

Model Based Data Exchange of Alphanumeric Facility Management Data (according to BFR Building Inventory) with the Product-Neutral Interface Industry Foundation Classes (IFC)

Short version, November 15, 2008

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Short Version

Purpose of the Research

On the basis of the IFC (Industry Foundation Classes) building information model (BIM) and the “IFC View Facility Management Inventory Data” defined in 2006, product-neutral exchange of Facility Management (FM) inventory data covering the scope of the German BFR GBestand (Architectural Guidelines Facility Management Data Documentation) was first implemented and tested in practical pilot studies. In particular, the possibilities of reproducing catalogue references for external catalogues in the IFC structure were examined. The handling developed for catalogues should make it possible to exchange differing catalogue content in data exchange between two CAFM systems.

It is expected that developers of construction software will implement the “IFC View Facility Management Inventory Data” in their products and make them available to the market. This interface should significantly reduce the effort of exchanging electronically-produced planning and inventory records between those involved in construction, building users, and facilities managers.

Implementation of the Research

First the technical requirements were researched and defined to supplement the specifications in the “IFC View Facility Management Inventory Data”. Essential determinations for access to external catalogues in the IFC structure were made and specified for individual FM catalogues. Further, the specific FM items/attributes were assigned to the corresponding IFC structures and documented as the basis for the concrete data exchange project.

Once clear identifiers were established for use in the research project for the provided FM catalogues (building type catalogue, types of use under DIN 277-2, attribute/characteristic catalogue, article/fittings/fixtures type catalogue), they were formatted in Excel data format according to a uniform structure. At the same time, the decision was made to specify the FM catalogue within the framework of the research project as an XML catalogue and make it available to the market. For this purpose, the development of a uniform XML schema was necessary, which was developed in coordination with those responsible at IAI (International Alliance for Interoperability). On the basis of this schema, any hierarchical catalogues can be reproduced and exchanged according to the same logical structure.

For the implementation of the software (SW) test, a test plan was developed in which the test scenarios were planned with the necessary work steps, responsible positions, and deadlines. This test plan was coordinated with the participating SW companies and afterwards used as the uniform basis for the SW tests of IFC data exchange. For each test, a separate questionnaire was developed in which the SW companies documented the progress and results of the test. The evaluation of these questionnaires took place at the end of the research project and was prepared in the form of test reports for each SW company.

The test data was recorded using the internet-based CAFM software “Morada” as a reference system. First, examples of test data were recorded and exported in this software, so that they could be available to the other SW companies to test the IFC Import Interface. Testdata1 contained one site, one building, two floors, and 20 rooms with the

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attributes/characteristics required by the BFR GBestand and the catalogue references to the DIN 277-2 types-of-use catalogue for the rooms. For Testdata2, the available Testdata1 was supplemented with catalogue references from the building-type catalogue and the fixtures required by the BFR GBestand (windows, doors, radiators, wall, floor and ceiling coverings) and their attributes.

On the available IFC Export Interface, the test data were exported in the form of ifcSTEP (SPF) and subjected to a quality inspection, in which the IFC data were checked according to the specifications. The quality inspection of the exported test data led to numerous extensions and improvements of the IFC Export Interface in the reference system. At the same time, corrections were undertaken to the IFC data, which were documented together with explanations of the quality inspection and other commentaries.

The IFC Import of Testdata1 was tested by five SW companies and took place on the assumption that the same catalogue would be used in the receiving CAFM system as in the sending system. The IFC Import of Testdata2 was tested by three SW companies and also carried out with the same catalogues. The IFC export of FM data with fixtures and any catalogues was undertaken by one SW company.

The use of different FM catalogues in the sending and receiving CAFM systems could not be tested, because the functionality necessary to do so was not implemented in any of the available IFC interfaces.

Summary of Results

1. Clear Specifications

To carry out data exchange of alphanumeric descriptive data on the basis of the “IFC View Facility Management Inventory Data” the following specifications must be considered in the order provided:

1. IFC Version 2x3
2. IFC Coordination View (2x3)
- 3. IFC View Facility Management Inventory Data (2x3)**
4. project-specific specifications with concrete assignment of FM content to the IFC structure.

CAFM systems can develop interfaces based on the “IFC View Facility Management Inventory Data” which also write and/or read either the geometry or only the alphanumeric data. The basic structure of the IFC data is essentially the same in both cases. Basically, it is assumed that all generally-valid specifications for the exchange of FM inventory data are contained in the “IFC View Facility Management Inventory Data”. In concrete data exchange, they must be supplemented with additional project-specific specifications and the concrete assignment of individual FM contents to the IFC structure.

Rules for Use of *Name*, *LongName* and *Description*

Most FM-relevant IFC items have the attributes *Name*, *LongName*, and *Description*. These fields should be used according to the following logic:

- *Name*: Number/text for logical identification of an IFC item.
- *LongName*: Identification of the IFC item (e.g., room identification: “Office”).
- *Description*: comment field for an IFC item (e.g., “without light”).

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Rules for Use of Project Specific Quantities

The conclusion from the existence of BaseQuantities that a fundamental distinction should be made between “quantity attributes” and “non-quantity attributes” within the IFC and that they should be related to project-specific attributes was assessed negatively through the experience of the research project. Such a distinction could only function if there were a general rule for distinguishing. Since no generally valid rules exist for distinguishing between “quality attributes” and “non-quantity attributes,” there should be no definition of **project-specific** “IFC quantity attributes” (e.g., BFRQuantities).

Room or space references for Fixtures [an Ausstattungen]

Since a room or space reference plays a central role in reproducing fixtures in the CAFM systems, in the future, the “IFC View Facility Management Inventory Data” should require that, for exchange of FM data, all fixtures should be exported with an assignment to a spatial structure (site, building, storey, space). For provision of FM data from CAD systems, corresponding rules for spatial assignment of fixtures (e.g. walls) should be defined.

2. Concept of the Interface

The IFC interface should be designed in such a way that project-specific specifications, such as assignment of FM items/attributes to IFC structures, create no additional programming effort. Because new FM items/attributes can continually be named in project specific specifications, which leads to a new user-specific definition of features (Psets) and attributes in IFC (e.g., Pset BFR_Xxx), the functionality for creating and using user-specific Psets and their attributes should be implemented flexibly in the IFC interface.

3. Access to External FM Catalogues

In IFC data exchange, it is assumed that catalogues and their contents are prepared and exchanged between the sending and receiving systems outside the IFC file. Only the clear, identifying keys of the catalogue references used (as a rule, the sending system) are transferred in the IFC file.

As part of the research project, agreements were made for basic access to external catalogues and for concrete reproduction of individual FM catalogues in the IFC structure, and they were documented as project-specific requirements. These stipulations are generally valid and should therefore be integrated into the “IFC View Facility Management Inventory Data”.

The following catalogues are relevant to FM data exchange, and basically possible:

- classifying catalogues, such as building type catalogues and types of use under DIN 277-2,
- article/fixture type catalogues,
- attribute/characteristic catalogues.

For the classifying catalogues and the article/fixture-type catalogue, any number of catalogue references can be defined. For this, the constructs *IfcClassification Reference* and the classification table *IfcClassification* are used, through *IfcRelAssociates Classification*.

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In the current IFCVersion2x3, catalogue references for attribute/characteristic catalogues can only be transferred in the description field of the respective IFC attribute, which must however be seen as an interim solution. Starting with IFC-Version2x4, catalogue references for attribute/characteristic catalogues will also be referenced through a classification structure.

Establishing Catalogue Names

GUID (Global Unique Identifier) of catalogue entries are urgently needed for IFC data exchange. It is assumed that clear identifications of catalogue entries within a catalogue are created as the responsibility of the catalogue producer and are available. Consequently, the global clarity of catalogue entries of many different catalogues can be produced by the assignment of globally clear catalogue names.

The following GUIDs and names were established and used for German FM catalogues within the research project:

GUID	Catalogue name	Version	Description of the Catalogue
ed7a13cf-b5f9-460c-8e03-5681360bd69a	D_RBBau_Katalog_GTyp	Version 18 RBBau 2006	RBBau building type catalogue (for federal buildings) <u>Publisher:</u> BMVBS, RBBau
f45f16bc-c133-41db-af9e-aa762b5d46bd	D_DIN277-2	Version 2005	DIN277-type of use catalogue <u>Publisher:</u> DIN
7240e63d-2449-4ff7-9649-cf46774dcb67	D_BFR-Merkmalkatalog	Version 6 from June 24, 2003	Attribute/characteristic catalogue for federal properties <u>Publisher:</u> IuD Office in BBR Berlin
871beac3-84a4-49a6-b632-697b701bc7e4	D_BFR-Artikelkatalog	Version 6 from June 24, 2003	Article/Fixture type catalogue for federal properties <u>Publisher:</u> IuD Office in BBR Berlin

Illustration: 3-1 Establishment of uniform catalogue names

The clear GUIDs and catalogue names must be included in the XML file of the respective FM catalogue. For this purpose, in creating XML files, GUIDs are generated; they should be managed in future by a basic IAI rule.

4. Mapping Different FM Catalogues

For different FM catalogues under one type of catalogue (e.g., the attribute/characteristic catalogues) of the sending to receiving system, the assignment of catalogue entries should be done through mapping tables that are provided, assuming an assignment that fits content and a 1:1 assignment of the catalogue references in it. If this 1:1 assignment in the mapping table cannot be assured, no assignment of different catalogue entries is possible.

In assigning the tested BFR catalogue references to the Bavaria catalogues, it was found that mapping catalogue entries varies greatly depending on type of catalogue. For the attribute/characteristic catalogues, we can assume a possible 1:1 assignment. Either the sent attribute/characteristic exists in the receiving system with the logic described (data type, measurement, semantic meaning), or it must be created on the basis of the sent information. For the article/fixtures type catalogue, this logic cannot be achieved, since, depending on the view of the catalogue producer, catalogue entries can be structured and defined very differently, and therefore m:n linkages frequently exist.

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Mapping of catalogue entries from various catalogues can, however, only occur if a 1:1 assignment is present in the mapping tables. Therefore, it must be assumed that practical implementation for attribute/characteristic catalogues seems more likely than mapping of article/fixture types. In both cases, the catalogue entries to be exchanged for the mapping must be examined, assessed and assigned within the framework of project-specific coordination.

5. Recommendations on IFC Reproduction Structure of Attributes/Characteristics

For data exchange of attribute/characteristic values, in addition to the names, the data types that go with them, and the attribute's available measurements, the definition and rule for calculating the attribute/characteristic value are important. This information must agree overall if an attribute/characteristic is to be correctly exchanged between the sending and receiving systems. Therefore, the following process is recommended:

- The available, generally valid IFC properties (common) should always be applied if the identifier, data type and measurement agree.
- The available quantity-based properties (*IfcElementQuantity*/"Base Quantities") should always be used when, in addition to identifier, data type, and measurement, the definition and calculation rule agree with the applied attributes/characteristics of the CAFM software.
- Project specific properties (e.g. BFR_XXX) should only be defined and used if the generally available IFC properties (common) and the available quantity-based properties (*IfcElementQuantity*/"Base Quantities") are not suitable to reproduce the characteristics used in the CAFM software.
- Project-specific quantity attributes (e.g. "BFRQuantities") should not be defined.
- The description field of the respective IFC attribute in Version 2x3 should always be used to reproduce and transfer the catalogue reference (usually the sending catalogue) of an FM attribute within the IFC file.

Conclusion

1. For future IFC data exchange, the necessary FM catalogues (RBBau building type catalogue, DIN 277-2 type of use catalogue, characteristic catalogue and article catalogue from the BFR GBestand) will be generated as **XML catalogues**. For this, the definition of a uniform **XML schema** was necessary. This schema was developed for the German-speaking world and describes a uniform logical reproduction structure for hierarchical catalogues. The schema and the XML catalogues from the BFR GBestand will be made available in the future free of charge at www.iabi.eu.
2. For further IFC exchange of catalogue information, it is urgent that clear **GUID for catalogue names** will be established within the IAI. For this purpose, the German-language chapter of the international IAI should submit a proposal in which the GUIDs and the catalogue names of the IAI working groups "Model Based Quantities" and "Facility Management" are reserved.

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3. In addition to the “IFC View Facility Management Inventory Data” there is a basic need for IFC exchange of FM inventory data to agree upon additional project-specific specifications, with concrete assignment of FM data to the IFC reproduction structure, and that it be documented for data exchange. This additional need for coordination can become an obstacle to practical data exchange and hinder the distribution of the IFC interface. At the moment, however, there is no attempt at a solution for the elimination of a need to coordinate in a concrete data exchange project.
4. Within the framework of the research project, the following problems became apparent; they can be eliminated through **expansions in the IFC model (after 2x4)**:
 - Clear identification and definition of IFC attributes through introduction of the International Framework for Dictionaries (IFD).
 - Reproduction of catalogue references for attributes/characteristics in a defined IFC structure that makes possible references to a classification structure (not in the description field)
 - Integration of the developed XML schema for hierarchical catalogues into the IFC data model, so that an internationally valid XML schema for catalogues exists.
5. The following agreements should be added as supplements to the **“IFC Coordination View”**:
 - stipulation of the semantic meaning of the attributes Name, LongName, and Description and supplementing the documentation with explanations and examples.
6. The following stipulations should be added as supplements to the **“IFC View Facility Management Inventory Data”**:
 - Stipulations for basic access to external catalogues and to concrete reproduction of individual FM catalogues in the IFC structure, documented within the framework of the research project as project-specific requirements.
 - The recommendation that no project-specific “IFC Quantity Attributes” (e.g. BFRQuantities) should be used.
 - The recommendation that simple hierarchically classifying catalogues be reproduced both as “project specific IFC attributes” and as “classifying catalogue entries (*IfcClassificationReference*).”
 - The urgent requirement for IFC export that fixtures always be exported with an assignment to a spatial structure.
 - The recommendation that, for IFC export, the essential criteria for typification of FM articles/fixture types be exported into the IFC file as additional IFC attributes (e.g., “type of material” and “type of construction”).
7. **The research project showed that the extent of the data of the BFR GBestand can be successfully implemented with the “IFC View Facility Management Inventory Data” and that catalogue references from external FM catalogues can be transferred.**