

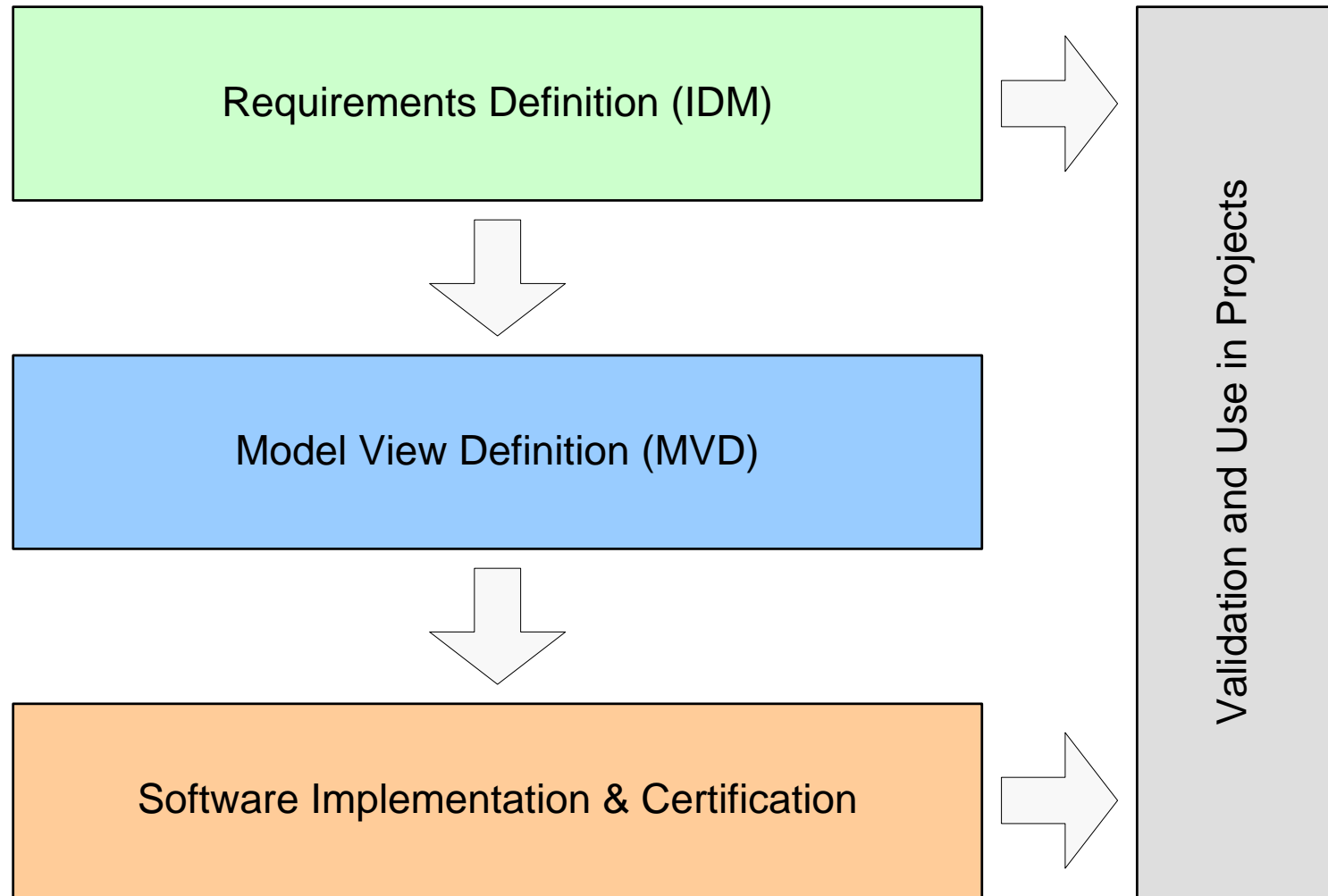
construction operations building information exchange (COBIE)

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Director, AEC3 Ltd

IFC – COBIE Mappings

- (1) IDM for contracted data exchanges
 - Exchange requirements
 - Function Parts
 - Business rules
 - (2) MVD for FM View
 - Plus local rules
 - (3) Partial schema
 - Part of ifc2x3
 - (4) Working document
 - Spreadsheet with options and alternatives
 - (5) Published tolerant transformations
 - IFC->COBIE
 - COBIE -> IFC
-

IDM/MVD Overview



(1) Information Delivery Contract

Functional Part

Name	Control Service Life		
Identifier	xxx	IFC Release	IFC2x2 Addendum 1

Change Log

2006-09-29	Created	idm@bentley.com
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Overview

The service life of an element is an appropriately reliable estimate of its durability in service. It describes the length of time that an element may be expected to perform its required function including the provision of any material, component, assembly or system maintenance or replacement that may be required.

An element may be an assembly or systematic grouping of other elements each of which may also have their own service life assessment. Within IFC, any subtype of IFCProduct may have a service life assigned as also may groups that are assets or systems.

Within the service life of a containing element (such as a building), the service life of contained elements may be significantly less and therefore such items may need to be replaced within the containing element lifecycle. Service life planning may need to include projections of the needs for, and timing of, element replacement and end of life recovery.

These facts may all be used to determine life cycle cost profiles and estimate whole life costs. It is also information that informs environmental assessment. Service life planning is increasingly being linked with sustainable development and wholelife value.

Service life may be assessed in various ways depending on when doing the assessing and the purpose of the assessment. There can include:

- Actual Service Life** The service life that an artifact has given.
- Design Service Life** The period of time during which the artifact is expected by its designers to work within its specified parameters; in other words, the life expectancy of the item.
- Estimated Service Life** The service life that an artifact is expected to have under current operating conditions.
- Optimistic Service Life** The best or most optimistic estimate of service life that is quoted for an artifact under reference operating conditions.
- Pessimistic Service Life** The least or most pessimistic estimate of service life that is quoted for an artifact under reference operating conditions.
- Reference Service Life** The typical service life that is quoted for an artifact under reference operating conditions.

Service Life Factors

Service life planning is typically carried out using a factor method such as is defined in ISO 15686. This is based on the assumption that several parameters have an impact on the service life of an artifact. These factors are:

- A= Quality of components e.g. natural durability or preservative treatment
- D= Design level e.g. protection by design
- C= Work-execution e.g. joints gaps

D= Indoor environment e.g. temp., RH, condensation
 E= Outdoor Environment e.g. climate, driving rain, shadow
 F= In use conditions e.g. wear, mechanical impacts
 G= Maintenance level e.g. revisions, repainting

These parameters are brought together in the following general formula:

$$ESL = RSL * EAB.C.D.E.F.G$$

Where:

- ESL = estimated service life
- RSL = reference service life

The function involved may be a simple multiplication, but in many cases the parameters may be interdependent, and more sophisticated combinations may be necessary. The parameter values may also be probabilistic in nature.

The ISO factor method is fully explained in ISO 15686, which should be consulted for a broader understanding.

Reference

<http://www.bentley.com/topic/iso-15686>
 ISO 15686 Buildings and constructed assets - Service life planning (published parts)

Suggested modifications to IFC model and documentation

- Model currently refers to 'Expected Service Life'. This should be changed to 'Estimated Service Life'.
- Design Life should be introduced as a 'Service Life Type'.
- ICServiceLifeServiceLifeType should be changed to PredefinedType to be similar to other type specifications.
- This will also allow a USERDEFINED NOTDEFINED addition to the ICServiceLifeTypeSet.
- ICServiceLifeServiceLifeFactors is an IFCMeasure which is specified as a real value that is normally measured in seconds. Typically, service life (or mean time between failure) may be measured in much larger units (months/years for a typical building or building component). This fact has to be either dealt with in software (currently as indicated) or as an alternative approach to measuring time measure determined for IFC.

Results

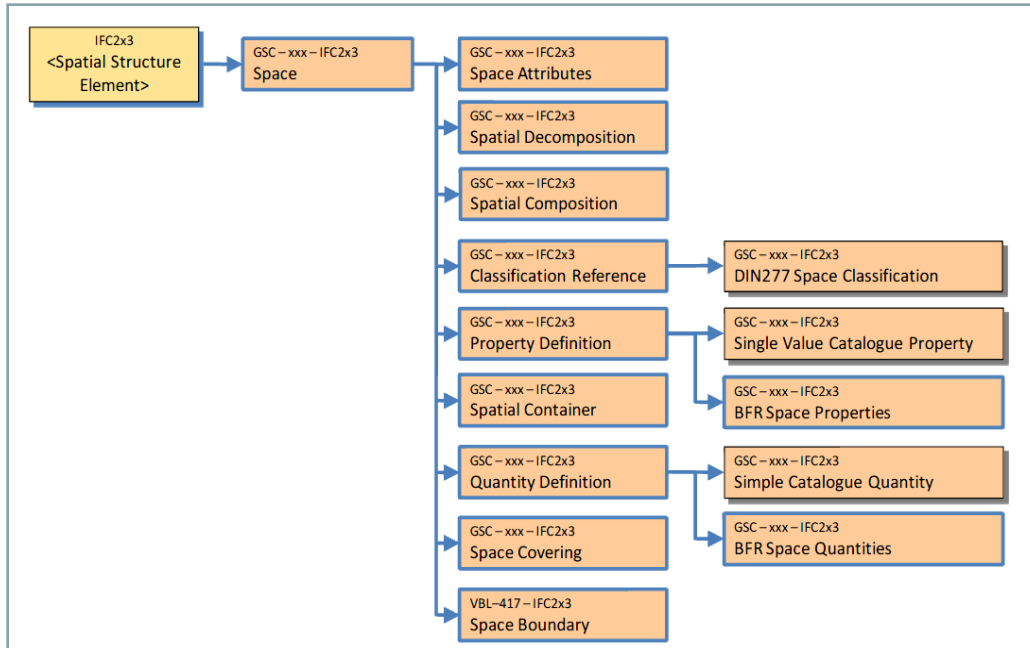
A service life specification is assigned to an artifact. Note that there are several types of service life that may be defined and it is possible to assign a mixture of more than one type of service life to a particular artifact (so that, for instance, both design life and expected life may be captured).

Information Needed	Entity/Port/Functional Part	MAN	RFC	OPT
CONCEPT: Control the service life of a product type or an occurrence of a product				
This is the assignment of a service life value to an instance of a product type or to an individual product occurrence as defined within the product structure of the IFC model. It may be a constructed or assembled product such as a building, storey or a building or a physical product such as a pump or a window.				

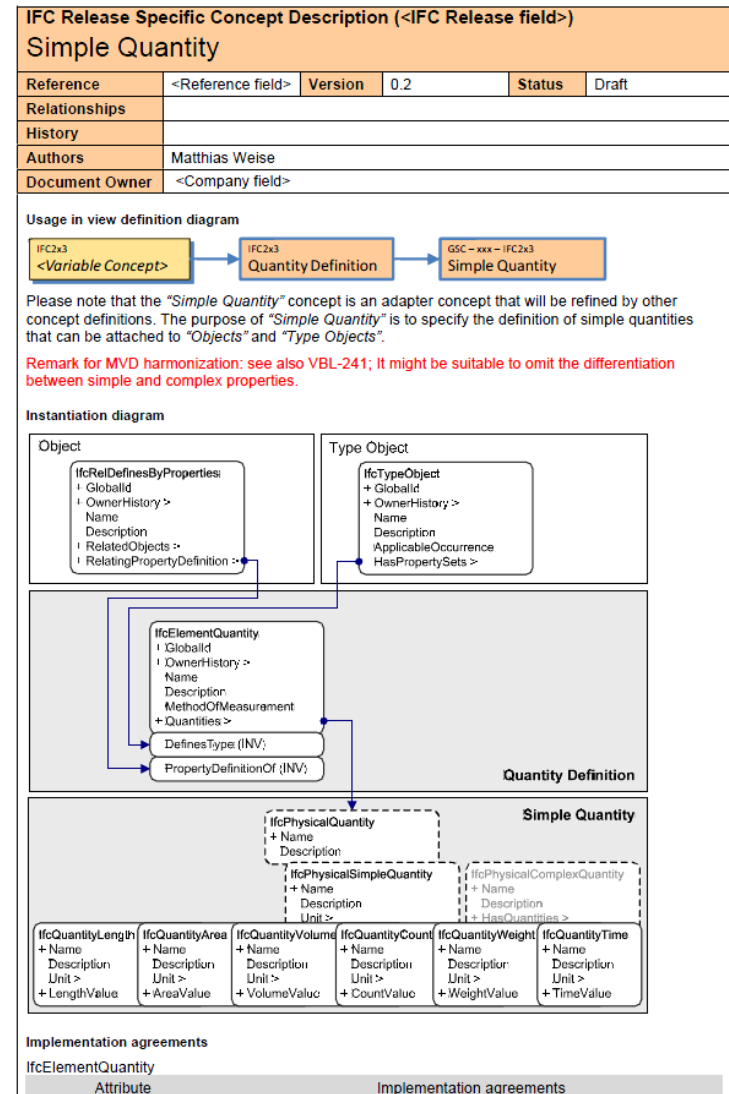
Information Needed	Entity/Port/Functional Part	MAN	RFC	OPT
for a given service life. For each factor, the following apply:				
Select the predefined type of service life factor that is to be defined.	ICServiceLifeFactorPredefinedType → ICServiceLifeFactorTypeSet	✓		
The predefined type of service life factor that are typically used are those defined in ISO 15686 and include: QUALITY OF COMPONENTS DESIGN LEVEL WORK EXECUTION LEVEL INDOOR ENVIRONMENT OUTDOOR ENVIRONMENT IN USE CONDITIONS MAINTENANCE LEVEL				
The reference letters used are the identities of the service life factors in ISO 15686. More complete specification of the service life factor name is used in IFC for semantic reasons.				
Set the mean or most used value of the service life factor being defined.	ICServiceLifeFactorMeanValue → ICParameterValue	✓		
The measured value of a service life factor must be defined whether or not upper and lower values are used.				
Set the lower value of the service life factor being defined.	ICServiceLifeFactorLowerValue → ICParameterValue		✓	
Set the upper value of the service life factor being defined.	ICServiceLifeFactorUpperValue → ICParameterValue		✓	
Define the service life factors for the service life				
Define each occurrence of service life factor that is to be applied within the service life.	fp_define_by_properties	✓		
Assert the attributes of the relationship				
Note that it might be expected in a service life version as is the case in the description below. However, by assigning the products to the service that they may expect to have, the relationship between product and service life is easier to control within IFC.				
Assert the control element of the relationship relationship.	ICRelAssignToControlRelatingControl → ICServiceLife	✓		
Assert the elements that are controlled in the relationship.	ICRelAssignToControlRelatedObjects → ICObjectDefinition	✓		

• Users checklist

(2) MVD

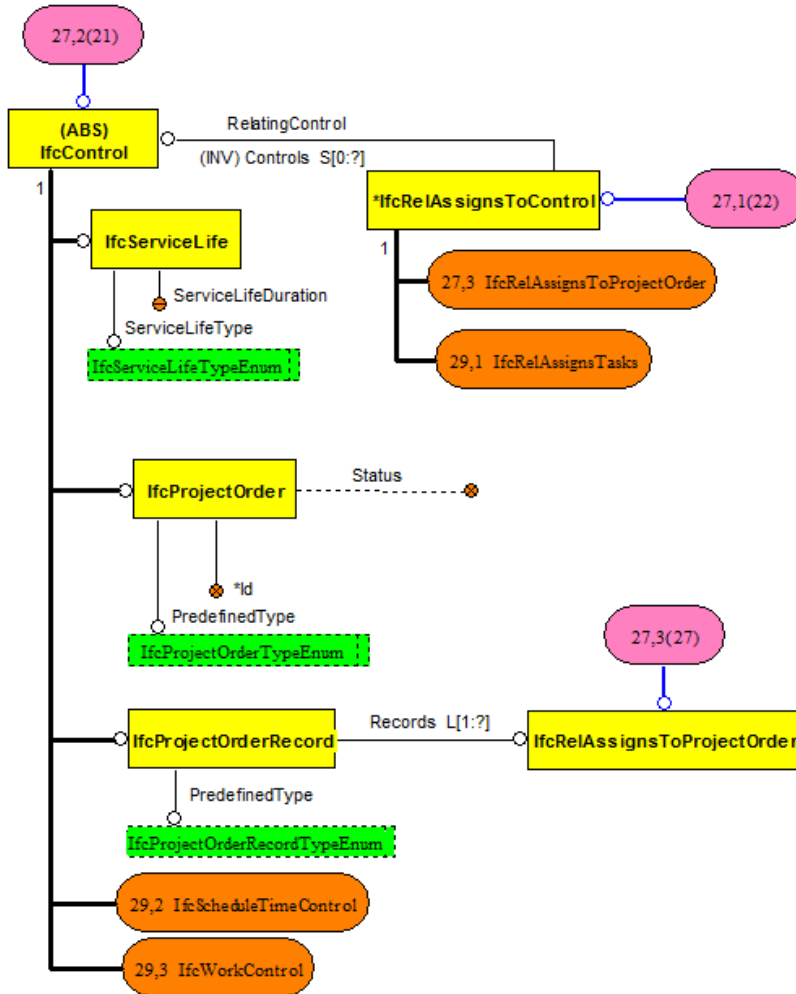


• Implementers checklist



(3) Schema Subset

- i.e. Service Life



IfcServiceLife

EXPRESS specification:

```
ENTITY IfcServiceLife
  SUBTYPE OF (IfcControl);
  ServiceLifeType : IfcServiceLifeTypeEnum;
  ServiceLifeDuration : IfcTimeMeasure;
END_ENTITY;
```

Inheritance graph

```
ENTITY IfcServiceLife;
  ENTITY IfcRoot;
    GlobalId : IfcGloballyUniqueId;
    Name : OPTIONAL IfcLabel;
    Description : OPTIONAL IfcText;
    OwnerHistory : IfcOwnerHistory;
  ENTITY IfcObjectDefinition;
  INVERSE
    HasAssignments : SET OF IfcRelAssigns FOR RelatedObjects;
    HasAssociations : SET OF IfcRelAssociates FOR RelatedObjects;
  ENTITY IfcObject;
    ObjectType : OPTIONAL IfcLabel;
  INVERSE
    IsDecomposedBy : SET OF IfcRelDecomposes FOR RelatingObject;
    Decomposes : SET [0:1] OF IfcRelDecomposes FOR RelatedObjects;
    IsDefinedBy : SET OF IfcRelDefines FOR RelatedObjects;
  ENTITY IfcControl;
  INVERSE
    Controls : SET OF IfcRelAssignsToControl FOR RelatingControl;
  ENTITY IfcServiceLife;
    ServiceLifeType : IfcServiceLifeTypeEnum;
    ServiceLifeDuration : IfcTimeMeasure;
  END_ENTITY;
```

(4) Spreadsheet

- i.e. 06-Register ⇔ Ifc Type Product

Information Exchanges																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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(5) Transform

```

<xsl:call-template name="putString">
  <xsl:with-param name="mode" select="$mode"/>
  <xsl:with-param name="shade">Specifiable</xsl:with-param>
  <xsl:with-param name="text">
    <xsl:choose>
      <xsl:when test="$mode='Header'">FacilityDescription</xsl:when>
      <xsl:otherwise>
        <xsl:value-of select="ifc:Description"/>
      </xsl:otherwise>
    </xsl:choose>
  </xsl:with-param>
  <xsl:with-param name="alternative">
    <xsl:value-of select="substring(name(),4)"/>
    <xsl:if test="ifc:LongName">
      <xsl:text> </xsl:text>
      <xsl:value-of select="ifc:LongName"/>
    </xsl:if>
  </xsl:with-param>
</xsl:call-template>

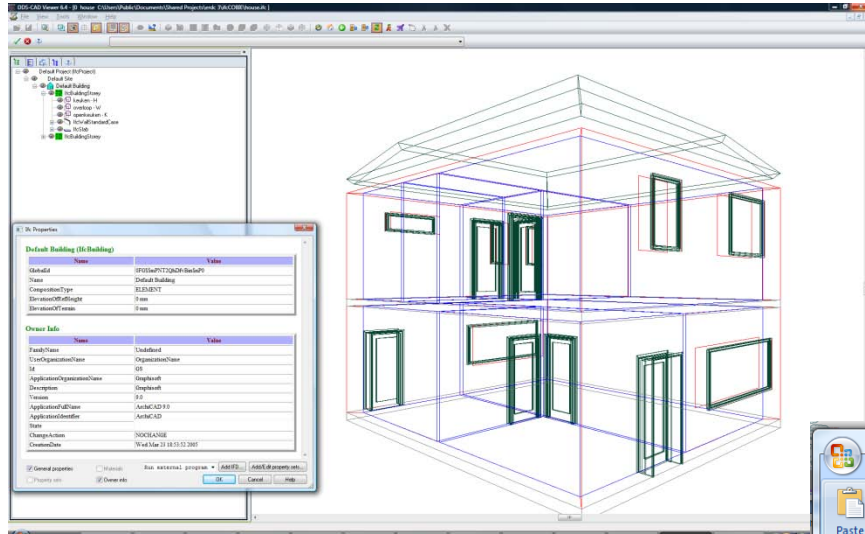
```

	A	B	C	D	E	F	G	H	I	J	K
	FacilityID	ExternalSystemName	ExternalNameID	FacilityName	FacilityDescription	CreatedBy	CreatedDate	CreatedTime	ReplacesID	Withdrawn	FacilityDPick
1											
2	1	ArchiCAD 8.0	1N1PuA0Jv1ihOPQQHKW8pc	gatehouse	Building gatehouse	1	2008-07-09	12:34:56		No	1, gatehouse

Information 01-Contact 02-Facility 03-Floor 04-Space 05-System

COBIE ⇔ IFC tool

<http://www.buildersnet.org/IFC-BIM>



- translate between COBIE spreadsheet and IFC data.

- report and compare asset representations

</

ifcCOBIE - transforming

- `C:>ifcCOBIE house.ifc`
- `ifcCOBIE (c) AEC3 2008.07.10 email:nn@aec3.com`
-
- `Source 1: house.ifc`
- **Reading** : `house.ifc buildingsSMART` (ISO PAS 16739:2005) **STEP** (ISO 10303 Part 21) (engine)
- `Schema : IFC2X3_FINAL.exp` (external resource)
- **Writing** : `house.ifx buildingsSMART` (ISO PAS 16739:2005) **XML** (ISO 10303 Part 28)(engine)
- `Reading : house.ifx buildingSMART` (ISO PAS 16739:2005) **XML** (ISO 10303 Part 28)(msxml)
- `Map : ifcXML_cobie.xsl` (external resource)
- `Mapping : ifcXML_cobie.xsl` (msxml)
- **Writing** : `house.xml COBIE` (Excel XML Spreadsheet 2003) **spreadsheet** (msxml)
-
- `ifcCOBIE finished.`

ifcCOBIE - reporting

- C:> ifcCOBIE -l model7.ifc
- (c) AEC3 2008.07.10 email:nn@aec3.com
- Source 1: model7.ifc
- Reading : model7.ifc buildingSMART (ISO PAS 16739:2005) STEP (ISO 10303 Part 21) (engine)
- Schema : IFC2X3.exp (external resource)
- Object : COBIE_Master, Project (2qJ78_GWH5jvuSGGMg\$GPY)
- Value : ..LongName Cobie Demonstration
- Related : ..IsDecomposedBy RelatedObjects RelAggregates
- Object :Madison Alabama, -, Site (3APct_4CX3KP3IfyeDhIwc)
- Value :LongName Madison Alabama
- Related :IsDecomposedBy RelatedObjects RelAggregates
- Object :BIM Sample US, -, Building (3cbtxXMir4xRdNOOI5ZGkr)
- Value :LongName BIM Sample US
- Related :IsDecomposedBy RelatedObjects RelAggregates
- Object :First Flr, First Floor, BuildingStorey (2cl0clo09AGB3qtucGbh4d)
- Value :LongName First Flr
- Related :IsDecomposedBy RelatedObjects RelAggregates
- Object :1-107, Reception, Space (1qMCLLDnX8P9RUv9mSPzSh)
- Value :ObjectType Reception
- Value :LongName Reception
- ...

ifcCOBIE - differences

- C:> ifcCOBIE -l model7.ifc model7a.ifc
- (c) AEC3 2008.07.10 email:nn@aec3.com
- **Compare : model7.ifc with model7a.ifc**
- Schema : IFC2X3.exp (external resource)
- Reading < model7.ifc (engine)
- Reading > model7a.ifc (engine)
- ...
- **Matched =2-205, Office, Space** (3G\$hd2FQj9JBoIgjvFN2mA)
- *Related :IsDefinedBy RelatingPropertyDefinition*
- **Matched =ArchSpace, -, PropertySet** (2PwiWZlIz2ohMRPLVSkVU\$)
- *Related :HasProperties*
- **Matched =Label, -, Office, PropertySingleValue**
- **Matched =Number, -, 2-205, PropertySingleValue**
- **Matched =Label 2, -, , PropertySingleValue**
- **Matched =Ceiling Height, -, 2.5908, PropertySingleValue**
- **Matched =Program Area, -, 13.93546, PropertySingleValue**
- **Matched =Actual Area, -, 14.67694, PropertySingleValue**
- **Changed <NominalValue 11.50146**
- **Changed >NominalValue 14.67694**

compliance

Nicholas Nisbet, MA, DipArch
buildingSMART ifcXML Coordinator
Director, AEC3 Ltd

Example challenge

- Rename space

15	1,Floor 1	13-85 11 11 00 Corridor	n/a	OPS 2008, by Onuma, Inc.	5660	115	Hallway	Hallway
16	1,Floor 1	13-11 11 27 00 Social Room	n/a	OPS 2008, by Onuma, Inc.	5661	116	LIBRARY	LIBRARY
17	1,Floor 1	13-11 11 17 00 Classroom	n/a	OPS 2008, by Onuma, Inc.	5662	117	TRAINING	TRAINING
18	1,Floor 1	13-11 11 17 00 Classroom	n/a	OPS 2008, by Onuma, Inc.	5663	118	Training 2	Training 2

15	1,Floor 1	13-85 11 11 00 Corridor	n/a	OPS 2008, by Onuma, Inc.	5660	115	Hallway	Hallway
16	1,Floor 1	13-11 11 27 00 Social Room	n/a	OPS 2008, by Onuma, Inc.	5661	116	LIBRARY	LIBRARY
17	1,Floor 1	13-11 11 17 00 Classroom	n/a	OPS 2008, by Onuma, Inc.	5662	117	TRAINING and MultiPurpose	TRAINING and MultiPurpose
18	1,Floor 1	13-11 11 17 00 Classroom	n/a	OPS 2008, by Onuma, Inc.	5663	118	Training 2	Training 2

- Refine the type information

I	J	K	L	M	N	O	
RegisterNameID	RegisterName	RegisterReference	ReplacementCost	ReplacementCostUnit	ExpectedLife	ExpectedLifeUnit	CreatedBy
	Air Handling Units Type 1	23 00 00,,,,Part 2	1600	Dollars	12	year	1,Onuma,

J	K	L	M	N	O	
RegisterName	RegisterReference	ReplacementCost	ReplacementCostUnit	ExpectedLife	ExpectedLifeUnit	CreatedBy
Air Handling Units Type 1	23 00 00,,,,Part 2	1200	Dollars	8	year	1,Onuma,Ki

Sample Check Result

Processing '06-Register' Worksheet Check

Data file display suppressed per user request for non-verbose output.

(45 XML records found (include column header), 44 possible COBIE records were analyzed as noted below.)

Column		Rule Description	Rule		
Letter	Name		Pass/Fail	Errors Found	Offending Records
A	RegisterID	record ID's must be numeric	Pass	-	-
A	RegisterID	record ID's must be increasing	Pass	-	-
A	RegisterID	record ID's must be unique	Pass	-	-
B	ProductType	All register records shall have OmniClass product codes	Pass	-	-
C	RegisterType	All register records must indicate data type	Pass	-	-
D	AssetType	All register items must indicate asset type	Pass	-	-
E	RegisterApprovalBy	All register items must indicate approval level	Pass	-	-
F	SystemIDList	Product Data submittals must indicate related system(s)	Pass	-	-
H	ExternalSystemName	If created by software export, system name must be listed	Pass	-	-
I	ExternalNameID	If created by software export, external ID name must be listed	Pass	-	-
J	RegisterName	Submittal item name must be provided	Pass	-	-
K	RegisterReference	Submittal specification reference must be provided	Pass	-	-
L	ReplacementCost	A numeric value may be provided for replacement cost	Check	11	1, 2, 3, 4, 5, 6, 8, 22, 23, 24, 44
M	ReplacementCostUnits	A value must be provided for the replacement cost units	Pass	-	-
N	ExpectedLife	A numeric value may be provided for expected life	Check	11	1, 2, 3, 4, 5, 6, 8, 22, 23, 24, 44
O	ExpectedLifeUnits	A value must be provided for the replacement lift units	Pass	-	-
P	CreatedBy	records must identify who created the data	Pass	-	-
Q	CreatedDate	records must contain a data stamp	-	-	test type 'Date' not yet operational
S	ReplacesID	updated records shall not identify themselves	-	-	test type 'SelfReference' not yet operational
S	ReplacesID	updated records shall reference an ID on the sheet	-	-	test type 'SheetReference' not yet operational

Legend: =required =conditional =optional =change control

OPS summary

- Producing COBIE directly
 - 06-Register:
 - some missing replacement cost
 - some missing expected life.

Vectorworks

- Producing COBIE via IFC
 - 04-Space:
 - no area measures
 - no function
 - aggregate spaces used
 - 05-System:
 - none
 - 06-Register:
 - same number of register and component entries.
 - 07-Component:
 - 14 doors and windows have no space
 - Some doors are allocated to three spaces

Revit

- Producing COBIE directly
- Twice
 - Several issues ...

Revit direct to COBIE (1)

- 00-Structure
 - the instructions file did not contain information about the specific project, but reflected the "railyard maintenance project" example
 - in general -. IFC GUID's or equivalent (i.e. system ID's) must be provided to allow checking across different spreadsheet submissions if the data is created from BIM software.
- 03-Floor.
 - InteriorGrossArea a non-numeric character was written to the field, possibly a "space" or equivalent in lieu of blank or "n/a". same for all in this worksheet.
- 04-Space.
 - SpaceReferenceID value must be blank unless showing nested spaces (error not shown in the checker since SelfReference check not included in checker at this time)
 - ExternalSystemName value does not identify "Revit Architecture 2009". The value for the system name does appear in the ExternalSystemName column in the Floor worksheet.
- 05-System.
 - repeated problem with SystemReferenceID and ExternalSystemName
 - inspection reveals that the list of systems seems unusual given the size of the building.

Revit direct to COBIE (2)

- 06-Register
 - **register ID records not unique, two values of "19"**
 - register type not spelled correctly "Test Report" provided vs. "Test Reports" which is allowable value.
 - while the number of Types (register) and Components (equipment) are not the same they are very close: there is not strong typing.
 - typically expect that register records, i.e. "types" will be part of a building service, hence missing system id's in the register are not correct. for example one would expect that Register ID 7 "Exhaust Air Grill" would be part of System ID "HVAC", note that when trying to identify which system the component belongs that this small building cannot really have all of these different mechanical systems.
- 07-Component
 - **records 6, 7 reference spaces that do not exist.** Rooftop and outdoor are specifically to be designated in spaces. This is consistent with the way that people think about areas outside the building envelop.
 - **all named components must link back to 06-Register**

Revit: Direct to COBIE

Processing '07-Component' Worksheet Check

Data file display suppressed per user request for non-verbose output.

(214 XML records found (include column header), 24 possible COBIE records were analyzed as noted below.)

Column		Rule Description	Rule		
Letter	Name		Pass/Fail	Errors Found	Offending Records
A	ComponentID	record ID's must be numeric	Pass	-	-
A	ComponentID	record ID's must be increasing	Pass	-	-
A	ComponentID	record ID's must be unique	Pass	-	-
B	SpaceID	Each component record must list it's SpaceID	FAIL	24	All rows include this fault.
C	RegisterID	Each component record must list it's RegisterID	FAIL	24	All rows include this fault.
C	RegisterID	Register data must be strongly typed. (RegisterCount <> ComponentCount)	Pass	-	-
D	ExternalSystemName	If created by software export, system name must be listed	Pass	-	-
E	ExternalNameID	If created by software export, external ID name must be listed	Warning	24	All rows include this fault.
E	ExternalNameID	External identifiers must be unique	-	-	test type 'ExternalNameUnique' not yet operational
F	ComponentName	Each component must be identified by name	Pass	-	-
F	ComponentName	Most components should have have a unique number	-	-	test type 'UniqueComponent' not yet operational
G	ComponentDescription	Identifying product type in the description may be helpful	Pass	-	-
H	CreatedBy	records must identify who created the data	Pass	-	-
I	CreatedDate	records must contain a data stamp	-	-	test type 'Date' not yet operational
J	ReplacesID	updated records shall not identify themselves	-	-	test type 'SelfReference' not yet operational
J	ReplacesID	updated records shall reference an ID on the sheet	-	-	test type 'SheetReference' not yet operational

Legend: =required =conditional =optional =change control

Revit

- Producing COBie from IFC:
 - 02-Facility:
 - Not named
 - 04-Space
 - Super spaces present
 - 05-System:
 - None
 - 07-Component:
 - Many components without link to space

Bentley

- Producing COBIE from IFC:
 - 04-Space
 - ceiling heights invalid (ifcCOBIE)
 - 06-Component
 - Some doors, windows and ducts not associated to any space.

Metrics

- Summary

		Scie	Cvie	COBie
	Route	Space areas	Proxies	C/T ratio
OPS	direct	net, gross	n/a	22.578
Bentley	via IFC	yes	2	4.071
Revit	direct	yes	n/a	0.532
Revit	via IFC	yes	1820	5.516
Vectorworks	via IFC	none	0	1.000

Summary

	Route	Pass/fail	Quality /10
OPS	direct	pass	9
Bentley	via IFC	pass	8
Autodesk	direct	fail	4
Autodesk	via IFC	pass	6
Vectorworks	via IFC	pass	7