FIG WORKING WEEK 2019
22–26 April, Hanoi, Vietnam

"Geospatial Information for a Smarter Life and Environmental Resilience"
Practical Issues and Solutions in BIM GIS Interoperability

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BIM GIS Interoperability

Interoperability approaches

Integrated unified federated

Organizational technological conceptual

Business Processes Service Data

Interoperability concerns Interoperability barriers

cf. ISO 11354-1
Our Principle

• We want to rely on Open-BIM standards → IFC

• The implemented tools follow a integrated conceptual and data driven interoperability concept

integrated
caseptual
Data
Need for Georeferencing BIM

Issue:
- Co-ordinated placement of related BIM-Models required
- Way of georeferencing should be identifiable
- Pessimistic assumption: building models in IFC are not perfectly referenced in practice

Our Solution:
- Delivered BIM-Models should be automatically checkable for georeferencing
  → Level of Georeferencing Concept
  → GeoRefChecker tool
Level of Georeferencing (LoGeoRef) Concept

- The higher the LoGeoRef is, the more information of georeferencing
- Increment is 10 with intermediate steps possible e.g. for elevation or project specific extensions
- Higher levels do not automatically include information out of lower levels.
LoGeoRef 10

- Simplest way to add (indirect) georeferencing information using an address
- Address defined by: Postal code, town, region, country and address line
- Only a rough approximation for setting the location of a IfcSite or IfcBuilding
LoGeoRef 20

- IfcSite instances must contain RefLatitude and RefLongitude
- Specified as geographic coordinates with respect to WGS84
- Elevation as a metric value related to a local datum
LoGeoRef 30

- Georeferencing on IfcBuilding/-Site level using a single point and the direction of X- and Z-axis
- No specification of used CRS
- Kind of misuse since IfcProject should contain these information
LoGeoRef 40

- Georeferencing for IfcProject using IfcGeometricRepresentationContext
- World CRS can be specified
- In addition: true north attribute \( \theta \) deviation of project north to true north
LoGeoRef 50

- Specifies transformation parameters for transforming from the local coordinate system to the world coordinate system using a IfcMapConversion
- Ability to specify EPSG-Code
- Introduced in IFC Version 4
Solution: GeoRefChecker tool

- Application for determining the LoGeoRef for a IFC-File
- saves result in a Log-File
GeoRefChecker updating function

- Extracts building footprints and saves it as Well Known Text
- Place building accordingly in map and write back results of LoGeoRef 50 to IFC File
Need for **Digital Terrain Models** in BIM
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• Correct Placement of building models
Need for **Digital Terrain Models** in BIM

- Correct Placement of building models
- Clash Detection
Need for **Digital Terrain Models** in BIM

- Correct Placement of building models
- Clash Detection
- Visualization
Need for Digital Terrain Models in BIM

Issue:
• Different GIS/CAD file formats (LandXML, DXF, …)
• Different BIM-Viewer capabilities
• not everyone has professional BIM software
Need for **Digital Terrain Models** in BIM

**Issue:**
- Different GIS/CAD file formats (LandXML, DXF, …)
- Different BIM-Viewer capabilities
- Not everyone has professional BIM software

**Our Solution:**
- Small tool, reads different file formats, writes IFC only
- TINs preferred
- Different IFC geometric representations possible
Different Input File Formats

- Reading is possible if a format description available (LandXML, DXF, …)
- The main problem is the geometric representation of the DTM.
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Irregular Points
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Grid

Irregular Points

Points and Breaklines
Different Input File Formats

- Reading is possible if a format description available (LandXML, DXF, …)
- The main problem is the geometric representation of the DTM.

Grid → Irregular Points → Points and Breaklines → TIN
How to represent DTM geometry in IFC?

- Terrain is geometrically represented by an closed surface
- Three IFC types of geometric representation are suitable, depending on input format and viewer capabilities:
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<tbody>
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*since IFC Version 4*
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How to represent DTM in IFC semantically?
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- Since IFC Version 4 special Entity for geographic Elements IFCGEOGRAPHIELEMENT with PredefinedType: TERRAIN

```plaintext
#31=IFCTRIANGULATEDFACESET(#20, #14, #1, #11, #10, #4, #7, #8, #23, #24, #29, #25),
#32=IFCSOLIDREPRESENTATION(#21),
#33=IFCGEOGRAPHIELEMENT('1Vg55cd05BxRz6_NHnevVd', #2, 'TIN', $, $, #34, #39, $, .TERRAIN.);
#34=IFCLocalPlacement(#23, #39),
#35=IFCAXIS2DPlacement3D(#36, #38, #37);
```
How to represent DTM in IFC semantically?

• Since IFC Version 4 special Entity for geographic Elements IFCGEOGRAPHICELEMENT with PredefinedType: TERRAIN

• Workaround for older IFC Versions, direct use of IFCSITE (Downside → lost of semantic information)

```plaintext
#31=IFCTRIANGULATEDFACESET(\[...\],\{1,4\},\{1,4\},\{2,1\},\{2,1\},\{3,4\},\{3,4\}),
#32=IFCSPACEREPRESENTATION(\[\#31\],\#32);,
#33=IFCGEOPHYSICALELEMENT('1V55c06S5BxRz6_NHnevVd',\#2,'TIN',\$,\$,\#34,\#39,\$,\$.TERRAIN.);
#34=IFCLocalPlacement(\#29,\#35),
#35=IFCAXIS2PLACEMENT3D(\#36,\#38,\#37);
#32=IFCSPACEREPRESENTATIONCONTEXT(\"Building Plan View\",\"Plan\",\#21,\#22);,
#24=IFCSITE('OnRyb1b17i18aDuUimCC$Z',\#2,\"Site with Terrain\",\$,\$,\#25,\#44193,\$,\$.ELEMENT.,\$,\$,\$,\$);
#26=IFCAXIS2PLACEMENT3D(\#27,\#29,\#30);
```
Implementation

- Small desktop application built on .Net-Framework and xBIM-Toolkit*
Implementation

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- 3-Step conversion:
  1. Read Source

*docs.xbim.net
Implementation

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Implementation

- Small desktop application built on .Net-Framework and xBIM-Toolkit*
- 3-Step conversion:
  1. Read Source
  2. Configure
  3. Write IFC
Results
Results
Results
Tools are available for download!

- http://www.dd-bim.org/?page_id=31

- Contact us if you find any bugs :)  
  dd-bim @ htw-dresden.de