has broken through what is considered environmentally safe. The "take-make-waste" economy is stressing natural resources to the point of no return.

Emerging technologies like Artificial Intelligence (AI), the Internet of Things (IoT), robotics and cloud computing offer promise. But they are undefined and potentially misunderstood for now. They can, however, unlock the need for the built environment to improve efficiency, reduce waste, and address the urgent call for carbon emissions reduction. These technologies could drastically improve how the built environment works, viewing data as a valuable asset and allowing stakeholders to make better-informed decisions faster and more accurately.

The topic of "Digital twins" has been explored by buildingSMART International (bSI) by the formation of a working group and following a series of workshops and white papers, digital twins look set to have a big impact on the built environment.

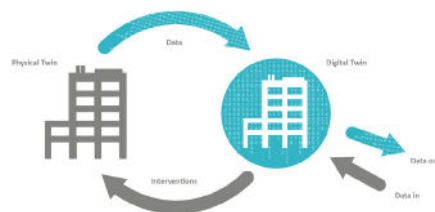
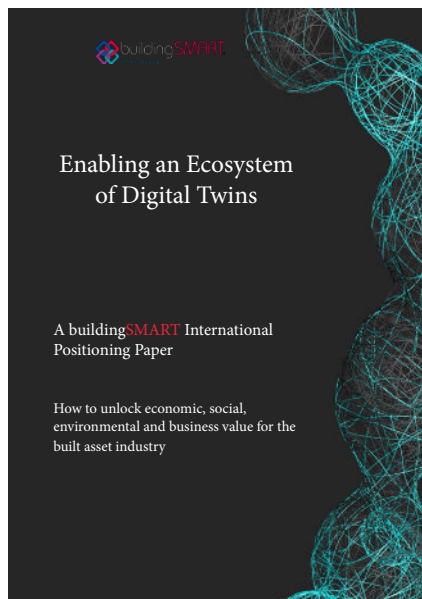
In 2020, bSI published a positioning paper titled "Enabling an Ecosystem of Digital Twins," [1] offering insights into the role of digital twins and their potential benefits for the built environment. The paper viewed digital twins as systems rather than isolated sets of technologies that would provide more comprehensive insights and support better decision-making across the value chain and asset lifecycle.

One of the central premises of the paper was introducing the idea that there needs to be an ecosystem of digital twins where multiple twins will coexist and align through open data to be truly valuable.

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Digital twins positioning paper

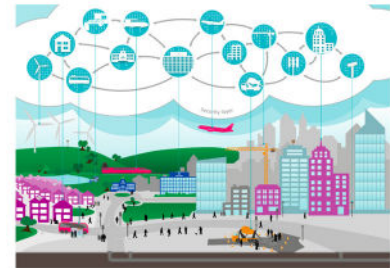
May 2020



Full lifecycle



Creating an ecosystem of digital twins



Finally, it positioned bSI as an important industry body to contribute to the further development of digital twins, given the key role it plays in collaboration, the development of standards and services and the support for global interoperability.

The road towards this ecosystem of digital twins will be marked by a significant shift in the built environment. In construction projects, digital twins can simulate the construction process, enabling teams to identify potential risks early and optimize their processes before construction begins. In asset operations, digital twins can provide real-time insights into the performance of physical assets, enabling teams to make informed decisions about maintenance, upgrades, and replacements. They can also directly tackle climate change. A good example could be how digital twins can help to deliver a circular economy.

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Example: how digital twins contribute circular success

The 'circular economy' is a term that is widely used but not always considered accurately [2]. However, it aims to address the urgent need for industries to focus efforts on addressing climate change. Construction significantly contributes to resource depletion, waste generation, and carbon emissions, making it imperative to transition towards a more circular approach. The global economy is now only 7.2% circular, and it's getting worse year on year—driven by rising material extraction and use [3]. The built environment is the biggest single user of raw materials, and the current projection is not good. By adopting circular principles, such as designing for disassembly, reusing materials, and implementing efficient recycling systems, the industry can minimize resource consumption, reduce waste generation, and reduce environmental impact. Embracing the circular economy supports the conservation of natural resources and presents economic opportunities through cost savings, job creation, and the development of innovative business models.

As outlined in the paper titled "Our Shared Understanding: a circular economy in the built environment"[4], digital twins can help to drive sustainability by enabling better asset and facility management, spanning lifecycles, connecting systems, and facilitating informed decision-making for long-term asset performance. Digital twins, from a circularity perspective, for example, give an insight into existing conditions and products of an asset while helping to define potential value and opportunity to reuse in the short and near future.

The potential use-cases of digital twins applied to many industries is vast, however there are pioneers, working groups and consortiums that are looking at how to better structure the different workstreams spanning many industries.

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Digital twins today and purpose of this report

In 2019, bSI formed what was known as the Digital Twins Working Group (DTWG), created by members and leading experts in the industry. Since the publication of the positioning paper in 2020, the DTWG has continued to meet and develop plans for addressing the topic.

In March 2023, bSI published its Strategic Roadmap, which included the position and placement of digital twins. It is clear that digital twins will play a crucial role in the not-too-distant future in helping shape our industry, and they will rely on industry standards to ensure data flow is possible.

This paper is also designed to document some of the progress and plans for the DTWG and the role we want the industry to help play moving forwards.

It is focused on two main topics:

- The three horizon model as introduced at the bSI International Standards Summit in Rome in 2023 (part 2)
- The focus on seven perspectives that play an essential role in Horizon two (part 3)

This paper aims to outline these two concepts and keep the community updated on progress.

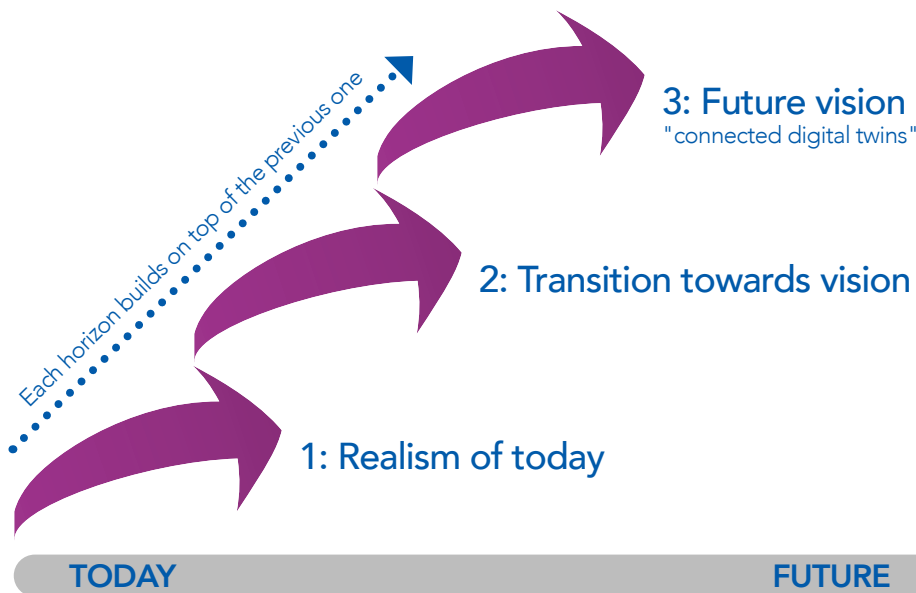
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Part 2:

Horizon thinking

To structure the journey towards an ecosystem of digital twins, the DTWG introduced a framework to consider three horizons. This framework helps the industry better structure the development and prioritize related activities. Each horizon represents a different time frame and level of innovation required to achieve the result.

Three horizons model



The Three Horizon model demonstrates an opportunity for the whole industry to focus efforts on different phases as it goes through a period of improvement. It makes clear where we are today (horizon one: realism of today), where we aim for (horizon three: future vision) and how to get from horizon one to horizon three via horizon two.

Many of the benefits of horizon three are far off, but some might argue that organizations can start small. In line with our three horizons model, McKinsey has argued that once an organization creates a digital twin, they can move on to interconnecting multiple digital twins to unlock even more use cases and, finally, layer on the additional technologies required to transform this network of digital twins into the enterprise metaverse [5].

Horizon One: Current Reality

Digital twins today are emerging but not yet widespread. The DTWG has identified five challenges in how digital twins are applied today.

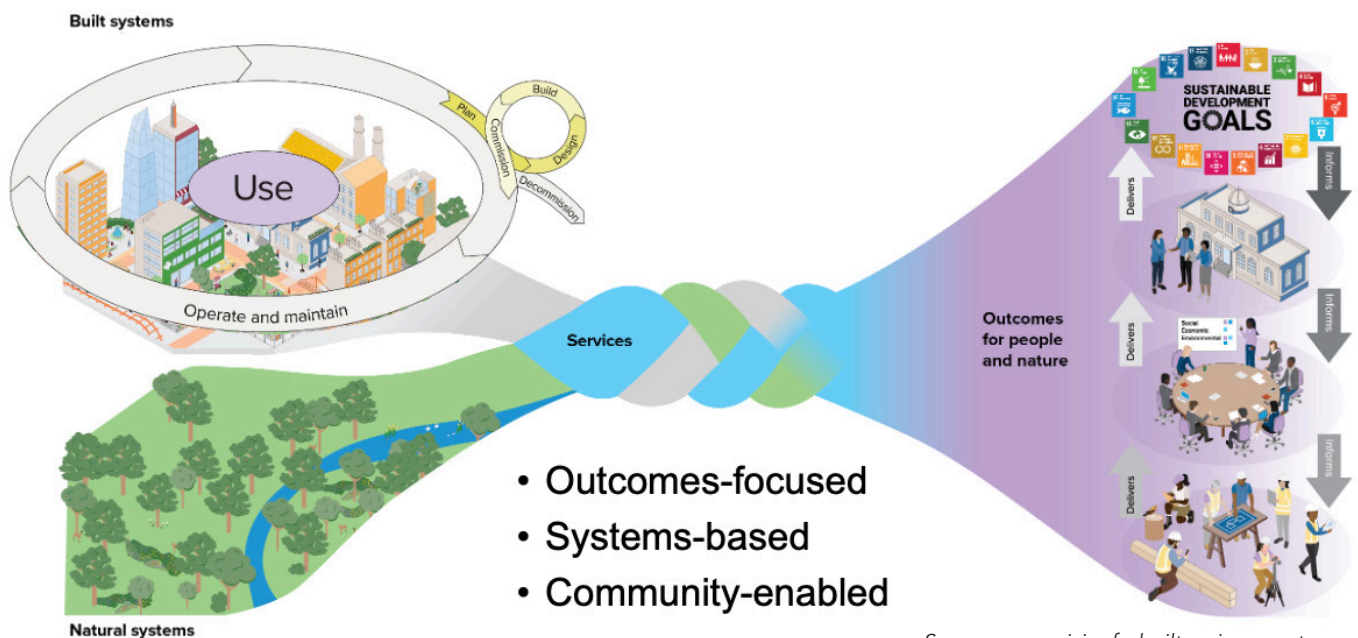
Currently, the construction and asset operations industries operate traditionally and fragmentedly. Teams still rely heavily on physical inspections, paper-based documentation, and manual processes. This leads to inefficiencies, miscommunication, and potential risks to the construction project and asset operations. In addition, the lack of real-time data and insights makes it challenging for teams to make informed decisions, leading to increased costs and time delays.

The industry has yet to adopt open standards in a systematic way to tackle some of these significant challenges. There are various reasons; however, the industry needs to be faster to recognize the benefits of open standards, such as increased efficiency, reduced costs, and improved data quality. It can be challenging to make a business case for adopting open standards, especially in the short term; however, this has to change. With new services and technologies available to end users, the opportunity to show a return on investment or even the business case for open data has never been more apparent.

Horizon Three: Future Vision

The industry's future vision and digital twin role are symbiotic. Many believe an ecosystem of interoperable digital twins is vital to achieving a more sustainable planet and productive sector. It is already clear from many use cases and requirements that technologies capture progress and report and affect change. In our quest to make the planet more sustainable, these capabilities will be required to reduce the carbon footprint.

Asset owners and city planners are looking at digital twins to improve their asset whole life value. In operations and maintenance, digital twins can unlock value in many phases and ways to inform and guide decision-making. If decisions are improved, and the results are high-performing assets, the return on any investment is considerable.



Source: www.visionforbuiltenvironment.com

Getting to Horizon Two: Evolution of an Ecosystem of Digital Twins

During the discussion at the buildingSMART International Standards Summit in Rome in March 2023, it was clear that horizon one and three are apparent. Still, there needs to be a clear definition and clarity when describing horizon two.

Therefore the DTWG continued to work to provide more definition on the development of horizon two.

Part 3:

Horizon two: The building blocks

Horizon two is the most challenging to define; however, the DTWG foresees a two-level approach will be required to define horizon two further.

The first level is using a practical approach by focussing on tangible use cases. To advance this phase, bSI has launched the "Accelerator Program" to help with adoption and use. Projects with bSI have hands-on experience with how openBIM and connected services can deliver for real projects. They can lay the foundations for digital twins to flourish and, most importantly, provides the framework for connected systems and workflows. Projects under the Accelerator Program can also better define the economic benefit of using standards and services, thus paving the way for digital twins. Some questions, however, remain.


Alongside this more practical approach, a second level with a more holistic view is required. Therefore, the DTWG offers seven perspectives to horizon two, as outlined below.

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The 7 Perspectives:

1. Societal perspective

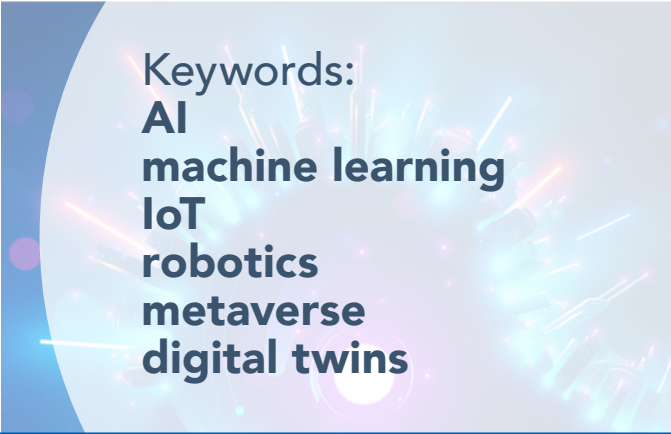
The demands for public services have dramatically increased, fuelled by growing awareness of the finite levels of resources on our planet and the need to meet higher expectations. The construction industry must respond to these societal challenges by adopting sustainable practices, minimizing environmental impact, and meeting the rising demand for public infrastructure while ensuring responsible resource management. In parallel, the industry needs to raise productivity levels and reduce failure costs through better collaboration. The DTWG views digital twins as a powerful enabler for providing insight and foresight to help make the right short, mid and longer-term decisions.



Keywords:
climate change
circularity
labour shortage
change resilience

2. Technological perspective


One of the primary opportunities and challenges of our time stems from the rapid emergence and ongoing evolution of cutting-edge technologies. Disruptive solutions such as Artificial Intelligence, and the continuous ascent of immersive technologies like augmented, virtual, and mixed reality, are constantly surfacing, offering fresh avenues for the development of digital twins. Nevertheless, alongside these prospects come the formidable challenges of integration and interoperability. The need to adapt to the changing horizon of technological advancements is crucial for the industry.



Keywords:
AI
machine learning
IoT
robotics
metaverse
digital twins

3. Economic perspective

Defining business value and accurately assessing return on investment has become a pressing issue. Business models need to evolve to reflect the changing landscape, placing greater emphasis on long-term sustainability, resilience, and the creation of shared value. Evaluating economic outcomes must extend beyond short-term gains to consider broader social and environmental impacts.




Keywords:
business value
business models
use cases
commercial benefits

The 7 Perspectives:

4. Capability perspective

There is a significant gap between the demands placed on businesses and the availability of the right mindset, skills and leadership. The construction industry must address this disconnect by fostering a mindset that embraces innovation, collaboration, and adaptability. Developing the necessary capabilities, both in terms of technical skills and cultural behaviours, is essential to navigate the industry's digital twin journey successfully.



Keywords:
people
skills
mindset
education

5. Data perspective

To develop an ecosystem of digital twins, seamless data exchange will be essential. Open data standards are undeniably crucial for facilitating this seamless interoperability within the industry. However, modernizing and advancing the information management frameworks and standards is necessary to keep pace with evolving technologies and address ongoing interoperability challenges. Embracing standardized formats and protocols will enhance data accessibility, transparency, and efficiency.

Next to this, data ethics has become a critical component in managing industry data. Establishing the correct protocols and safeguards is essential to ensure data security and privacy while maintaining transparency and trust. Adhering to robust data governance practices will enable the construction industry to leverage the potential of digital transformation while protecting sensitive information. Finally, strategies for data ownership will impact how to organize the exchange of data in the best way.



Keywords:
ecosystem
APIs
data exchange
interoperability
standards
security
privacy
ownership

6. Organizational perspective

Numerous initiatives are actively addressing the imperative of enabling organizations to adapt to constant change and leverage emerging business opportunities. Standards are widely recognized as a valuable means of facilitating businesses in structuring their data to make it market-ready. Ongoing efforts are dedicated to enhancing data workflows within the supply chain, with the potential to significantly enhance logistics, data transparency, and overall operational efficiency.



Keywords:
industry change
contracts
workflows
processes

The 7 Perspectives:

7. Governance perspective

Legal and commercial regulations play a pivotal role in shaping data requirements within the industry. Recognizing the need for efficient workflows and combating inefficiencies, standards are now being integrated into legal documents to guide construction-related processes. Embracing these regulations fosters consistency, transparency, and accountability throughout the industry.

Keywords:
regulation
ethics
authority
legal

The seven perspectives are related and influence one another. While the societal and technological perspectives are more the outcomes, capability and data perspectives are the foundational building blocks that enable the economic values that create these outcomes. The organizational and governance perspectives could be seen as allowing this overall transition.

In line with the initial positioning paper, the DTWG believes bSI has a crucial role. However, for each perspective, the role may be different: potentially more leading on the capability and data perspective, while collaborating with the marketplace on the economic perspective and providing input to a wider group of stakeholders that primarily lead the organizational and governance perspective.

Part 4: Conclusion and next steps

The built environment stands at a pivotal moment, poised for transformation. A journey towards an ecosystem of digital twins as a central element of this journey can revolutionize the industry, leading to enhanced productivity, improved sustainability, and greater resilience. By leveraging the power of data, connectivity, and simulation, the construction industry can forge a path towards a circular economy while addressing the urgent challenges posed by climate change and resource depletion.

The DTWG would like to further discuss and validate the seven perspectives with the buildingSMART community at the next Summit in Norway in September 2023. There will be a workshop to define and discuss these topics.

In parallel, the group aims to support the Accelerator Program from bSI as a means for testing and implementing some of the perspectives in real projects. The longer-term goal is to provide regular updates to coincide with the bSI Summit schedules occurring every six months.

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