

# Implementation of IFC, IfcXML and IfcXML Property Set

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## Abstract

The designing of the Industry Foundation Classes (Ifc) is fully determined to the exchange of data between various CAD tools. The main prospective behind writing of this paper is to understand the architecture of Ifc, IfcXML and the collaboration of IfcPropertySets with IfcXML. The IfcXML is able to gather the full information about the project is provided with. Hence for an optimal development of the project Ifc is best suited. IfcXML is compatible with the Building Information Modeling (BIM). since the main goal of making the Ifc was the variation among the different languages of Architecture, Engineering and Construction (AEC). Thus to provide a common sharable platform to AEC for the better development of the building Ifc was made, in which Building Information Modeling (BIM) allows data related to buildings design, construction and operation to be created and accessed by all of the project stakeholders.

*Keywords:*

BIM, IFC, IFCXML

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## 1. Introduction

Data transfer between Two Dimensions Computer Aided Design (2dCAD) tools started in the late 1970s and early 1980s. NASA initiated the first attempt to establish a single public exchange format developed by Boeing and General Electric which resulted in the initial graphics exchange Specification (IGES)[1]. In the past format of the file and the semantic content were separated which was then changed by IGES in ISO STEP data modeling language EXPRESS[2, 3, 4, 5, 6].

This language describes the product modeling technology and schemas such as IFC and the CIM Steel Integration, version 2(CIS/2). Extensible Markup Language (XML) is another language used as a base for schemas.

Some Features Of XML Schemas

- Public or proprietary
- Part of the document that is being exchanged or defined externally[1].

- Direct links between software is established[7, 1].
- Generally robust and developed specifically for the software in question
- Rely on application programming interface (API) to write data from initial tool to target tool.
- Standardization efforts In international framework for dictionaries IFD, the OMNiclass construction classification system and the construction operations building information exchange (cobie).

### 1.1. ISO Step

Data models like IGES and the Drawing exchange Format (DXF) were used to transfer data (2d and 3D geometry) between applications before the adoption of BIM. But file exchanges became too complex and large with the growth of the need to transfer more semantic data about various systems. The EXPRESS language was a product developed as a result of this issue from the Standard for the Exchange of Product Model Data (STEP), number ISO-10303 formed by the Technical Committee (TC184) and a subcommittee of the International Standards Organization (ISO). This language was used in a large number of domains. The EXPRESS-G language was then developed as a graphical version

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.ifc	IFC data file using the STEP physical file structure according to ISO 10303-21. The *.ifc file shall validate according to the IFC-EXPRESS specification. Default IFC exchange format.	
.ifcXML	IFC data file using the XML document structure. It can be generated directly by the sending application, or from an IFC data file using the conversion following ISO 10303-28, the XML representation of EXPRESS schemas and data.	
.ifcZIP	IFC data file using the PKzip 2.04g compression algorithm (compatible with e.g. Windows compressed folders, winzip, zlib, info-zip, etc.). It requires to have a single .ifc or *.ifcXML data file in the main directory of the zip archive.	

Figure 1: Formats of IFC[11].

to facilitate better readability for users. The several building related product models developed by STEP are [6, 8, 9, 7]:

- STEP Application Protocol 225 (AP225)
- IFC
- CS/2

### 1.2. Industry Foundation Classes (IFC)

IFC is a standard that describes the whole buildings life cycle. It is widely used to exchange data by most BIM authoring tools. It is developed by buildingSMART international (BuildingSMART international ltd. 2013a) which was earlier known as international alliance for interoperability (IAE). IFC is often called Information for construction. It is registered with ISO as ISO :16739.

The IFC data model is object oriented hierarchical, and composed of several schemas[6, 4, 10]. The architecture principle is based on IFC architecture which consists of four layers[11, 12]:

- The Resource Layer : This layer being lowest of all holds the concepts which described properties like geometry, material, quantity, date, time, cost.
- The Core Layer : The second layer contains the kernel and core extensions.
- The Interoperability Layer : The concepts that are common in a range of industries or applications are contained in this layer.
- The Domain Layer : The highest layer contains concepts specific to individual domains and applications.

IFC Release	ifcXML Release	Methodology	Notes
IFC1x	ifcXML.1x	IAI's own EXPRESS to XSD conversion rules	Outdated, shall not be used any longer
IFC1x2			No official ifcXML release
IFC1x2 Add1	ifcXML.2x2	Part28 ed.2 CD level RC2	now obsolete, final release published
IFC1x3	ifcXML.2x3		Part28 ed.2 CD level
IFC1x3 TC1	ifcXML.2x3		Identical to IFC1x3 on EXPRESS level, therefore ifcXML.2x3 is used for IFC1x3 TC1

Figure 2: Describing latest versions of ifc[12].

#### 1.2.1. Document conventions

Extracts from schemas and files are presented in Courier New[4].

- Hyperlinks are colored blue for example <http://www.w3.org/2001/XMLSchema-instance>.
- IFC entities are colored blue for example IfcSpaceBoundary.
- IFC properties and attributes in running text are quoted for example Longitude.
- IFC data is shown in bold and in red for example.

```
<IfcOrganization id=i1650>
<Name>Graphisoft</Name> </IfcOrganization>
```

Examples of complete files follow the following convention:

Green	:	Directives
Red	:	Attribute names
Brown	:	Entities
Blue	:	Structured mark-up
Black	:	Data

Table 1: Convention

For compatibility with IFC standards, spelling is American English. Only elements taken directly from the ISO/STEP standard 10303 are spelled in British English.

#### i. Why IfcXML should be used over IFC?

IfcXML has a marvelous advantage of extensible markup language (XML) which is used to carry the data. XML is used for carrying the data not for displaying the data[2, 4, 10]. So attaching XML with IFC gives the IFC a superb platform of carrying the data from



GlobalId	OwnerHistory	Description	Name
<ul style="list-style-type: none"> <li>• Assignment of a globally unique identifier within the entire software world</li> </ul>	<ul style="list-style-type: none"> <li>• Assignment of the information about the current ownership of that object, application, local identification and information captured about the recent changes of the object, NOTE: only the last modification is stored.</li> </ul>	<ul style="list-style-type: none"> <li>• Optional description, provided for exchanging informative comments</li> </ul>	<ul style="list-style-type: none"> <li>• Optional name for use by the participating software systems or users. For some subtypes of IfcRoot the insertion of the Name attribute may be required. This would be enforced by a where rule.</li> </ul>

Figure 5: : Description of IfcRoot.

defines the relationship defined by *IfcPropertySetDefinition*. *IfcPropertySetDefinitions* defines the *IfcPropertySet* which has properties as *IfcProperty*. *IfcProperty* demonstrates the description optionally which is defined by the *IfcRoot*, contains couple of different properties such as *IfcComplexProperty* and *IfcSimpleProperty* (fig 8).

### 2.1. Defining Property set

Properties can be defined by model maker of building[6]. In market there are numerous types of softwares available which claim for the best output by their software. There are following famous and mostly used softwares available.

- Archicad developed by graphisoft.
- Revit by AutoDesk

These are the two dominating software. Here for making a model ArchiCAD is used in which the properties of the model as new ifc properties are defined.

### 2.2. IfcPropertySet

Definition: The dynamically Extensible properties are defined the *IfcPropertySet*. It behaves like a property set which structures a property tree to contain the properties which can be diversified according to their names. Property sets are dedicated to objects (*IfcObject*) through a objectified relationship i.e. *IfcRelDefinedByProperties*. It can be assigned to set of object by a single instance of *IfcRelDefinedByProperties* (shared property sets).

END_ENTITY	Unit
<ul style="list-style-type: none"> <li>• It holds the Value and measure type of this property.</li> <li>• That is selected from the SELECT <i>IfcValue</i>, the appropriate unit can be found within the <i>IfcUnitAssignment</i>, defined for the project if no value for the unit attribute is given as</li> <li>• This attribute is made optional in the ifc 2X3 addition</li> </ul>	<ul style="list-style-type: none"> <li>• Unit for the nominal value, if not given, the default value is used as defined by the global unit assignment at <i>IfcProject</i>.</li> </ul>

Figure 6: Description of IfcPropertySingleValue.

A property set consists one or more properties which could be single valued (e.g. string, numeric, unit of measurement), a bounded value (having limits MIN and MAX), an enumeration, a list and table of values or a data structure. While IFC describes about several hundred property sets for specific types, custom property sets defined by application vendors or by end users.

#### 2.2.1. IfcPropertySingleValue

- ENTITY : *IfcPropertySingleValue*
- SUBTYPE OF : *IfcSimpleProperty*
- NOMINAL VALUE : *IfcValue*(Optional)
- UNIT : *IfcUnit*(Optional)

#### 2.2.2. IfcRelDefinesByProperties

- ENTITY : *IfcRelDefinesByProperties*
- SUPERTYPE OF : *IfcRelOverridesProperties*
- SUBTYPE OF : *IfcRelDefines*
- RelatingPropertyDefinition : *IfcPropertySetDefinition*

## RelatingPropertyDefinition

- Holds the reference to the property set definition for that object or set of objects for a give property set

Figure 7: Description of IfcRelDefinesByProperties.

## HasProperty

- Has properties Contain set of properties for property sets defined as part of the IFC Object model, the property objects within a property set are defined as part of the standard. If a property is not contained within the set of predefined properties, its value has not been set at this time

Figure 8: Description of IfcPropertySingleValue.

### 2.2.3. IfcPropertySet

- ENTITY : IfcPropertySet
- SUBTYPE OF : IfcPropertySetDefinition
- HasProperties Of : IfcProperty
- IsDefinedBy : IfcRelTemplatesPropertySet
- WHERE
- WR31 : EXISTS(SELF IfcRoot.Name)
- WR32 : IfcUniquePropertyName(HasProperties)

### 2.3. Assigning Values To Existing Psets Of Model

- Checking the Fire Rating checkbox that represents the IfcLabel.

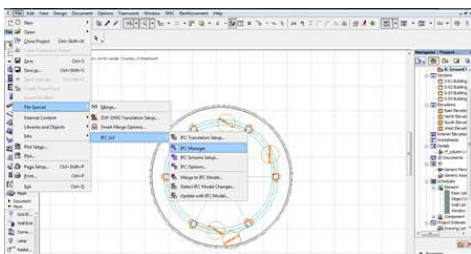


Figure 9: Snapshot Example opening a file in the software as and then doing as following for setting the psets to an existing model.

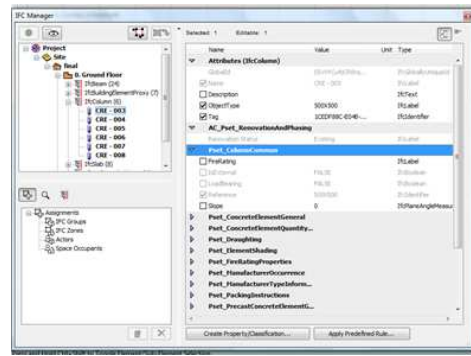


Figure 10: Snapshot Example the Ifc Manager prompts out with Psets .for existing model supposed Pset ColumnCommon is set of IfcColumn

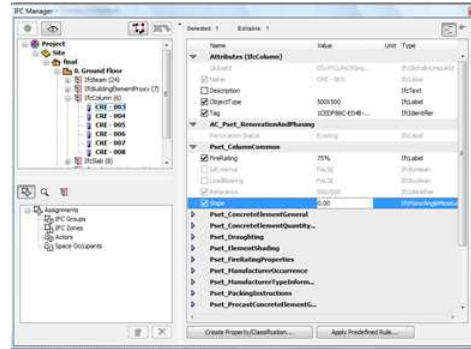


Figure 11:

- Checking the slope checkbox which value would be stored into the IfcPlaneAngleMeasurement.

## 3. Conclusion

This system demonstrates the use of the IFC and IfcXML schema in providing access to external building information. Specifically it illustrates the efficiency to define manufactured models as property sets and a generic mechanism for searching for models against the values of their attributes with the help Ifcroot property sets.

This IFC model is drastically evolving and there is keen anticipation of getting more comprehensive and enhanced features in forthcoming releases of the IFC model. Thus for the betterment of future the development of the IFC model is mandatory.

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