ABRIDGED REPORT

Optimisation and Evaluation of a 3D Building Data Model (IFC Standard) for Facility Management

Kerstin Hausknecht, Thomas Liebich, Matthias Weise (AEC3)
Markus Groll (ISAR1)
Rudolf Juli (OBERMEYER PLANEN + BERATEN)

KINDLY SUPPORTED BY:

Rainer Walser (Data Design Systems)
Hartmut Potreck (SMB AG)
Alwin Schauer (sMotive/EuSIS)

OBJECTIVE OF THE RESEARCH PROJECT

The management and maintenance of buildings often commences with the recapturing of already existing building data. Frequently the necessary planning data are not supplied, or not in time, or are available in differing, often unstructured formats. The goal of the research project was to reduce the resulting additional workload by means of the enhanced integration of design and facility management (FM): The basis of the project is formed on the one hand by the Building Information Modelling (BIM) approach, which brings together the required technical information in just one 3D building model, and on the other by the international Industry Foundation Classes (IFC) standard, which permits the multivendor exchange of the 3D building models and hence also their transfer to FM.

The following goals were formulated at the start of the project:

1) the incorporation of FM-relevant building data for the tendering and award of building operation services
2) the investigation and optimisation of the planning processes in order to take account of the subsequent FM processes at an early stage and to facilitate the management of the buildings
3) the conception and targeted extension of the IFC model in order to assist the operation and documentation of the buildings

These investigations were accompanied by practice-oriented tests in order, on the one hand, to document the data exchange which can already be effected today with available software and, on the other, to identify existing problems and develop suitable solutions. It is expected that the project results will give new momentum to the sensitization of the design process to the requirements of FM as well as initiate the accelerated conversion of corresponding program functions, including the associated IFC interfaces, in design and FM software. Yet it is also intended that building owners will be addressed by the project results. They may appreciate the benefits of the building models in terms of sustainable building management and thus derive precise requirements with regard to both design and FM.

IMPLEMENTATION OF THE GOALS

The following project partners were involved:

- Obermeyer Planen + Beraten GmbH (www.opb.de)
- isar1 aktiengesellschaft für planung + design + management (www.isar1.de)
- AEC3 Deutschland GmbH (www.aec3.de)

These companies covered the sectors architecture and building services engineering, FM and BIM/IFC and hence complemented each other in the project. In addition, the project was actively supported by the following companies and individuals:

- Data Design Systems GmbH (Mr Rainer Walser, www.dds-cad.de)
- SMB AG (Mr Hartmut Potreck, www.smbag.de)
- EuSIS (Mr Alwin Schauer, www.eusis.de)

Throughout the entire project period there was close cooperation and coordination with the project "*Model-based data exchange of alphanumeric building stock data (as per BFR GBestand) with the multiproduct Industry Foundation Classes (IFC) interface*" carried out as part of the 'ZukunktBau' initiative as well as with the IAI/IFC working groups *"Facility Management"* and *"Model-based quantity determination"*. Because the project goals and the work performed were coordinated, it was possible to obtain complementary project results.

The project was carried out in four work packages:

- WP1: Preparatory analysis of the technical requirements from the standpoint of the FM service provider and the designer including the preparation of a practical example
- WP2: Specification of the application scenarios and data flows with simultaneous checking of the AS-IS state of the definition and conversion of the IFC interface
- WP3: Prototypal conversion of the specification for the incorporation of the building model data into CAFM systems including assessment and reappraisal of the approach developed
- WP4: Documentation and dissemination of the results including the handing over of the requirements for standardization

To begin with, already completed preliminary work was inspected and prepared for the research project. This includes the IRB documentation guideline, the IFMA code of practice "*FM-oriented design and implementation*", the "Construction-Related Building Stock Documentation Guidelines" of the German Federal Office for Building and Regional Planning, standards for the documentation of technical installations (VDMA and AMEV), IFC specifications and finally the results of the relevant currently active IAI/IFC working groups. The identified requirements were used to prepare a sample project, which was set upby way of example as a 3D building model in the CAD systems:

- Revit 2009 (Autodesk, www.autodesk.de)
- AutoCAD Architecture 2009 (Autodesk, www.autodesk.de)
- Archicad 11.00 Release 1 (Graphisoft, www.graphisoft.de)
- AutoCAD MEP 2009 (Autodesk, www.autodesk.de)
- DDS-CAD Version 6.5 (Data Design System, www.dds-cad.de)

and transferred via the IFC interface, version 2x3, to the following CAFM systems, already equipped with IFC import:

- sMotive (EuSIS GmbH, www.eusis.de)
- GEBman (KMS Computer GmbH, www.gebman.com)
- Morada (SMB AG, www.smbag.de)

For two selected FM processes - cleaning management and maintenance - the transferred building models were finally produced as corresponding bills of quantity and cleaning and maintenance plans respectively. The test was accompanied by corresponding specifications, which were in particular intended to represent the formulated requirement in the IFC data structure. In contrast to these options is the IFC interface which, although currently implemented in the tested CAD programs, is still in an early stage of development when it comes to FM. On the basis of the architectural and technical building equipment data an attempt was made, employing very special IFC and program skills, to supplement the required FM-specific information such as general communication interface number, year of manufacture of technical installations, etc. in order to be able to test the import of data into CAFM systems as comprehensively as possible. Using this empirical experience, which constitutes a snapshot and conveys a feeling for the current status of the development, provisional conclusions were drawn on the application of the BIM/IFC approach and recommendations made with regard to its further development.

SUMMARY OF THE RESULTS

With regard to achieving the goals that were set the project has contributed to the following aspects:

- Description of the requirements placed by FM processes on the design
- Utilisation of the IFC data structure for transfer of design data to FM
- Scenarios for the incorporation and preparation of IFC models in FM
- Implementation and tests with available software and prototypes

Definition of Requirements

Parameters which have to be taken into account during the design were elaborated in terms of content for the FM processes under investigation, namely cleaning management and maintenance. The information requested for this purpose should be represented in the building model and made available to the CAFM systems via IFC. However, design and FM view the building in different ways; consequently, it is possible to observe the following differences or restrictions:

- In the case of FM the focus lies on alphanumeric values - i.e. unlike in the case of the design, the building geometry is not required or is merely of secondary importance
- The structure of the design data has to be prepared and/or supplemented for incorporation by FM Required above all is a room-centred and maintenance-oriented combination of necessary data which have not been converted consistently enough in the design phase.
- Often it is not possible to derive FM-oriented quantities (e.g. cleaning surfaces, floor-space indices) and FM-specific features (installation maintenance rates) directly from planning data; additional data are required (e.g. design regulations and manufacturer's data).

- The classification and designation (coding) of planning data (e.g. in respect of buildings, rooms, materials, etc.) do not necessarily comply with the conventions employed in FM and therefore have to be rewritten and/or supplemented accordingly.

If the requirements with regard to the subsequent management of the buildings are already available at an early stage, it is possible to prepare a lot of information during the design with only a minimum outlay and later this information merely requires a few amendments. A prerequisite is, apart from the support provided by the planning tools, an unequivocal description of the requirements which the FM and/or the building owner have to call for.

Utilisation of the IFC Data Structure

The investigations have shown that the IFC data structure does not possess any significant restrictions for an FM-oriented data transfer. The classification of features and quantities which, in the current IFC version 2x3, is still solved via a separate implementation agreement, is integrated in the data structure in the new IFC version 2x4 (with the aid of supplementary reference notes on the project).

However, the implementation of the IFC-based data exchange still requires clarification. Questions arise with regard to the correct and uniform utilisation of the necessary functional range - also in connection with the internationalisation of the IFC interface. As a result of the country-specific differences, and the employment of exclusively English terms, it is unfortunately not always possible to effect the transfer to the German market unambiguously or, as a result of differing degrees of detail, completely.

To avoid misunderstandings in the application and implementation of the IFC interface, large parts of the IFC terminology in the sectors architecture, technical building equipment, electrical engineering and building services control systems were allocated German technical terms at the beginning of the project. Especially in the field of technical installations, which is very complex and multifaceted, the application of the IFC still remains difficult, thus calling for the coordination of additional implementation agreements with the manufacturers. The translation into German is a first step in this context.

The existing need for coordination and adjustment to own requirements can be solved by means of the application of country-specific agreements and/or the utilisation of classification mechanisms. The specification prepared in the context of the 'BFR Gbestand' [1] gives an idea of what can be done here which can also be applied to other standards and guidelines. Such a, sometimes project-specific, adjustment is primarily of importance for FM as differing parameters and requirements often exist side-by-side. For this purpose IFC affords the opportunity of referring to external catalogues, guidelines and standards and thus achieves the desired flexibility.

[1] For this purpose the MVD format was employed, which is used and further discussed within the IAI and can be assimilated into the IFC specifications of the Implementer Support Group.

Scenarios for Incorporation and Preparation of IFC Models

In the project two ways of incorporating the building models are demonstrated for the conversion in CAFM systems:

- The direct import of alphanumeric data via an own IFC interface.
- The access to building models via a connection to an IFC-compatible CAD system.

The incorporation of an own IFC interface is supported by all the tested CAFM systems. As a whole the transfer of the planning data functions relatively smoothly. However, it was still necessary here to prepare and condense the information in order, above all, to utilise the element features and quantities in the own system, as these can vary depending on the requirement and the classification and/or catalogue system employed. To achieve a certain degree of automation and efficiency, configurable "mapping tables" are used which describe the representation of the information in the own format. As a result the data import is adaptable to differing requirements and sending systems and hence very flexible. This type of implementation is considered to be trend-setting because, in this way, it is also possible to solve the problem of the country and/or project-specific requirements versus generally applicable standardisation relatively simply and largely without alterations in the program code.

As a rule only a comparatively small part of the building model is of interest for the import of the planning data. Yet building models can be very extensive (easily several 100 MB), so the pre-filtering out of the required data often makes sense from a technical standpoint or is desirable for reasons of access rights. The effectiveness of an FM filter was tested by way of example with the aid of the GMSD procedure developed at Dresden Technical University. Applied to the sample project, it was possible to create an IFC model subset consisting exclusively of alphanumeric FM data which, instead of 1.4 MB, had a size of only 37 KB (2.6%). The processing of such a file - reduced to the bare essentials - is much more efficient in the import into CAFM systems.

Besides the direct import of IFC models, access via a CAD system is also possible. While this involves a connection to a particular CAD system, it can, provided the CAD system supports the multivendor IFC interface, be employed just as universally. Where particular program functions are used (e.g. access to ground plans for cleaning management) and the CAD system is employed by the FM planner anyway, this method can offer advantages compared to a direct IFC import.

The transfer of the planning data into the CAFM system, finally, constitutes the starting point for the subsequent, program-specific condensation of the data into operator BoQs. Once the model data have been transferred, then, the FM planner can immediately begin his actual task and is no longer preoccupied with the collation and re-entry of the planning data.

Implementation and Tests

A realistic sample project was elaborated with current CAD and CAFM systems in order to test both the creation of the 3D building model and the incorporation of the data. Both steps were documented in a test table and permit conclusions to be drawn as to their degree of suitability for practical operation.

The implementation of the BIM approach and corresponding IFC interfaces is still characterised by a number of gaps compared to the theoretical possibilities. At present the greatest restrictions occur as a result of the as yet incomplete support of the required FM parameters and the partly still insufficiently user-friendly application of the IFC interface. Some of the tested CAD programs also display marked differences with regard to the functional range and quality of the IFC models, which means it is not possible to make generalized statements. Moreover, the programs are being constantly extended and this has, in particular on the CAFM side, led to considerable advances within the project period. It is however discernible that in the field of architectural CAD, which has hitherto been the main focus of the development, there are only a few complaints. In the field of process engineering, on the other hand, the necessary richness of the IFC specification was so pronounced that even the description of the test requirements was not always unequivocal and was the subject of controversial discussions. Accordingly, a greater number of possible solutions is to be expected, which will complicate the import of the information. The longer experience in the field of architectural CAD, and the implementation agreements successively reached for this purpose, which are also part of the IFC interface certification[2], have a generally positive impact, although here too restrictions are to be anticipated with regard to FM-specific requirements.

One central requirement which is unfortunately not always met is a consistent room reference[3] for the plant and equipment; this would enable the data exchange to be reliably effected on a purely alphanumeric basis. Here, too, the IFC data structure provides several possibilities, so the recipient should as a matter of principle check the various options and plausibility of the imported data. In order not to overlook relevant FM data here, it is necessary to reckon with missing room references and to react accordingly during the import.

EVALUATION OF THE RESULTS

The project results show that the planning data required by FM can be concentrated in a "3D building model" and successfully transferred to FM processes via the IFC format. Many factors have to interact for this to be achieved. Under the premise of a BIM-based planning, the tools required for this purpose, a generally accepted data interface for the transfer of the planning data, through to the corresponding condensation and preparation routines for the incorporation of the data, each of these factors is important and can have a negative influence on the overall result. Although already more or less entirely utilisable today, given appropriate technical knowledge, there are still a number of partly critical weak points in this chain which have to be removed in order to ensure a promising application. This can be accomplished if not only the theoretical possibilities, but also the limits and risks are known. Against this background it is important, first, that the project partners are introduced to a BIM-based working method and, then, to continuously improve the individual factors as well as the overall result.

[2] The certification only takes place for part of the IFC model, the so-called Coordination View.

[3] A room reference embraces not just rooms in the strict sense of the term, but also spatial structures such as storeys or zones.

Despite all the restrictions, the results obtained in the tests are very promising in consideration of the multitude of factors involved. It would only take a limited number of straightforward further developments to resolve many of the problems that have occurred in a satisfactory manner. However, a reliable data transfer certainly presupposes control and correction possibilities so as to gain, if nothing else, the trust of the users. With the incorporation of the building structure, including the rooms and clearly defined base quantities, a practical application is already perfectly conceivable today and can hence constitute an initial, auspicious step. The exchange of technical installations, on the other hand, cannot be recommended yet, since the necessary prerequisites on the part of the program manufacturers are not yet completely given. Provided appropriate technical knowledge is available, though, it is also possible to transfer a considerable amount of information here too.