

Site Plan for BIM? – A Free and Open Source Plug-In for As-Is Vicinity Models to be Used in Small and Medium-Sized BIM-Projects

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Key words: BIM, site plan, topography, IFC, GML, CityGML, Land Management, Revit

SUMMARY

Building Information Modeling (BIM) is a method of optimized, software-supported planning, execution and management of construction projects, based on the active networking of everyone involved in construction. The virtual 3D model forms the core of the method, but the semantic model (classification, attribution) is the leading perspective and produces the main benefit of BIM. However, nowadays standard deliveries from land- und engineering surveys, such as detailed terrain model, site plan with topography, parcel map or development plans are seldom syntactically, semantically nor logically linked with the building model or integrated into automated processes of planning, building and maintaining the built environment. The aim of the research presented in this article is to show practical ways in which a site plan for BIM projects can be created. From the academic authors' point of view, the currently available software is not sufficient for this task. Therefore, several software packages and a plug-in were developed in several research projects by research assistants and with the help of students. The released binaries and source code are free and open source available as a plug-in for Autodesk Revit (application level) and IFC-converter (data level). All presented tools help to deliver standard information deliveries of the surveyor. The delivered model contains the same information as traditional CAD files, but the vicinity model is BIM-ready prepared. Some of IFC-converters might be used for “Extract-Transform-Load” (ETL) processes by advanced user. The main target group are practitioners, which want to work in a general-purpose BIM authoring tool (BAT), e.g. Autodesk Revit. All converters are accessible via a graphical user interface (GUI). The research results are presented as the functionality of the Revit plug-in. All functionalities start with the georeferencing the BIM-site and the corresponding vicinity model. The next step is the Revit import, transformation and IFC-Export to openBIM. The presented software supports the following information types: 2.5D digital terrain models in many data formats; 2D-data that describe site-related rights (e.g. property) and restrictions as GML application schema; 3D-buildings that are in the vicinity of the planned construction and provided with CityGML; additional, detailed measurements that were carried out by a surveyor and modelled in CAD/DXF. The many open points of the current research are briefly discussed in an outlook.

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1. INTRODUCTION AND MOTIVATION

Building Information Modeling (BIM) is a method of optimized, software-supported planning, execution and management of construction projects, based on the active networking of everyone involved in construction (translated, BMVI, 2015). The virtual 3D model forms the core of the method, but the semantic model (classification, attribution) is the leading perspective and produces the main benefit of BIM. However, nowadays standard deliveries from land- und engineering surveys, such as detailed terrain model, site plan with topography, parcel map or development plans are seldom syntactically, semantically nor logically linked with the building model or integrated into automated processes of planning, building and maintaining the built environment. The aim of the research presented in this article is to show practical ways in which a site plan for BIM projects can be created. From the academic authors' point of view, the currently available software is not sufficient for this task. Therefore, several software packages and a plug-in were developed in several research projects by research assistants and with the help of students. The released binaries and source code are free and open source (DD-BIM, 2021) as a plug-in for Autodesk Revit (application level) and IFC converter (data level). Figure 1 shows the main tools of the processing chain.

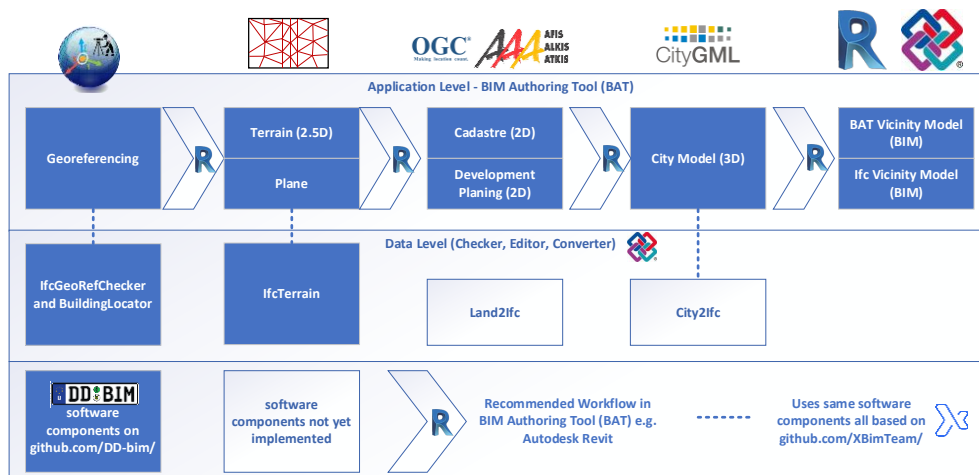


Figure 1 Packages and Workflow of the presented open source plug-in

All tools help to integrate standard products of the surveyor into the BIM workflow. The delivered model contains the same information as traditional CAD files, but the vicinity model is BIM-ready prepared. Some of the IFC converters (data level) might be useful for “Extract-Transform-Load” (ETL) processes by advanced user. The main target group are

practitioners, which want to work in a general-purpose BIM authoring tool (BAT), like Autodesk Revit. As shown in Figure 2 the software modules are accessible via a graphical user interface (GUI).

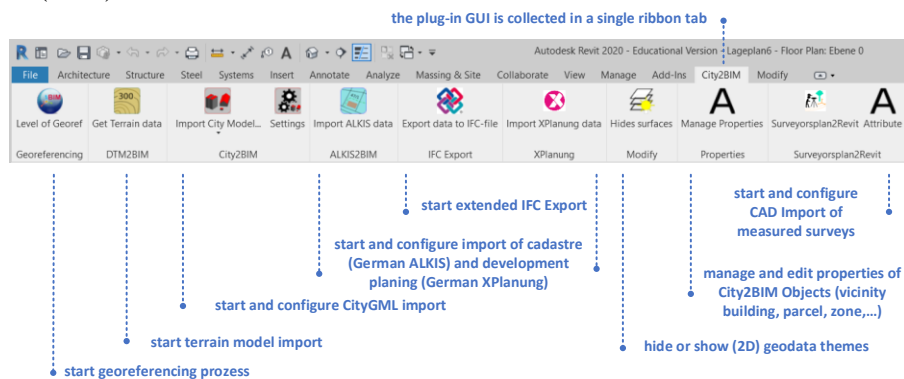


Figure 2 Graphical User Interface (GUI) of the presented Free and Open Source Autodesk Revit plug-in

With the presented free and open source plug-in, a variety of heterogenous geospatial data-sources are loaded to Autodesk Revit. The geospatial data can be checked, edited and annotated. Finally, the as-is-vicinity-BIM-Modell (Figure 3) can be delivered to closed BIM projects as Revit rvt-file or exported to open BIM projects via IFC.

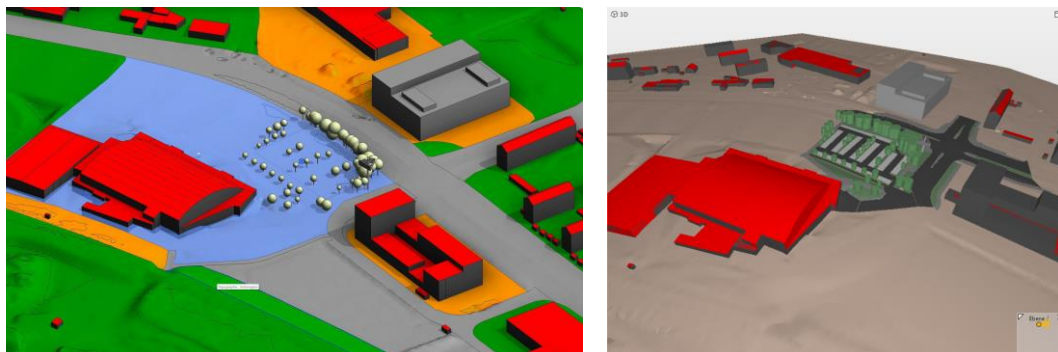


Figure 3 The georeferenced vicinity BIM contains the terrain model (xyz), city model (CityGML), property boundaries (ALKIS, GML) from cadastre and some measured objects e.g. trees (dxf). Left Autodesk Revit, Right IFC Model visualised with Solibri Anywhere

2. RESEARCH METHOD AND RELATED WORK

The software and the associated methods presented in this paper were developed in several very different research projects. The initial project was “DD-BIM”, which was initiated by the partners of a competence network. In a regional association, several engineering offices, companies and authorities under the direction of HTW Dresden have set the thematic focus on the digital connection of the geospatial world (GIS) and the construction world (BIM). The project was funded by the City of Dresden as a component in their Smart City initiative. In order to link both worlds together, “connectors” are required. Three different workflow types are conceivable: a) The transfer of the GIS data into a BIM model, b) the transfer of the BIM data into a GIS system or c) the linking of the two specialist models. With the DD-BIM tools, geodetic products should be made usable in the simplest possible way in BIM projects. The

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tools developed relate to workflow type a): GIS to BIM. The plug-ins are being developed for Autodesk Revit. The decision in favour of Autodesk Revit (and against other BIM authoring tools) is not justified for technical reasons, but rather because the university has easy access to Autodesk licenses and uses Autodesk products regularly in teaching. On the long term and from an academic perspective (e.g. Roxin, et al. 2019) linking approaches c) are more promising.

The aim of another research project "CityBIM" (2018-2019) conducted together with the company Virtual City Systems (VCS) was a market-ready product which enables architects and construction planners of small and medium-sized architecture and engineering offices low-threshold access to virtual 3D city models within their familiar BIM authoring tools (BAT). According to the German federal government (BMVI, 2015), the BIM method should offer improved visualization of project variants, significantly fewer planning errors and a smoother construction process. This objective is only partially made possible by BIM software, as it focuses on the detailed digital description of the planned building. The geographical context around the building (vicinity) is often ignored in building construction BIM systems. CityBIM closed this gap by integrating BIM models into city models and city model entities and analysis results in the BIM context. The aim of an ongoing project "LandBIM" (2019-2021) with the land surveying company "Geo-office" are digital assistants that logically (!) link essential property-related data with a digital building model (BIM). It must also be mentioned that numerous students with university projects and final theses have made a significant contribution to the success of the software project. Even if the main programming tasks were carried out by the academic staff from the geospatial faculty, our students from the geomatics program were able to make a major contribution to the overall project through supporting studies and software testing. From a didactic point of view, it also makes a lot of sense to teach students the advantages of IFC-based approaches on the data level as well as authoring functionalities on the application level.

The conceptual and practical intersection of "Surveying", "Geospatial" and "BIM" offers a multitude of very interesting research fields that are out of scope in this paper. Other research topics not covered here, are for example detection of components in 3D point clouds (Scan to BIM), construction progress control (Scan vs. BIM), BIM/GIS for integrated facility management or shared use of geospatial and BIM models, for example with semantic web technology (Pauwels, 2016), 3D cadastre and BIM (Atazadeh, 2019), just to name a few. When reading the paper, please keep in mind that our research is about a very special BIM model type, namely the as-is-vicinity-model that is required for planning in BIM projects, including terrain, topography, legal rights and restrictions. This paper is not focusing on the model of the prospective building itself.

With a similar perspective the "GeoBIM benchmark" (ISPRS, EuroSDR) was carried out in 2019 and 2020 under the direction of the TU Delft. This superordinate initiative, with a large number of participants, provides a very good overview of the data exchange between BIM and GIS (Noardo et. al, 2020 and other publications referenced there). The focus of the GeoBIM benchmark is the investigation on how geometry and semantics can be transferred

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“loss-free” in the data formats IFC and CityGML into the other domains (GIS, BIM). As a result, it can be stated that in principle all relevant software systems for BIM and GIS offer basic functionalities for BIM and GIS integration. However, the functionalities differ considerably in terms of their type and quality, and each software must be adapted/configured to specific use cases. The aim of our plug-in "City2BIM" and the IFC converters is to support the specific BIM use cases of surveyors when it comes to the BIM-compliant provision of vicinity models for construction planning in BIM projects.

The following sections always describe the functionality of the plug-in based to the same pattern (purpose, related work, current research results of the intended solution). These functionalities start with the georeferencing of BIM vicinity models (3). The import to the BIM Authoring Tool (BAT), transformation and IFC-Export to BIM is implemented for 2.5D digital terrain models in many data formats (4); 2D-data that describe site-related rights (e.g. property) and restrictions (5) as GML application schema; 3D-buildings that are in the vicinity of the planned construction and provided with CityGML (6) and additional, detailed measurements that were carried out by a surveyor and modelled in CAD/DXF (7). The many open points of the study are briefly discussed in Outlook (8).

3. GEOREFERENCING

3.1 Purpose of Georeferencing

Use case: Model Set-up of a BIM project in order to be able to place geo-referenced models from GIS and surveying in the exact and coordinated position and elevation.

Georeferencing deficiencies of Revit: Correct georeferencing with Revit is very complicated because the specifications are distributed over several dialogs that concern one of the three coordinate systems (internal, project, shared) and their transformation parameter (unit/scale, translation, rotation). By default, the scale of the projection and height reduction are not considered by Revit when importing geodata. Revit doesn't export LoGeoRef 50 until now, rather (not standard conform) LoGeoRef 30 or LoGeoRef 40 (Clemen et al., 2019).

Relation to IFC: The additional user defined IFC property sets for georeferencing the IFC export module of the City2BIM plug-in provides a standard conform (buildingSMART Australasia, 2020) georeferenced IFC2x3 or IFC4 export.

3.2 Related Work to Georeferencing

A comprehensive and academically detailed overview on “Georeferencing in the context of building information modelling” is given by (Jaud et al., 2019). This article discusses the geodetic problems in infrastructure projects, in particular the mathematically exact effect of neglecting the scaling factor in BIM projects. They present a function to determine the maximum horizontal extents of a structure, depending on the distortion of the underlying CRS and the required level of precision of the end structure. This function can be used to narrow

down what "small and medium-sized" means. "For example, the maximum horizontal extent for a construction site with $\Delta = 20$ ppm and a required construction precision of 1 cm is 500 m" (Jaud et al., 2019). Approximately following this formula as a "rule of thumb" the project size 1000 m is good threshold, to call a BIM project large-sized with respect to its horizontal spatial extend. This also corresponds to a very practical instruction "How to Setup Georeferencing in a Building or Linear Infrastructure Model", which is provided by (buildingSMART Australasia, 2020). Beside the geodetic background this technical report describes "Model Setup Use Cases" and the embedded "IFC Site Concepts". (Clemen et al., 2019) give a deeper inside in the conceptual models of IFC for georeferencing BIM, also including less perfect level of georeferencing (LoGeoRef), than standard-conform IFC4. Further practical guidance related to georeferencing and BIM collaboration is provided on the respective help page by software vendors like Autodesk/ESRI/Safe, Bentley, Allplan/Graphisoft/Nemetschek, Hexagon/Listech Neo or Tekla/Trimble and should be consulted for practical data exchange management with both, native formats or vendor neutral formats like IFC, diverse GML Application Schemas or LandXML.

3.3 Current Research Results of the Intended Solution (Georeferencing)

All relevant information for georeferencing the BIM project with our plug-in is entered in a single dialog (Figure 4). Geographical and projected coordinates are synchronized, metadata is inserted as properties, meridian convergence is considered, IFC-compliant features are generated. The 3+1 parameters for horizontal and vertical transformation between coordinate reference system (CRS) and BIM-project coordinate system (PCS) are stored with the Revit API. Additionally, the local scale and metadata are internally stored and used for geodata and surveying import in the plug-in.

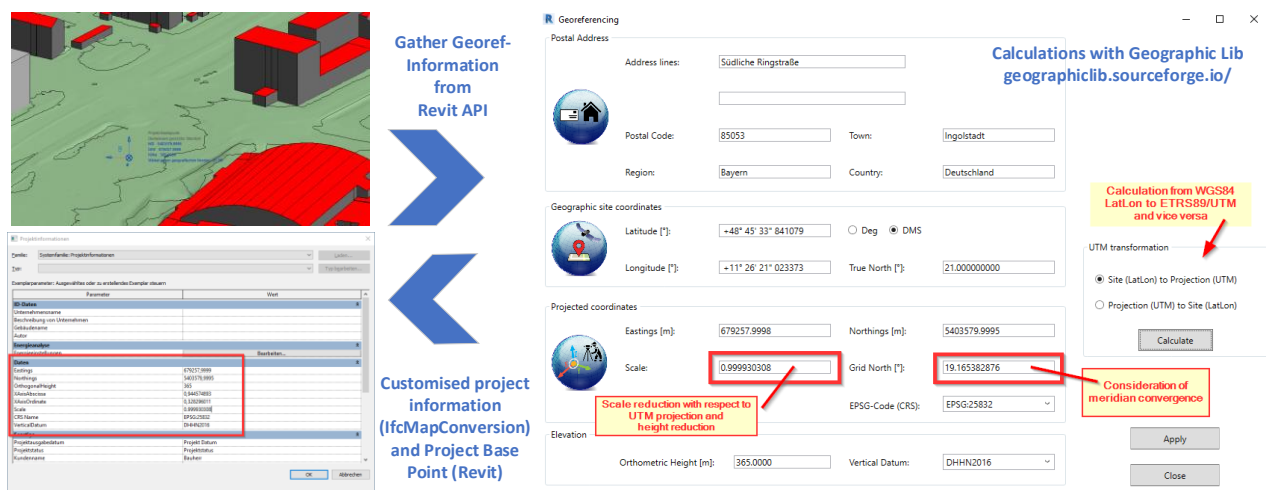


Figure 4 All advanced functionalities for georeferencing (synchronisation of adress, geographic and projects coordinates, scale, meridian convergence, IFC-PropertySets) are collected in a single dialog and can be calculated.

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In the future, the functionality of georeferencing must be expanded to include additional coordinate reference systems. With each new Revit version, the API changes / improves with respect to the transformation parameter and the plug-in has to be updated accordingly. Most important, however, is extensive functional testing in practical projects.

4. DIGITAL TERRAIN MODEL (DTM)

4.1 Purpose of Importing DTM to BIM

Use case: The DTM is consumed from a spatial data infrastructure (SDI). Or the surveyor has measured the DTM on site and used standard (not BIM) tools to create a high quality DTM with breaklines or other structural elements. This georeferenced, computational representation of the as-is terrain has to be imported to the BIM project. There the DTM serves as representation of the actual terrain (e.g. for collision detection) but also as a projection surface for 2D-Data (points, lines, surfaces) and as reference element for topographic objects. Therefore the 2.5D-DTM can also be regarded as supporting element to bring 2D geospatial data to the 3D BIM world.

DTM deficiencies of Revit: Revit knows only a few data formats for terrain import. Breaklines are not evaluated during import, only a simple Delaunay triangulation is carried out. Since Revit 2020, breaklines can be addressed via the API, loading facets instead of points only.

Relation to IFC: With the extended IFC export options of the plug-in, it is possible to assign the terrain to the desired IFC entities and IFC geometry types. In addition, individual partial areas can be provided with property sets. These sub-areas then represent, for example, properties or zones of urban land-use planning

4.2 Related Work to DTM and BIM

Mathematical operations with Digital Terrain Models (DTM) have been academically discussed since many years (e.g. Zevenbergen, 1987). A didactically very well-presented overview is the “Terrainbook” (Ledoux et al., 2020). The authors describe several model types, methods of data acquisition and algorithmic backgrounds how to store, traverse, filter, index and visualize DTMs. The German standardisation body DIN has published concepts, definitions and recommendations for DTM and meta data in (DIN 18740-6 2019). This shows that DTM are a standard “information delivery” for GIS and CAD, but not necessarily for BIM. A substantial contribution to pre-standardisation to integrate the shape of terrain is outlined in the “IFC Infra Overall Architecture Project Documentation and Guidelines” (Borrmann et al., 2017). This technical report is essential to understand the IFC concepts/datatypes for the geometric and topological representation of terrain as well as the semantic integration with IFC entities. The terrain related concepts are now part of the

candidate standard IFC4.3. The need and ways for surveyors to bring the terrain model to BIM are outlined in (Romanschek et al., 2019).

4.3 Current Research Results of the Intended Solution (DTM)

For the correct import of the DTM the BIM model must already be georeferenced. Several DTM data formats can be read in and - as far as the data allow it, breaklines can be generated. Points, lines, faces can be imported from DXF from a specific CAD-Layer, TINs from semantic data models (GML, especially CityGML), special measurement formats that explicitly identify breaklines (LandXML, REB, GEOgraf). After the import, the terrain is available as a BIM object in the "topography" category.

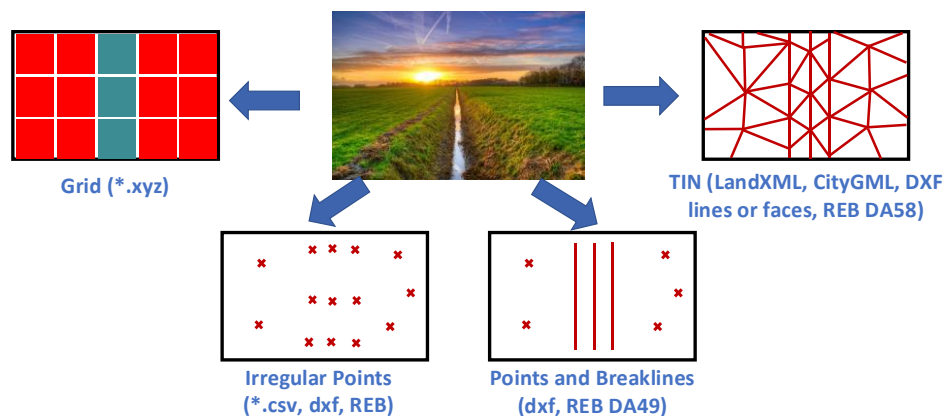


Figure 5 Same terrain represented in with different data structures and formats (adapted from Romanschek et al., 2019).

So far, the functionalities have mainly been implemented in the IFC converter "IfcTerrain" (DD-BIM, 2021). For practical use, these functionalities are currently being incorporated into the City2BIM plug-in. At the same time, an export-recommendation-matrix must be developed, that shows, which BIM viewer, BIM server, BIM authoring, BIM analysis tool or BIM Common Data Environment (CDE) can read and interpret which IFC geometry types (Table 1).

Table 1 Comparison of different possibilities of DTM conversion to IFC geometry representations. (adapted from Romanschek et al., 2019).

	IfcGeometric-CurveSet	IfcShellBased-SurfaceModel	IfcTriangulated-FaceSet (IFC4)	IfcIrregular Triangulated FaceSet (IFC4.3)
Grid	possible	no	no	no
Points	possible	no	no	no
Points and breaklines	best	no	no	no
TIN	possible	good	best	best

TIN with explicit breaklines, holes und voids	no	no	no	best
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Further developments will relate to the reading of OGC TINs (e.g. from PostGIS) and the creation of TINs using constrained Delaunay triangulation. Other structural elements (outer ring, voids) are also to be processed in the future.

5. CADASTRE AND DEVELOPMENT PLANNING

5.1 Purpose of Importing Land Information to BIM

Use case: Essential property-related data shall be logically linked with a digital building model in the BIM authoring tool (in our case Revit). This will help the designer to collect and present information on property related right and restrictions and also pre-evaluate conformance checking for building permit. Both the results of the data import and the calculation is visualized in a BAT and is available for user interaction. The property and land planning information is only needed in the close vicinity (around 500 m) for that purpose.

Land Information Deficiencies in Revit: Geospatial data cannot be imported with native Revit. This is not a purely syntactic problem because concepts between GIS and BIM are fundamentally different. The 2D geodata should be draped onto the 2.5D terrain model. In Revit, the inner area of sub-regions on surfaces must be disjunct, they must not overlap. This is of course always the case with different geographical topics such as property and land use restrictions. With our software, the Revit topographies (terrain models) are programmatically copied per theme. The user can select and deselect different topics, so that the presentation remains clear (no overlapping subregions on the terrain surface) in Revit.

Relation to IFC: The created sub-regions are exported to IFC as IfcSite or IfcGeographicElement representation. The imported or edited properties are exported to the IFC-model. An IfcPropertySet is generated for each topic. The aim is to make all relevant land information available for collaborative work in openBIM projects.

5.2 Related Work to Cadastre and Development Planning with BIM

A lot of research and governmental project are published to the topic “3D Cadastre”. A good literature overview, modelling instructions and query methods are described in Atazadeh et al. (2019). Oldfield et al. (2017) set the special focus on semantic integration of the Land Administration Data Model (LADM, ISO 19152), they use a collection of Open BIM Standards (IFC, MVD, IFC) to orchestrate this process. Investigations close to our research are published in Berlo et al. (2013). They present a promising showcase, how to check land administration regulations with BIM tools. The findings from Berlo et al. (2013) remain current until now: Modelling issues (2D spatial planning, verbal regulations) and technical issues with GML to IFC conversion are still not solved in a way that practitioners can easily

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benefit from GIS/BIM integration when checking geospatial regulations of land management authorities.

5.3 Current Research Results of the Intended Solution (Land Information)

The BIM model must already be georeferenced. The plug-in only reads and processes German data formats from cadastre (ALKIS) and land-use planning (XPlanung). These are the GML application schemes, both only in 2D. The results of the processing are lines and areas that are draped on the previously imported terrain model (DTM). All subareas are classified and attributed as individual BIM objects (Figure 6). The semantic information of the original data is now completely retained and available in the BIM project.

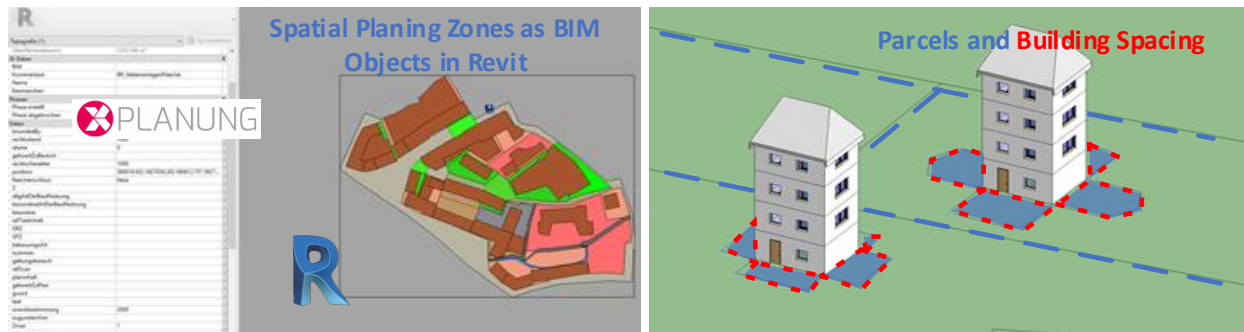


Figure 6 Spatial Planing Zones, property boundaries and calculated building spaces are now available as classified and attributed objects for BIM

So far, the developed software helps with information integration. An important step will now be the code compliance checking against the building law. Here the very special legal requirements of the federal states have to be programmed on a rule-based basis.

6. CITY MODEL

6.1 Purpose of importing City Models to BIM

Use case: City models help to take the geographic context into account when planning a new building. Aesthetics, shading and wind simulation play an increasingly important role in investment decisions. According to building law, spacing areas of building structures must not overlap. The basic information for these aspects should be integrated into the BIM and processed there. The imported city model describes the buildings in the vicinity, not the new building planned with BIM.

City model deficiencies of Revit: City models cannot be imported with native Revit. Nevertheless, Revit offers an extensive range of API commands for defining solid geometries. A major - but often neglected in the literature - difference between geospatial and BIM is the requirement for geometric quality. A deviation from the planarity of a polygon greater than $\sim 10^{-10}$ m is not tolerated in Revit.

The top semantic hierarchy level in Revit is called "Category". However, categories cannot be programmatically supplemented by the API. Therefore, the semantic depth of the geodata import remains very undifferentiated at this semantic level.

Relation to IFC: The structures in the vicinity of the planned building are exported to IFC. Due to the lack of semantics for environment models, `IfcBuildingElementProxies` are created. With the extensive pre-processing of the plug-in, parametric modelling with IFC can be used, instead of triangulation. All semantic data of the city model are transferred to IFC as `IfcPropertySets` and related to `IfcEnties` that are geometrically represented as solids or set of surfaces. Special German gml code dictionaries (roof shape, land usage) are evaluated and the dictionary entry (e.g. "residential house") is exported instead of the code (e.g. "31001_1000").

6.2 Related Work

The transformation between city models and BIM, including use cases, general concepts, transformation rules etc. are discussed academically since many years (e.g. Nagel and Kolbe, 2007). A large practical impact had the results from the Virtual Singapore projects (Stouffs et al., 2018). It showed the importance of the information cycle between BIM and GIS and also included a variety of BIM authoring tools. Also originating from this project (Jusuf, et al., 2017) present how to set up a "neighbourhood model" from IFC to CityGML with the spatial ETL-tool FME. However, our City2BIM approach is simpler and the other way around. We want to bring the city model to the BIM authoring tool. This direction/use case is underrepresented in academic literature, maybe because some software vendors support this import, at least partially. This transformation direction can also be implemented with visual programming and FME. However, our free an open source plug-in might be a good helper for small projects, where the engineers are not equipped with high-end and general purpose ETL software.

6.3 Current Research Results of the Intended Solution

The BIM model must already be georeferenced. The city model (LOD1, LOD2) is loaded via a CityGML file or a web service (here: Hosting Server from Virtual City Systems). Buildings can be imported as solids (fast) or as collections of surfaces (slower). The aim of the geometrical processing is to get a clean parametric model and avoid triangular meshing (Figure 7). Therefore, first a topological model (solid, face, half-edge, edge, vertex) is created and then the point geometry is calculated with plane intersection. If that doesn't work, it will be triangulated. If the geometry of a LOD2 model does not meet the high requirements of the BIM software for the geometric quality, a LOD1 solid is created from the footprint polygon and the height as "fallback". In addition to the building geometry, all (!) semantic data and the original GUIDs (gml.id) are included in the BAT representation.

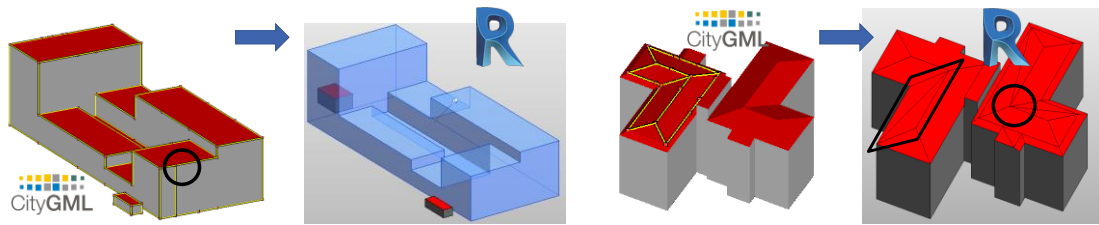


Figure 7 CityGML geometries are often slightly incorrect. The plug-in heals - if possible - these errors so that the strict numerical requirements of the Revit API can be met

The CityGML import is the most advanced part of the plug-in. Nevertheless, the many regional CityGML dialects still have to be checked. The robustness and the performance of the import can also be improved. As soon as CityGML3 is used in practice, the plug-in must be expanded accordingly.

7. MEASURED SURVEYS – CAD2BIM

7.1 Purpose of importing measured surveys from CAD Models to BIM

Use case: A model-based site plan has many advantages over a CAD drawing. The model of the (measured) outside area can be used, for example, when checking for collisions with other specialist models. In contrast to traditional CAD, object classes and attributes can be used very well for quality assurance (e.g. completeness of the attribution, consistency with information requirement specifications). For practical reasons the geodetic working method (field service, professional modelling in geodetic CAD software) should remain as unchanged as possible through BIM. Since most major CAD systems can export the dxf format, dxf was chosen as the input format for the tool.

CAD2BIM Deficiencies of Revit: Native Revit does not support CAD import with programmatically implemented object creation. However, the Revit API has many possibilities to create object templates (called “families” or “types” in Revit), objects with parametric behaviour (e.g. height of a tree), adaptive behaviour (e.g. fence along points of a polyline). The BIM-concept of layer (here seen as horizontal planes) being the dominant reference element for building components, is not very suitable for topographic objects in the vicinity of the planned building. Therefore, a layer “normal zero” (with negative height to the reference surface) is inserted by the plug-in. The height of topographic objects is either related absolutely to this “normal zero”-Layer or relatively to the interpolated height of the terrain.

Relation to IFC: At the moment the export to IFC is only implemented via the normal IFC export from Revit. A more detailed investigation into whether a separate implementation is necessary is still pending. As an experiment, the SurveyorsPlanToIfc tool was used to attempt to convert DXF to IFC directly on the data level. The use of IfcMappedItem, to reduce the size of an IFC model and establish a specific IFC object library for the vicinity’s topography turned out to be a very labour-intensive research task.

7.2 Related Work

A large number of publications on the CAD2BIM theme deal with the automatic conversion and component recognition of CAD floor plans. Our article discusses the simpler question of how classified and attributed drawing elements, which describe the topography of the outside area in CAD, can be automatically converted to BIM. Valdepeñas et al. (2020) describe the challenges for a BIM vicinity model for the conservation and maintenance activities in a harbour, also using Autodesk Revit with parametric objects. Fritsch et al. (2019) postulate a couple of BIM principles for “3D landscape objects for building information models (BIM)”, such as terrain, plants, paths and outer walls. They also differentiate between as-is-objects consumed from external geodata sources and measured objects from a topographic survey.

7.3 Current Research Results of the Intended Solution

Our solution is a supplementary tool to "objectify" site plans created with geodetic CAD and to convert them to IFC. The tools are characterized by the following functionalities: Import of CAD-layers, points, lines and above all CAD-blocks with attributes (semantic information) from dxf. The conversion is controlled via a simple Excel table that assigns certain generic BIM objects to certain layers and dxf geometry types (CAD). Dxf attribute data are transferred into Revit parameters and IfcPropertySets. The tool supports the analysis of the existing dxf file, if e.g. individual attributes do not have a BIM assignment.

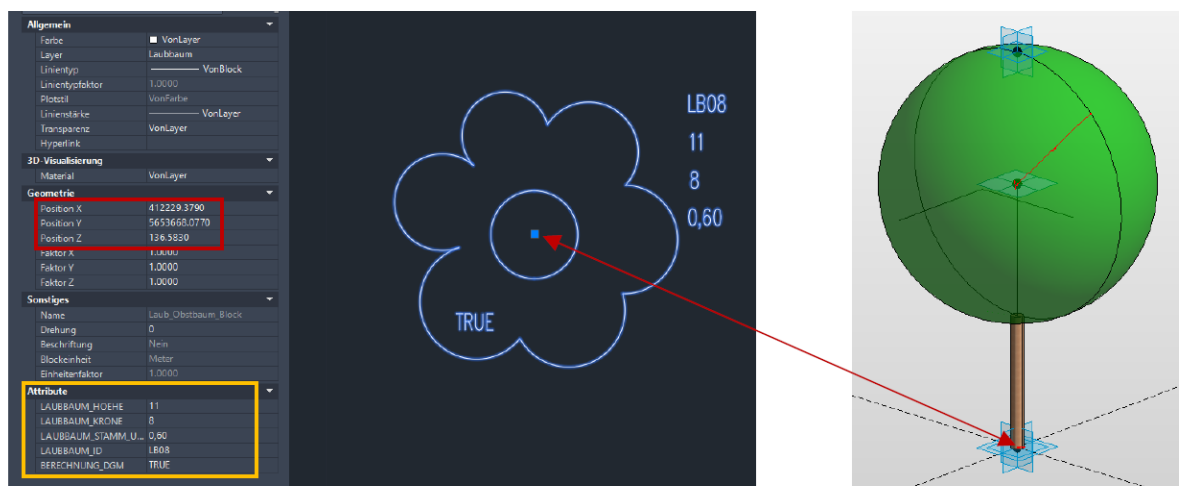


Figure 8 Georeferenced DXF-Blocks are converted to BIM Objects, using Block Attributes and an adaptive Object Type Library. The mapping rule (layer/block → BIM object type / parameter) is configured using a conversion table (Excel).

Acquisitions of the environment model can be very different. The task of an academic development can only be to show new ways of automatic BIM conversion, not to develop complete and marketable software. Our further investigations will increasingly examine the

use of parametric and adaptive components and their transition and relationship to the terrain and to the building.

8. OUTLOOK

There are still a lot of open technical tasks in the project, which has been outlined in the previous sections. At a larger strategic level, we will try to improve the software design and harmonize the individual modules so that more developers can participate in the open source project. At the same time, we will try to test and document the software better and more automatically. Internationalization will continue to be a very important point. With our contribution we hope to have made a practical contribution to the interoperability of the geospatial and BIM domains. Numerous initiatives are on the way: academic, international standardization, pre-standardization, open source and of course commercial software from large and small vendors. With international, national and regional networks theoretical knowledge must be compared with practical requirements. In the long term, and with many small steps, a lived integration of geospatial and BIM leads to a better built environment.

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