Industrial and Civil Digital Design Integration in Large-Scale Facilities

A CAD-to-BIM framework for efficient collaboration

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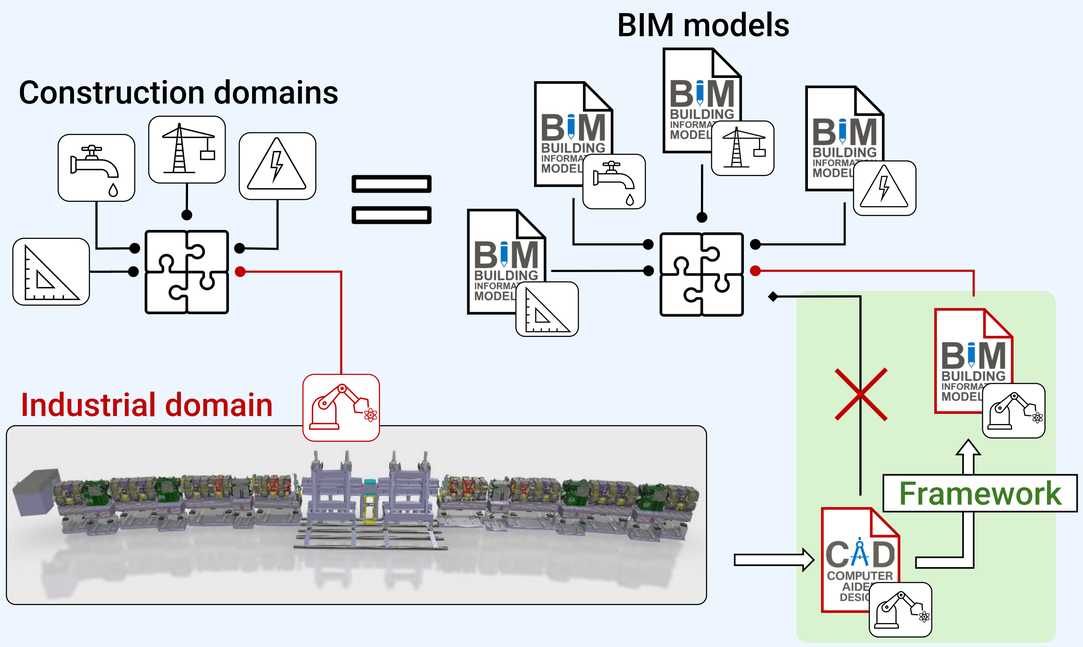
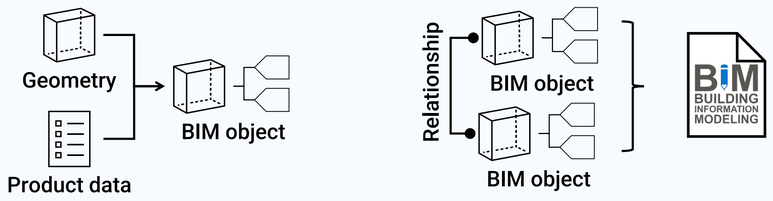
Introduction

Construction projects involve multiple disciplines that must be effectively coordinated to ensure efficient delivery. Current best practices and European/national regulations strongly promote or force the adoption of Building Information Modelling (BIM) for design and project management. In standard workflows, each discipline develops an independent BIM model, typically produced by specialized professionals, requiring subsequent coordination and integration across domains.



What's BIM?



In large-scale facilities context, additional complexity arises from highly specialized systems. Civil engineers are responsible for designing supporting structures and infrastructure for these systems. However, these components are developed using CAD-based tools, which exhibit limited interoperability with BIM. This gap represents a barrier to fully integrated digital workflows. Current state-of-the-art procedures are limited, as they do not fully address differences between design approaches.

Partners

Elettra Sincrotrone Trieste

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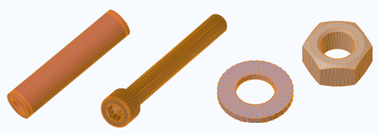
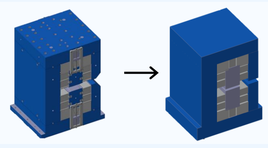
Differences in design

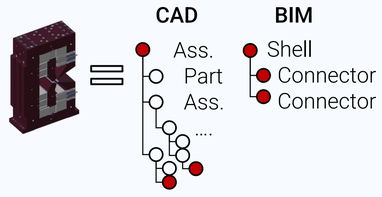
1. **Small components** such as screws and bolts are often irrelevant for civil purposes and result in highly detailed, heavy meshes



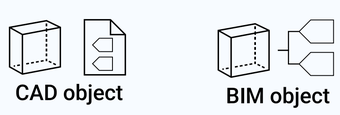
2. While CAD models require high geometric detail for manufacturing, civil applications typically need a lower **Level Of Detail (LOD)**



3. In CAD, products are structured as detailed **hierarchies** including internal components; in BIM, they are simplified as single objects representing the outer shell and connectors



4. In CAD, **product data** is typically stored in external software or documents, whereas in BIM it is embedded as properties of the objects



State-of-the-art procedures

Proprietary ecosystems	Manual redrawing	Import geometries	Automatic converters
1 ✓	1 ✓	1 ✗	1 ✗
2 ✗	2 ✓	2 ✗	2 ✗
3 ✗	3 ✓	3 ✗	3 ✗
4 ✓	4 ✓	4 ✗	4 ✗
Ecosystem dependency ✗	Time consuming ✗		
Costly licenses ✗	Error prone ✗		

Open file format

In some European countries, public administrations must exchange data using open file formats

Industry Foundation Classes (IFC): a standardized, open data model for representing built environment information in BIM (ISO 16739)

STandard for the Exchange of Product (STEP): a standardized, open data model for representing product data in CAx (ISO 10303)

Framework

User interaction

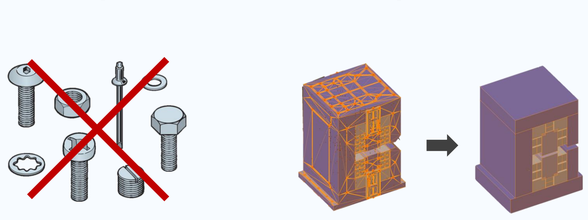
Web application

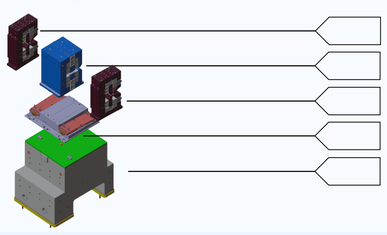
Importing STEP files → Create project hierarchy → Select product for civil engineers → Resulting IFC project hierarchy → Add IFC properties

Automatic scripts

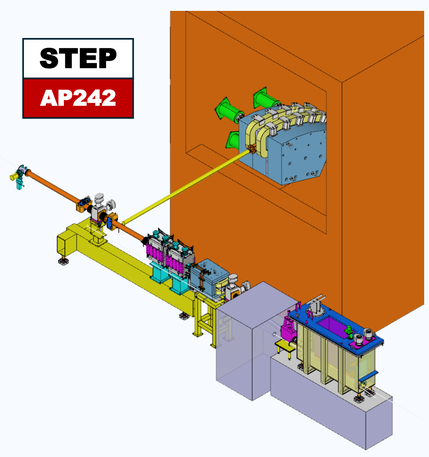
Backend

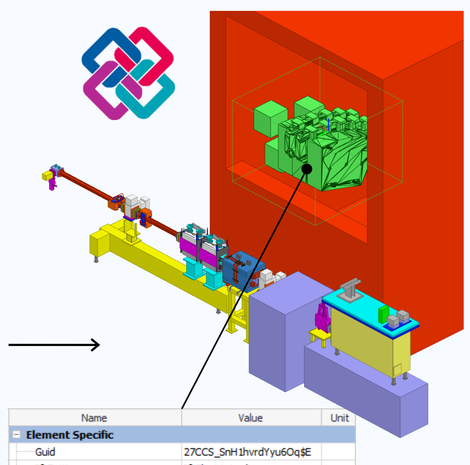
Removal of small parts → Geometries simplification → Product merging → Product data integration*



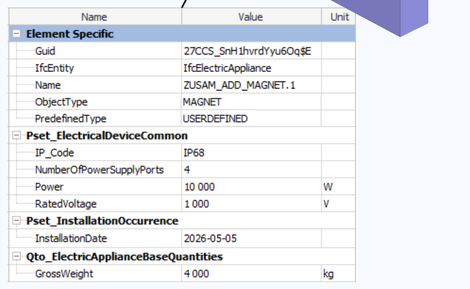


Results





	STEP	IFC	Δ%
Verts	8,171,990	149,799	↓ 98.2%
Faces	16,305,114	293,236	↓ 98.2%
Objects	2,311	115	↓ 95.0%
File size [MB]	58.5	13,5	↓ 76.9%
User time		67 min	



Case study from **PSI Impact TATTOOS** project

References

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