



FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

Presented at the FIG Working Week 2024,
19-24 May 2024 in Accra, Ghana

DIGITAL TWINS OF THE BUILT ENVIRONMENT – CHALLENGES AND PERSPECTIVES FOR SURVEYORS'

Prof. Dr.-Ing. Robert Kaden, DVW Working Group BIM
Erfurt University of Applied Sciences, Chair of Surveying and Geoinformatics



Univ.-Prof. Dr.-Ing. Jörg Blankenbach, Vice President DVW
RWTH Aachen University, Chair of Building Informatics and Geoinformation Systems and Geodetic Institute



ORGANISED BY



PLATINUM SPONSORS





FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

Digitals Twins – the Origin (ME Domain)

Conceptual Ideal for PLM
(PLM = Product Lifecycle Management)

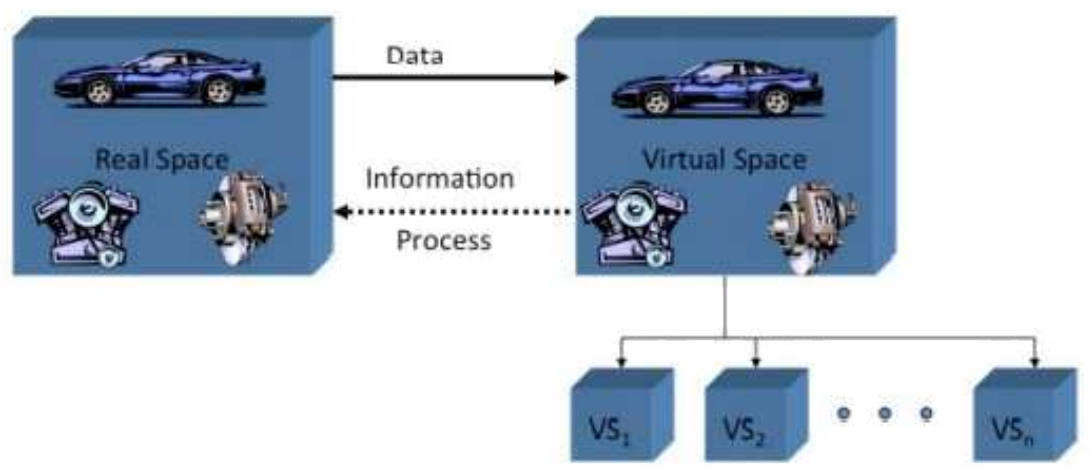


Figure 3

“The Digital Twin concept model [...] It contains three main parts: a) **physical products in Real Space**, b) **virtual products in Virtual Space**, and c) the connections of data and information that **ties the virtual and real products together.**”

(Grieves, M., 2014)

Dr. Michael Grieves, University of Michigan, Lurie Engineering Center, Dec 3, 2001





FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

Digital Twins – the Definition of BuildingSMART International (AEC Domain)



“A digital twin (DT) [...] is a **digital representation of a physical asset**. Linked to each other, the **physical and digital twin regularly exchange data** throughout the **plan-build-operate-decommission lifecycle and use phase**. Technology like **AI, machine learning, sensors and IoT** allow for **dynamic data gathering and right-time data exchange to take place**”

(buildingSMART: Enabling an Ecosystem of Digital Twins, Position Paper, 2020)

ORGANISED BY



PLATINUM SPONSORS





FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

Who knows „best“ about digitalization ?? ...than AI?!

Q: ...let's ask ChatGPT

Reality Capturing ...our Business!

A: “[...] digital twin is a virtual replica of a physical object,

[...] used to simulate, analyze, [...] its real-world counterpart.

esp. GIS Skills!

[...] is built using data from sensors

[...] to create an accurate, [...] representation.”

esp. Surveying Skills!

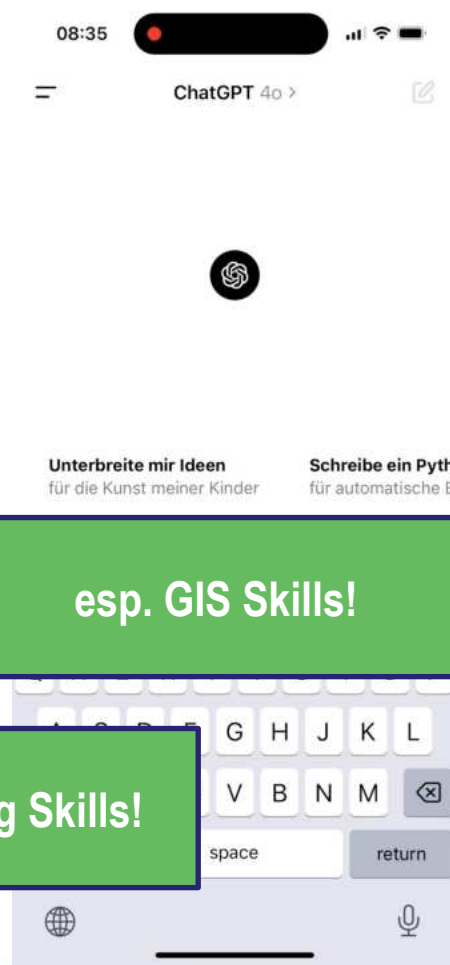




FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

Digital Twins of the Built Environment – Modeling Paradigms in AEC and Geodesy



AEC Domain

- Top-down:
 - Design/Planning Model
 - Realization
 - Real world
- Detailed representation of the planned world
- Modeling of constructive components (elements)

Geodesy Domain

- Bottom-up:
 - City/Landscape Model
 - Abstraction
 - Real world
- Generalized representation of the real world
- Modeling of observable surfaces (object surfaces)



→ led to different developments in software, interfaces, data models and formats



FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

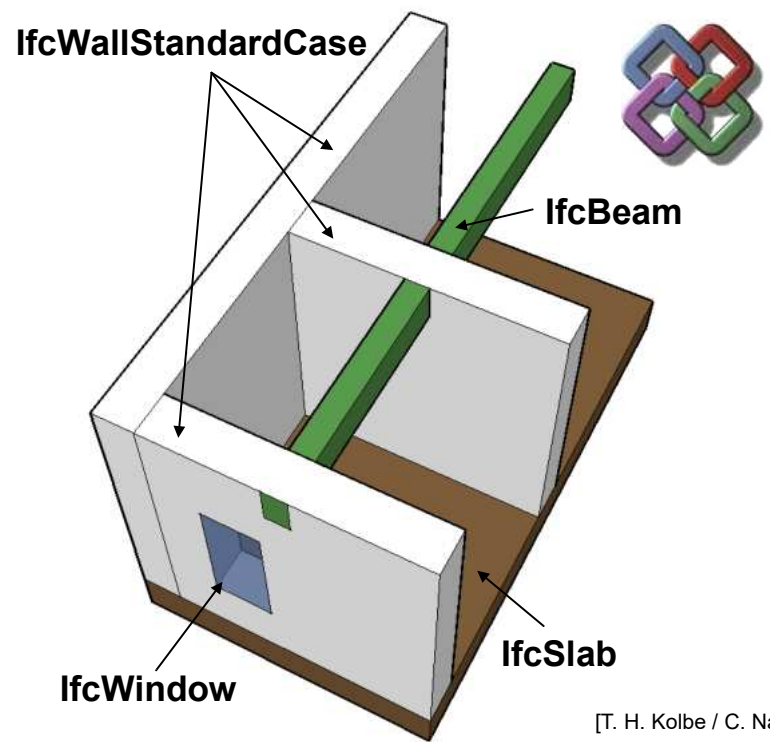
Challenges for Surveyors and Geoinformation Experts

...for comparison, the respective data models IFC and CityGML illustrate the challenges quite well

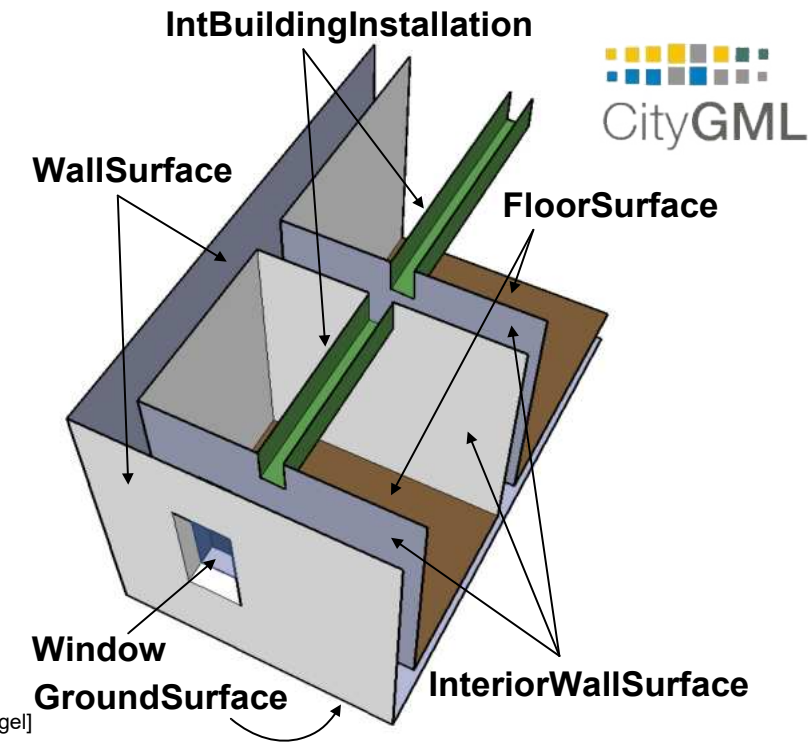
- IFC: focus on modeling components
- CityGML: focus on modeling space (...it can be seen as photographic positive and negative)

→ Very different concepts in modeling geometry, semantics and topology

AEC Domain (IFC)



Geodesy Domain (CityGML)



[T. H. Kolbe / C. Nagel]



FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

Challenges – Geometric Modeling

- B-Rep suitable for representing existing structures
- Parametric, CSG, Sweep suitable for representing planned constructions
 - “Unfamiliar” for GIS/surveying
 - Corner points, edges and axes have no explicit coordinates
 - E.g. plugins required in BIM authoring software to create stakeout/coordinate lists

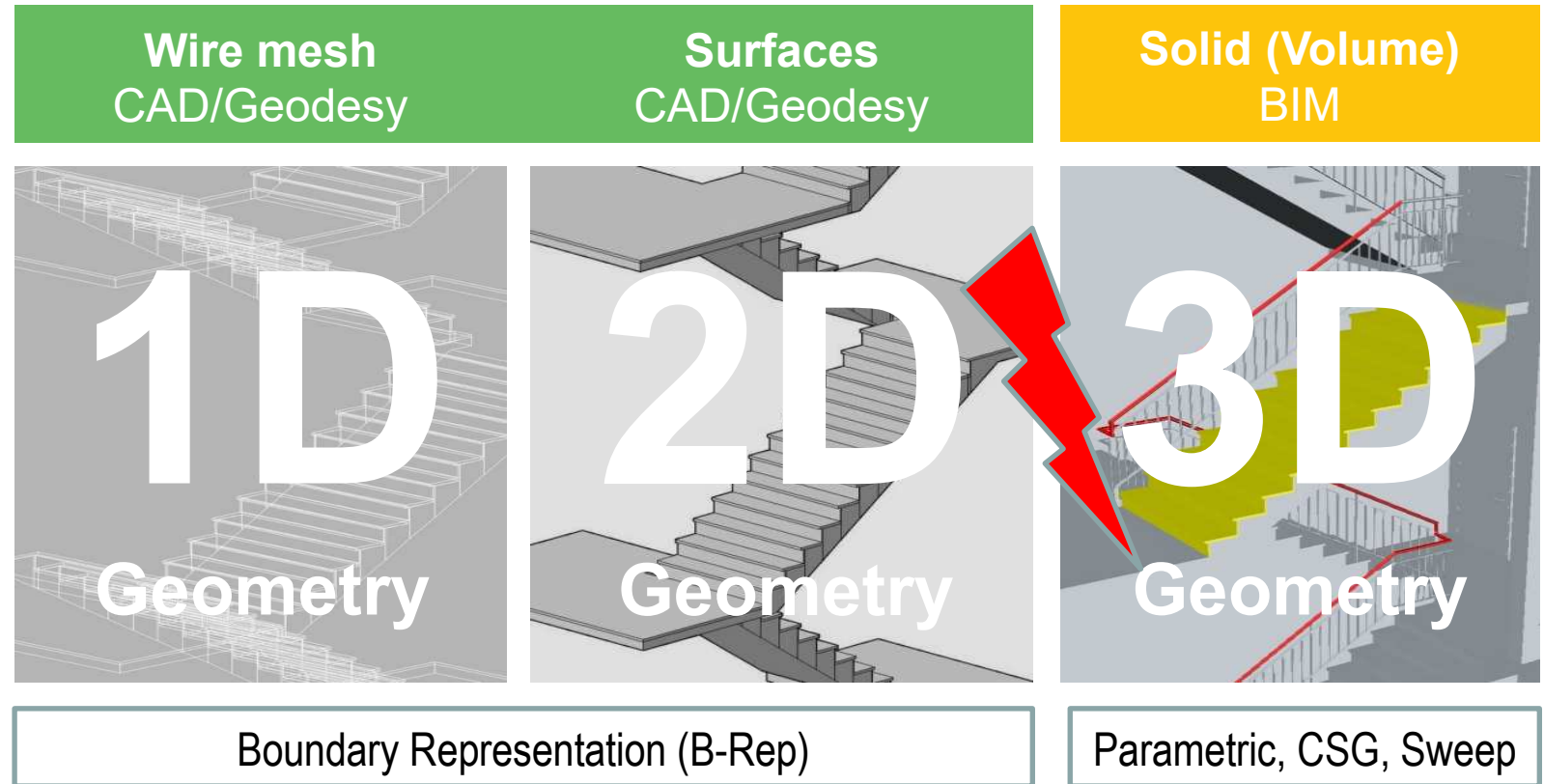




FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

Challenges – Semantic Modeling

- Semantic models are domain specific and suitable for its purpose, e.g. AEC and Geo Domain
- Differ due to the Scope and Scale of the model
- Different semantically content and granularity of Data
 - As-built/as-is survey requires knowledge of building construction and materials, some of which are not observable
 - BIM-GIS-data integration with no corresponding semantic class/element or n:m matching between objects and attributes → loss of information

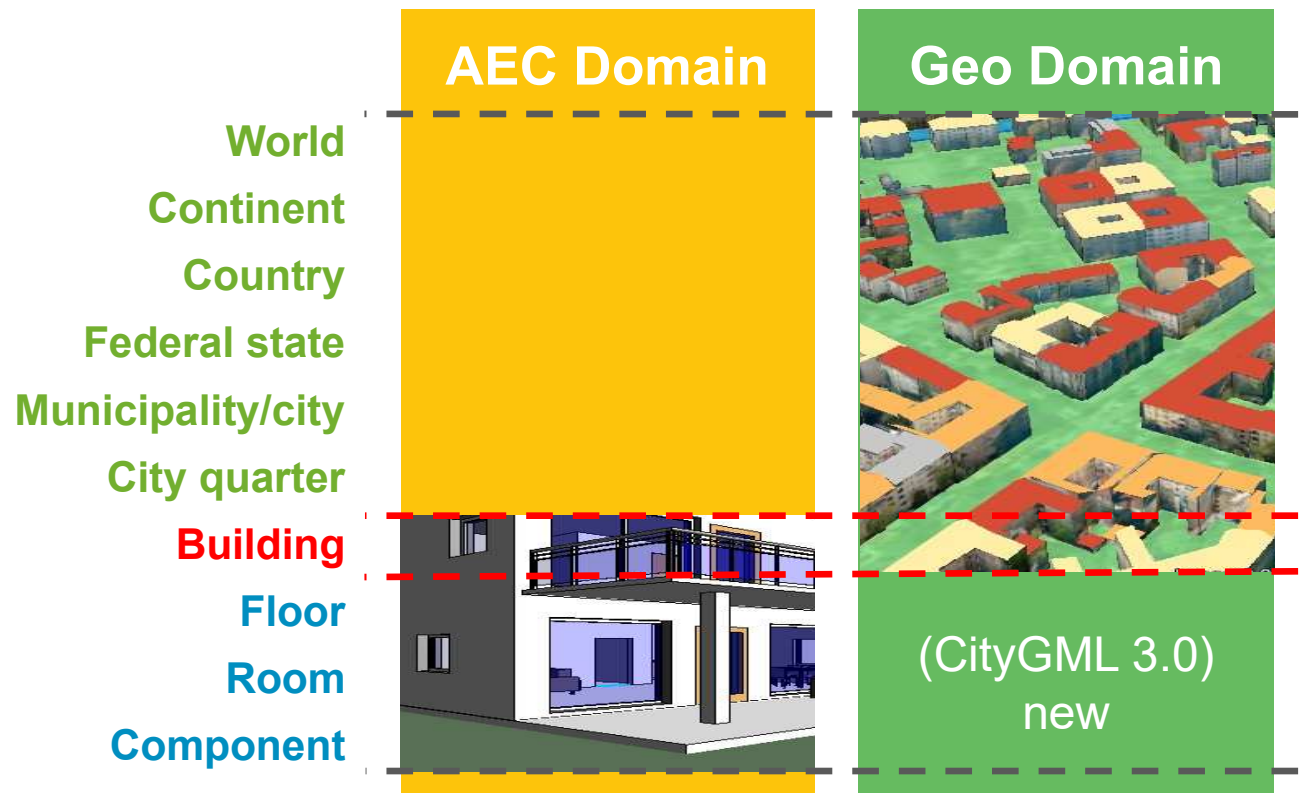




FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

Perspectives – Geodetic Business Cases within the BIM Lifecycle (Selection)

- Design / planning phase
 - Location plan and GIS data integration – linking planning to reality!
 - Georeferencing – deliver correct coordinates on the earth!
 - Spatial analysis – give answers with Location Intelligence and GeoAI!
- Construction phase
 - Staking out – assign model data to the site with confidence!
 - Construction progress – provide data to stay on time and budget!
- Operation / maintenance / renovation phase
 - Structural monitoring – alert on changes between model and building
 - Reality Capture – creation of a digital twins (as-built or as-is)

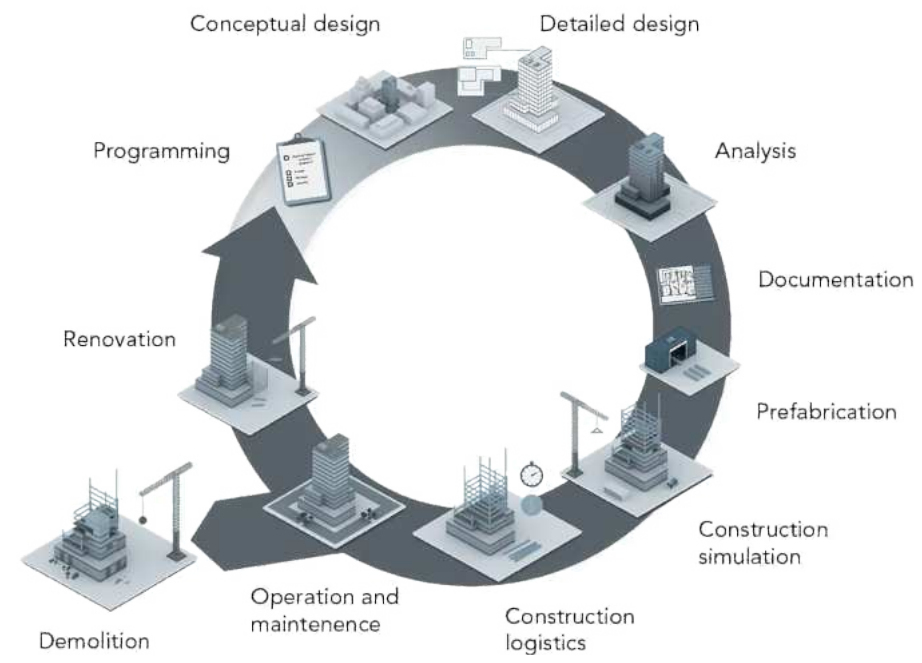




FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

Example: Digital Twin of the Built Environment

- BIM conform 3D location plan
 - Captured by total station survey
 - Enriched with construction/material information of the landscape architecture
 - Modelled in Nemetschek Vectorworks
- BIM conform 3D building models
 - Captured by using laser scanning (Scan2BIM)
 - Enriched with construction/material information of the planner
 - Modelled in Autodesk Revit
- Missing: Sensor integration/linking with BIM





FIG Working Week 2024

19-24 May

Accra, Ghana

Your World, Our World:
Resilient Environment
and Sustainable
Resource Management
for All

Conclusion – Swarm Intelligence of the FIG Pre-Workshop participants BIM for Surveyors (18th May, Accra, Ghana)

- Geodesists have decades of experience in object-oriented data management, sensor integration, digital data flow, spatial analyzes → GIS-based digital twins
- BIM-based digital twins and processes will be standard in future
- Massive potential for geodesics to play a central role in BIM processes, esp. as BIM manager / Data manager and deliverer of high quality digital twins of existing buildings
- However, we have to learn how to tackle the challenges, creating interfaces (CityGML 3.0 is a good example) etc.
- BIM knowledge should become an integral part of surveying training - so far there is still too little of it
- BIM authoring software is primarily proprietary and expensive. We should push open source initiatives as in the geodetic field (e.g. QGIS) so that surveyors in every country have an equal opportunity to participate in this new business cases

