BDTIC 4CH BUILDING DIGITAL TWIN International Congress

Insights about Technical Report by CEN/TC 442/WG 9 "Digital twins in built environment"

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Session 1:
Sister EU Projects for Digital Twins in the Built Environment

"Insights about Digital Twin Technical Report drafted by CEN/TC 442/WG 9 "Digital twins in built environment"

17 APRIL 2024

COAC BARCELONA

STREAMING

Roberto Redaelli
Project Manager R & I Department
Harpaceas

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HARPACEAS
Your digital partner

Harpaceas is a specialized system integrator, recognized as an advisor by major market players, to support **the digital transformation of the construction industry and the adoption of BIM (Building Information Modeling) as a method for supply chain innovation**. Pioneers of ICT in Italy's Construction, Infrastructure and Energy sector since 1990.

Product innovation

For years Harpaceas has been involved in IoT, Artificial Intelligence, Blockchain, Metaverse, Authoring Software, Collaboration, Structural and Geotechnical Computing, Structural BIM, Architectural, Plant and Infrastructure, LCA/LCC Management, Mixed Reality, Model&Code Checking, Planning&Data Management, Collaboration, Road&Rail Planning, Information and Standards Management for the entire supply chain.

Methodological innovation

Harpaceas was the first in Italy to believe in **BIM**, contributing to the evolution of regulations at the national and European level. This methodological expertise now spans all sectors of the Construction, Infrastructure and Energy markets.

https://www.harpaceas.it/

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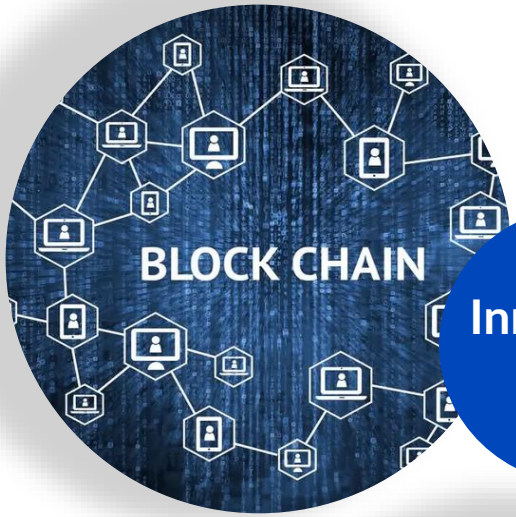
R&I Department



Innovation Chain

Digital Transformation Engineering

Innovation Cluster

Innovative Synergies and Partners

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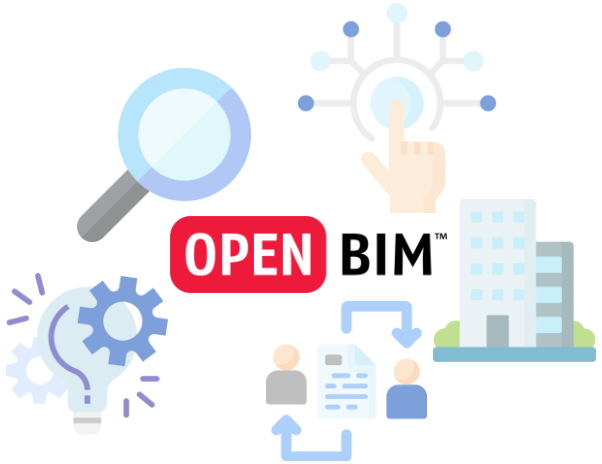
Research & Innovation Department

R&I Department chases digital innovation by acquiring **highly specialized skills**, anticipating technology transfer to clients, and ensuring their most innovative services and proposals.



Digital Twin of Milan Central Station

Digital Transformation Engineering

Development of Digital Twins for AEC domain for several purpose such as creating digital interface useful for maintenance, intervention, calculation activities

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Green Building Council Italia

Harpaceas' choice to join GBC Italy, leading association for sustainable construction in Italy, is a concrete expression of interest and willingness in identifying the most effective synergies between the domains of sustainability and digitization.

"**Sustainable digitalization**" to prevent the excessive and rapid reliance on increasingly automated and digital processes and methods from causing design and construction to lose touch with a primary factor:

"the built environment needs to be set up and safeguarded from a sustainable as well as economically effective and productive perspective."

Working Group SRI & Digitalization

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CEN/TC 442 - BUILDING INFORMATION MODELLING (BIM)

Working group	Title
CEN/TC 442/WG 1	Terminology
CEN/TC 442/WG 2	Exchange information
CEN/TC 442/WG 3	Information Delivery Specification
CEN/TC 442/WG 4	Support Dictionaries
CEN/TC 442/WG 5	Chair's Advisory Group
CEN/TC 442/WG 6	Infrastructure
CEN/TC 442/WG 7	Horizontal role
CEN/TC 442/WG 8	Competence
CEN/TC 442/WG 9	**Digital twins in built environment**
CEN/TC 442/WG 10	Strategy and planning

***Standardization in the field of structured information for the digital twins applied to the built environment**, considering methodologies and formats to define, describe, exchange, monitor, record and securely handle digital twin's data and its related processes in relation with AECOO (Architecture, Engineering, Construction, Operation & Ownership).*
Digital twins applied to other industries, such as aerospace, cars or machines, are out of the scope of this proposal.

2023: Technical Report under approval

FprCEN/TR 18077

→ Closure of Vote on TR: June 2024

Building information modelling - Digital twins applied to the built environment - Use cases

*This document collates **use cases of digital twins applied to the built environment**, including infrastructures, in Europe. These use cases were obtained from **CEN experts and related EU research projects**. This document identifies **common characteristics**, with the possibility of supporting the **establishment of further standardization work**.*

https://standards.cencenelec.eu/FprCEN/TR 18077

Insights about Technical Report by CEN/TC 442/WG 9 "Digital twins in built environment"

2023: First New Work Item

TR collecting Case Studies of DTs in Built Environment

Building information modelling — Digital twins applied to the built environment — Use cases

#	Name	General info	Main use	Asset type	Phase
1	D2EPC THESS	Building Residential	Energy Performance	Building Residential	Operation
2	D2EPC NICOSIA	Building School	Energy Performance	Building Tertiary	Operation
3	PLANON DT	Smart Climatized Asset/Space Management	Energy Performance, Control, Events, Space Management	Building Tertiary	Operation
4	SAMBA	Building Office, Coworking	Operation	Building Tertiary	Operation
5	H2 ELECTRO	DT For Technical Marketing	Marketing	Others (Machinery)	Production (Offsite Construction)
6	BRIDGE WEBGL	Bridge INFRA	Maintenance, marketing	Civil Infrastructure (Linear)	Operation
8	CRANE	Building Crane	Planning Construction Operations	Others (Machinery)	Operation
9	KUBIK	Building	Test Lab	Building Industrial	Design
10	BRIDGE ZUBIOTE	Bridge INFRA	test bridge	Civil Infrastructure (Linear)	Design
13	BIM2TWIN	Digital Twin Of Construction Execution	Construction Management	Building Tertiary	Execution (Onsite Construction)
14	ENERGY_TWIN	Building Office	Commissioning, Operation	Building Tertiary	Commissioning
15	BRIDGE BASt	Bridge Rail/Road Infra	Operation, Maintenance	Civil Infrastructure (Linear)	Operation
16	ROAD TU	Road Infra	Operation	Civil Infrastructure (Linear)	Operation
17	BRIDGE ROAD INFRA	Bridge Road Infra	Operation, Maintenance	Civil Infrastructure (Linear)	Operation
18	BUILDING OFFICE	Building Office	Construction	Building Tertiary	Construction

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Building information modelling — Digital twins applied to the built environment — Use cases

#	Name	General info	Main use	Asset type	Phase
19	BRIDGE RAIL INFRA	Bridge Rail Infra	Operation, Maintenance	Civil Infrastructure (Linear)	Operation
20	SNCF	Rail Infra	Knowledge optimisation	Civil Infrastructure (Linear)	Operation
21	ZADAR	Airport Infra	Maintenance	Civil Infrastructure (Punctual)	Operation
22	AVILES PORT	Port Infra	Operation, logistics	Civil Infrastructure (Punctual)	Operation
23	SETEC-StMALO	Port Infra	Heritage	Civil Infrastructure (Punctual)	Reconstruction/ preservation
24	LEGENDRE	Building, provisions for openings	Construction Management	Building Tertiary	Execution (Onsite Construction)
25	ETSICCP	Building School	Operation	Building Tertiary	Operation
26	IRRIGATION	Smart Irrigation Management	Operation	Utility network	Operation
27	LLOBREGAT	BUILDING (Council)	Operation	Building Tertiary	Operation
28	HIDROPOWER	Powerplant Rabenstein (AUSTRIA)	Maintenance, optimization, simulation and VR	Energy Infrastructure	Operation
29	NUCLEAR_DECOMM	(Confidential)	Optimization, Simulation, Training	Building Industrial	Dismantling
30	ST_ETIENNE	Building School	Optimization, simulation, operation	Building Tertiary	Operation
31	ECOLE CENTRALE	Building School	Building information model, CMMS and BMS DATA.	Building Tertiary	Operation
32	LILLE	Building Public	Facilities ticketing system interface	Building Tertiary	Operation
33	TNO SPHERE	Building Residential	Energy management	Building Residential	Operation
34	VTT SPHERE	Abloy factory	Energy optimization	Building Tertiary	Operation
35	EGIS	Gironde Estuary, Grand Port Maritime de Bordeaux	Operation and maintenance	Civil Infrastructure (Punctual)	Operation
36	ANDRA	Nuclear waste recycling plant	Waste management	Building industrial	Operation
37	VSB-TUO	Building office	Operation	Building Tertiary	Operation

SAMBA

Example of case study SAMBA

c. Case Study 4: SAMBA. SAMBA Smart Advanced Multitenant Building Automation – DT for occupants and manager

i. General information

Typology: offices, coworking
Location: Co+Fabb, Sesto San Giovanni (MI), Italy
Asset owner: VIARTE srl
Building Digital Twin (BDT) manager: Alchema srl, KALPA srl and Harpaceas srl

ii. Main use of the DT

SAMBA Digital Twin is a photorealistic model of an existing coworking building located in Sesto San Giovanni, near Milan (Italy). It is meant to be used in the operational phase, focusing on space usage and wellbeing conditions for occupants in each office.

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KALPA

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3P

ATS Advanced Technology Solutions

iv. Main improvements beyond the state of the art

Considering the nature of an existing building such as the Co+Fabb, SAMBA introduced an innovative level of technology on physical and digital level. The entire system, comprising the Digital Twin, allows the user and the building manager in controlling the ongoing and historical situation of the agreed parameters in the Co+Fabb. This approach facilitates several topics like energy consumption, space usage, safety and security and enable data collection useful to implement algorithms for building behavior learning.

Figure 7: SAMBA, room monitoring and occupancy

v. Replication potential

According to the tailored and scalable nature of the Digital Twin, this method could be improved for the Co+Fabb and of course it could be extended and potentiate for another asset. This could include bigger coworking buildings or other asset categories such as hospitals, airports. Some of the functions could be replicated with the same logics and algorithms, other could be revised for different user needs.

Example of case study
H2E Electrolyzer

d. Case Study 5: H2 ELECTRO. H2Energy Electrolyser – DT for technical marketing

i. General information

Typology: plant
Location: -
Asset owner: H2Energy
Building Digital Twin (BDT) manager: Daniele Arnone, H2Energy

ii. Main use of the DT

H2E Digital Twin is a photorealistic model of an electrolyser plant hosted in a container, located in a fictitious area. At the moment it is meant to be used for technical marketing purposes, focusing on displaying plant components and key information.

iii. Description of the DT

H2E Digital Twin has been developed for a request of H2Energy company. H2E provides turnkey solutions of hydrogen production systems for various applications: for blending in the natural gas grid, railway and automotive transport systems, steel production, port systems and various industrial and domestic uses to be studied together with customers. Green hydrogen is mainly produced by electrolysers, although this is still a niche industry.
This Digital Twin has been realized elaborating photos and videos taken on site.
Result model comprises two main functions meant for interacting with the asset and its information:

- Clickable objects (e.g door animation)
- Information sheets

H2Energy

iv. Main improvements beyond the state of the art

For the purposes of promoting this innovative technology during exhibition related to renewable energy, H2Energy decided to invest in recreating a DT of their container plant. This introduces new ways of showing and explaining – with associated information – the whole package without the need of moving and physically installing the plant in each fair.
The DT also allows to inspect the components in a quickest and easiest way, especially in narrow areas inside the container.

v. Replication potential

Although the main goal is to technically promote the plant, this DT could be improved for several uses such as simulation, training, connection with the existing plant also from the point of view of getting data from the onsite sensors.

Example of case study
Bridge WebGL

e. Case Study 6: BRIDGE WEBGL. Bridge DT for technical marketing maintenance oriented

i. General information

Typology: Civil Infrastructure (Bridge)
Building Digital Twin (BDT) manager: Harpaceas srl

ii. Main use of the DT

Digital Twin is a photorealistic model of a scene able to present and interact with various type of bridge degradations. It's meant to be used in the maintenance phase, focusing on degradation types and necessary steps to restore the structure according to methodologies and products proposed by a typical producer of infrastructures' restoring products.

iii. Description of the DT

The DT is developed as a WebGL (Web-based Graphic Library) application and allows the user to navigate in an agreed scene. The DT is designed to show different types of bridge degradation and enables the selection of several products included in the technical and methodological proposal of the Client.
In the scene there will be a bridge with different types of degradation that can be activated through a special user interface. The same user interface will allow user to interactively represent the processing phases to restore the damaged portion.
Each phase will be distinguished by a specific activity (using a maximum of one product for each phase) and will allow the reference to a specific web address (e.g., to a product page on the producer's website).
For each type of degradation, it will be possible to download a zip file containing PDF documentation (provided by producer).

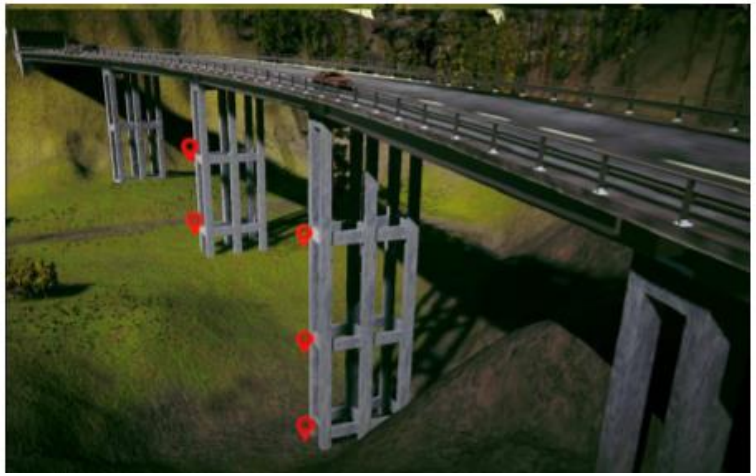
iv. Main improvements beyond the state of the art

Digital Twin enables a new way of technical marketing introducing specific features:
- Provide the customer with an interactive and three-dimensional product, for the choice of products to be applied in the various cases of deterioration.
- Provide guidelines on the applicability of various products in different deterioration situations.
- Innovative method for product choices and learning about their use, through a visual approach.
- Web application integrated into the customer's site.
- Allowing product description and promotion everywhere, without the need of physically moving components and assets.

v. Replication potential

This Digital Twin has a technical to marketing and can support better decisions regarding maintenance and intervention. This approach can be also replicated for different kind of technical marketing purposes such as MEP, civil and other domains.

Figure 9: Web interface of the application for bridges



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2023:
First New Work Item

TR collecting Case Studies of DTs in Built Environment

All the **case studies** have been **grouped following similar characteristics** to extract representative guidelines of the examples received, with dedicated focus on extracting potential use cases.

	USE CASE	MAIN USE	SECONDARY USE
I	Design Optimization		16, 36
II	Construction Optimization	8, 13, 18, 24	36
III	Commissioning Optimization	14	
IV	Operation Optimization (Energy Performance)	1, 2, 4, 14, 30, 33, 34	3, 4, 27, 31, 37
V	Operation Optimization (Space and Administrative Management)	3, 22, 25, 27, 32	4, 20, 30, 31, 37
VI	Operation Optimization (Logistics)	35	20, 22
VII	Operation Optimization (Waste Management)	36	
VIII	Maintenance Optimization	15, 16, 17, 19, 20, 21, 23, 28, 31	6, 22, 25, 27, 36
IX	Dismantling Optimization	29	16
X	Safety		4, 29
XI	Training		4, 28, 29
XII	Marketing	5,6	
XIII	Test Lab	9, 10, 19, 37	
XIV	Others	26	34, 35

2023: First New Work Item - **Key Points & conclusions**

- Main asset tipology: **tertiary buildings and infrastructure**
- Some case studies are representing a **fictitious physical asset**.
- Targets:
  - **constructive operations** (planning and design, construction, commissioning, energy performance, maintenance or dismantling)
  - **dedicated operative of the asset** (space management in buildings, logistics in transport infrastructures or heritage administration).
  - special case of dedicated operative as **"Test Lab"**
- **Additional purpose**: safety, training and marketing, irrigation operative, occupants (employees) wellbeing, climate change resilience estimation…
- **Replication potential:** many case studies with big possibility of being converted into a commodity or a massive product.

The analysis of the use cases will allow the development of a standardised framework and definitions for digital twins.

2024: New Work Item Proposal - in progress

Building information modelling - Digital twins applied to the built environment - Concept and definitions

This document defines the **framework for the digital twins in the built environment**. It includes the **terms and definitions**, the **relation with BIM** and addresses the lack of standards for the qualitative specification of a digital twin, which may include geometric, attributive, structural and infrastructural quality, as applicable.

It will be based on the experiences obtained in use cases and other TCs, including ISO/IEC 30173:2023 Digital twin. Concepts and terminology.

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