AALBORG UNIVERSITY

Building Informatics

Produkt og Procesmodeller (PPM) i byggeriet.
Product and Process models in Construction.

# 2. BIM tools and Parametric Modeling. Interoperability.

Part 2

Cand. Scient. Bygningsinformatik.
Semester 1, 2010.

# Chapter 3 in BIM Handbook

# Interoperability

## ACIS 3D Modelling Kernel

The 3D ACIS Modeler (**ACIS**) is a 3D modelling kernel (or engine) owned by Spatial Corporation (formerly Spatial Technology). ACIS is used by many software developers industries such as computer-aided design, (CAD), Computer-aided manufacturing (CAM), Computer-aided engineering (CAE), Architecture, engineering and construction (AEC), Coordinate-measuring machine (CMM), 3D animation, and shipbuilding. ACIS provides software developers and manufacturers the underlying 3D modeling functionality.

## ACIS functionality (1)

3D modeling
3D model management
3d model visualisation

## ACIS functionality (2)

**3D Modelling**

Extrude/revolve/sweep sets of 2D curves into complex surfaces or solids.

Fillet and chamfer between faces and along edges in surface and solid models.

Fit surfaces to a closed network of curves.

Generate patterns of repetitive shapes.

Hollow solids and thicken surfaces.

Interactively bend, twist, stretch, and warp combinations of curves, surfaces, and solids.

Intersect/subtract/unite any combination of curves, surfaces, and solids.

Loft surfaces to fit a set of profile curves.

Taper/offset/move surfaces in a model.

## ACIS functionality (3)

**3D Model Management**

Attach user-defined data to any level of a model.
Track geometry and topology changes.
Calculate mass and volume.
Model sub-regions of a solid using cellular topology.
Unlimited undo/redo with independent history streams.

## ACIS functionality (4)

**3D Model Visualization**

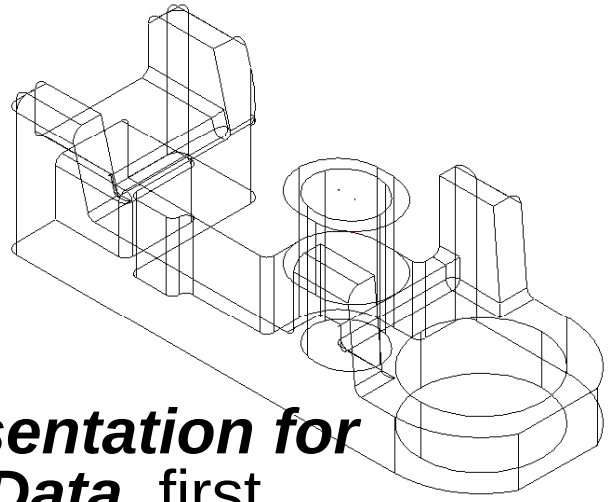
Tessellate surface geometry into polygonal mesh representation.

Create advanced surfacing capabilities with the optional Deformable Modeling component.

Generate precise 2D projections with hidden line removal using optional PHL V5 component.

Develop graphical applications

# IGES



The official title of IGES is ***Digital Representation for Communication of Product Definition Data***, first published in January, 1980 by the U.S. National Bureau of Standards as **NBSIR 80-1978**.

Using IGES, a CAD user can exchange product data models in the form of circuit diagrams, wireframe, freeform surface or solid modeling representations. Applications supported by IGES include traditional engineering drawings, models for analysis, and other manufacturing functions.

Kilde: http://en.wikipedia.org/wiki/IGES

## IGES history

The IGES project was started in 1979 by a group of CAD users and vendors, including Boeing, General Electric, Xerox, Computervision and Applicon, with the support of the National Bureau of Standards (now known as NIST) and the U.S. Department of Defense (DoD). The name was carefully chosen to avoid any suggestion of a database standard that would compete with the proprietary databases then used by the different CAD vendors.

Since 1988, the DoD has required that all digital Product Manufacturing Information (PMI) for weapons systems contracts (the engineering drawings, circuit diagrams, *etc*.) be delivered in electronic form, specifically in IGES format. As a consequence, any CAx software vendor who wants to market their product to DoD subcontractors and their partners must support the import (reading) and export (writing) of IGES format files.

Kilde: http://en.wikipedia.org/wiki/IGES

# DXF

**AutoCAD DXF** (Drawing Interchange Format, or Drawing Exchange Format) is a CAD data file format developed by Autodesk[*citation needed*] for enabling data interoperability between AutoCAD and other programs.

DXF was originally introduced in December 1982 as part of AutoCAD 1.0, and was intended to provide an exact representation of the data in the AutoCAD native file format, DWG (Drawing), for which Autodesk for many years did not publish specifications. Because of this, correct imports of DXF files have been difficult. Autodesk now publishes the *DXF specifications*, http://usa.autodesk.com/adsk/servlet/item?siteID=123112&id=12272454&linkID=10809853 on its website for versions of DXF dating from AutoCAD Release 13 to AutoCAD 2010.

# dwg

**DWG** ("drawing") is a file format used for storing two and three dimensional design data and metadata. It is the native format for several CAD packages including AutoCAD, IntelliCAD (and its variants) and Caddie. In addition, DWG is supported non-natively[2] by many other CAD applications.

DWG was the native file format for the Interact CAD package, developed by Mike Riddle in the late 1970s[3], and subsequently licensed by Autodesk in 1982 as the basis for AutoCAD.[4][5][6] From 1982 to 2007, Autodesk created versions of AutoCAD which wrote no fewer than 18 major variants of the DWG file format, none of which are publicly documented.[7]

# Industry Foundation Classes – IFC

International Alliance for Interoperability (IAI)

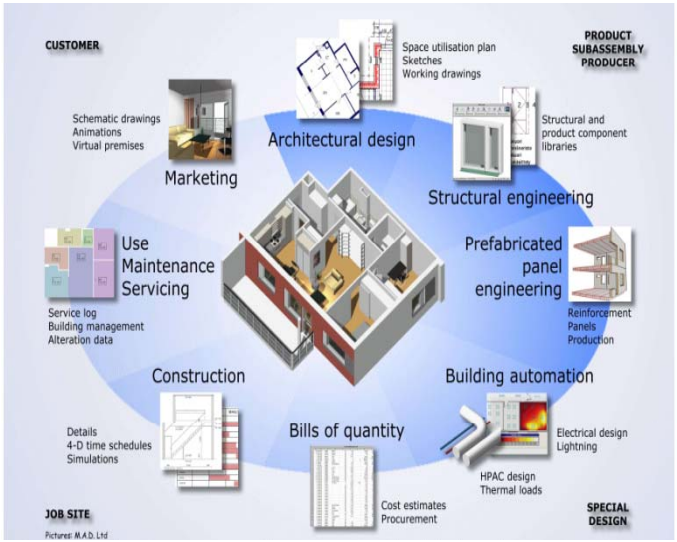
- Industrial Foundation Classes (IFC)
- Based on ISO STEP (ISO 10303)
  - STandard for Exchange of Product model data
- Oriented towards the building sector
- Building models can be exchanged based on IFC

Focus: on cooperation, integration, and interoperability
Implementation and use of IFC

- Open standard – non proprietary
- Software toolboxes available for multiple languages, e.g. Java

## Informationer om bygningen i dens levetid

Behov for repræsentation på forskellige niveauer i hele bygningens livscyklus




Flere områder skal repræsenteres

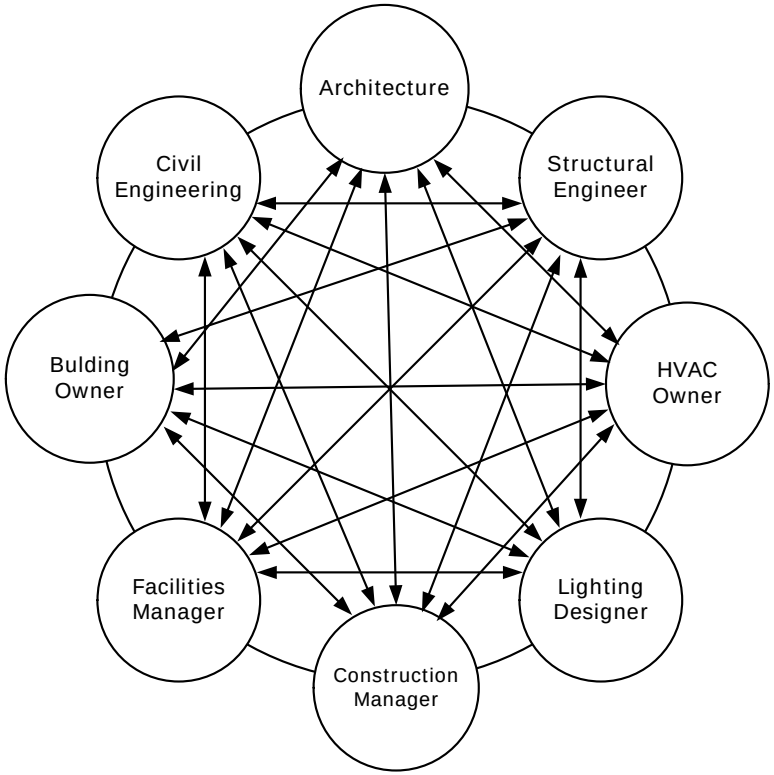
- Bygningen
- Aktører, materiel, etc.
- Planer, aktiviteter, etc.

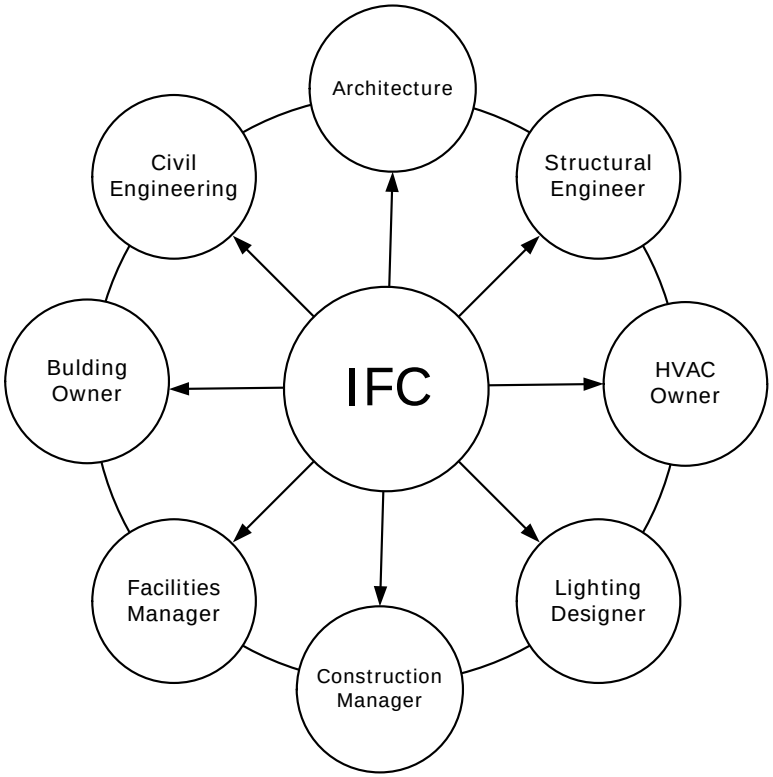
IAI har taget initiativ til en standardisering

- En internationalt standardiseret repræsentation af bygningsmodeller
- Dataudveksling på basis af standardiseret repræsentation
- Baseret på EXPRESS-sproget

## *Data Exchange between applications*

Direct, proprietary links between specific tools
Proprietary file exchange formats
Public product data model exchange formats
XML based formats

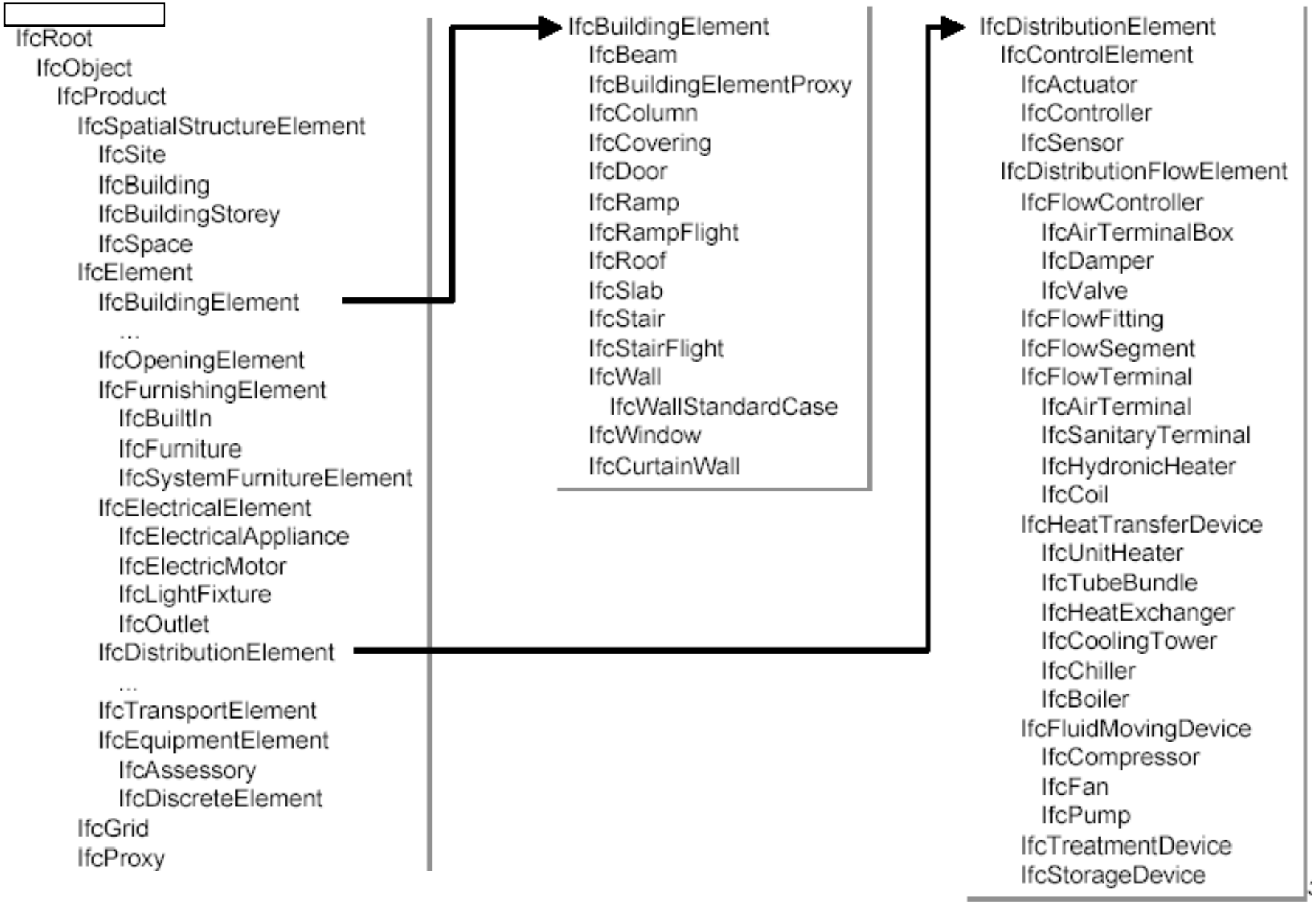


## IFC Data Udveksling via IFC-Filer

Tekstbaseret fil-format (Express Part21)
Eksempel på linier fra en IFC-fil:

```
#854=IFCDOOR('1hc4Jqw5f06vStCE7jOfLP',#16,$,$,$,#739,..
.);
#855=IFCRELFILLSELEMENT('3ZrCD712XDqfh7xpYMVFxW',#16,..
.);
#856=IFCRELDEFINESBYTYPE('3EnGpMYab01hpgV89dkoPL',#16,.
..);
#730=IFCOPENINGELEMENT('3hn$AtZKr5Guv7fGyZtp9i',#16,...
);
#857=IFCCARTESIANPOINT((0.,0.));
#858=IFCDIRECTION((1.,0.));
#859=IFCAXIS2PLACEMENT2D(#857,#858);
#860=IFCRECTANGLEPROFILEDEF(.AREA.,$,#859,2050.,800.);
```


IfcRoot
IfcObject
IfcProduct
IfcSpatialStructureElement
IfcSite
IfcBuilding
IfcBuildingStorey
IfcSpace
IfcElement
IfcBuildingElement
...
IfcOpeningElement
IfcFurnishingElement
IfcBuiltIn
IfcFurniture
IfcSystemFurnitureElement
IfcElectricalElement
IfcElectricalAppliance
IfcElectricMotor
IfcLightFixture
IfcOutlet
IfcDistributionElement
...
IfcTransportElement
IfcEquipmentElement
IfcAssessory
IfcDiscreteElement
IfcGrid
IfcProxy
IfcBuildingElement
IfcBeam
IfcBuildingElementProxy
IfcColumn
IfcCovering
IfcDoor
IfcRamp
IfcRampFlight
IfcRoof
IfcSlab
IfcStair
IfcStairFlight
IfcWall
IfcWallStandardCase
IfcWindow
IfcCurtainWall
IfcDistributionElement
IfcControlElement
IfcActuator
IfcController
IfcSensor
IfcDistributionFlowElement
IfcFlowController
IfcAirTerminalBox
IfcDamper
IfcValve
IfcFlowFitting
IfcFlowSegment
IfcFlowTerminal
IfcAirTerminal
IfcSanitaryTerminal
IfcHydronicHeater
IfcCoil
IfcHeatTransferDevice
IfcUnitHeater
IfcTubeBundle
IfcHeatExchanger
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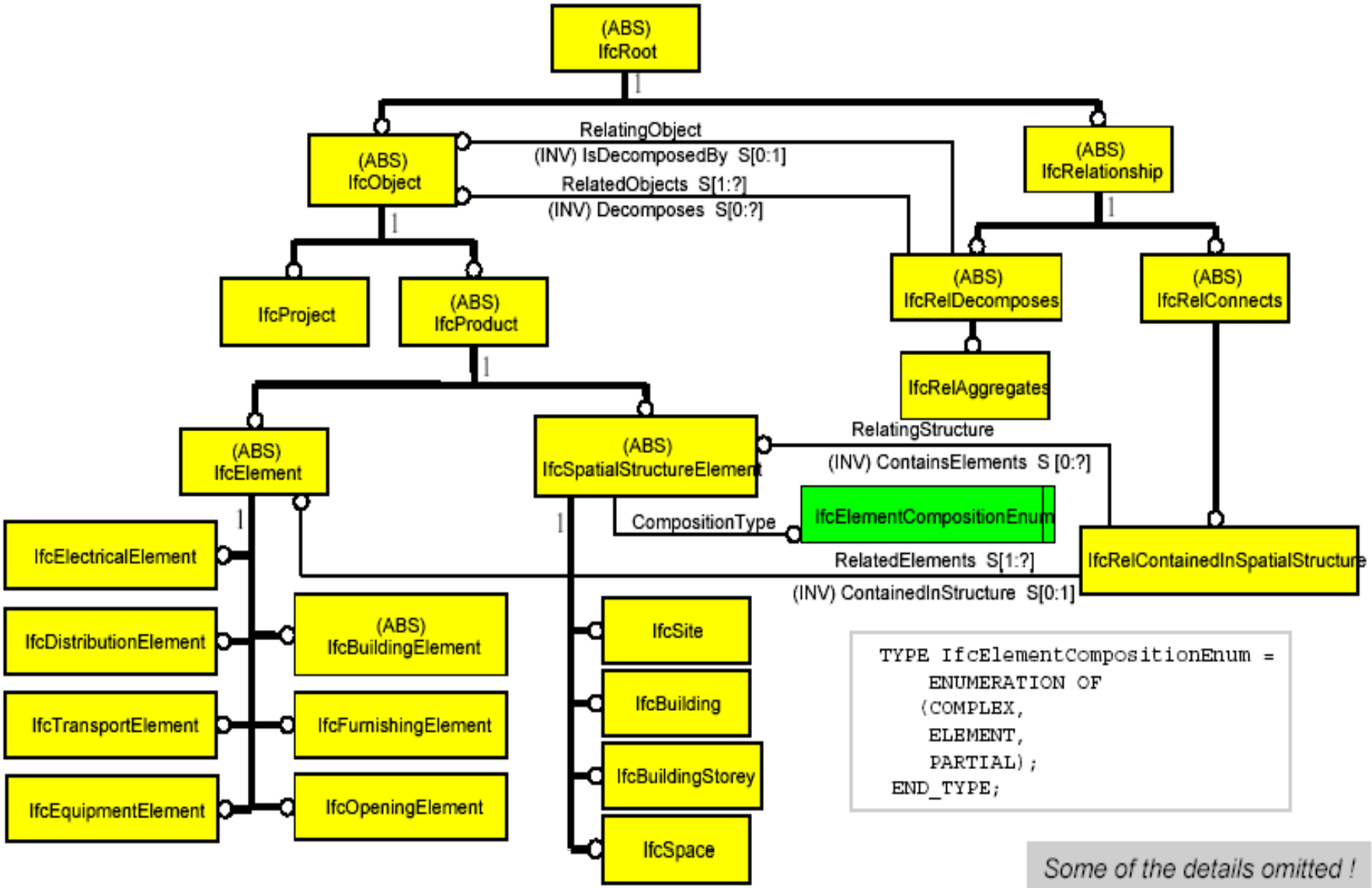
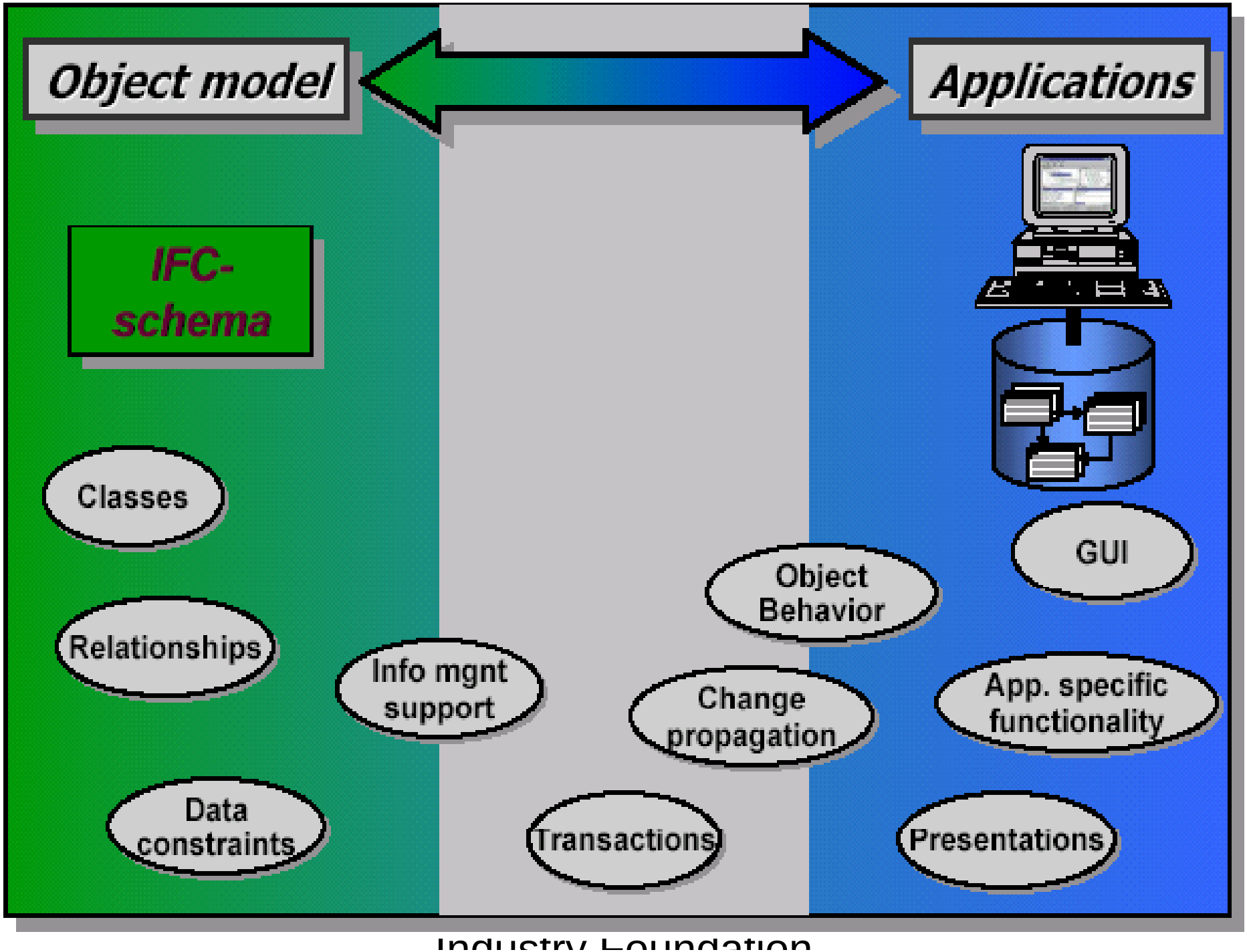
IfcFan
IfcPump
IfcTreatmentDevice
IfcStorageDevice

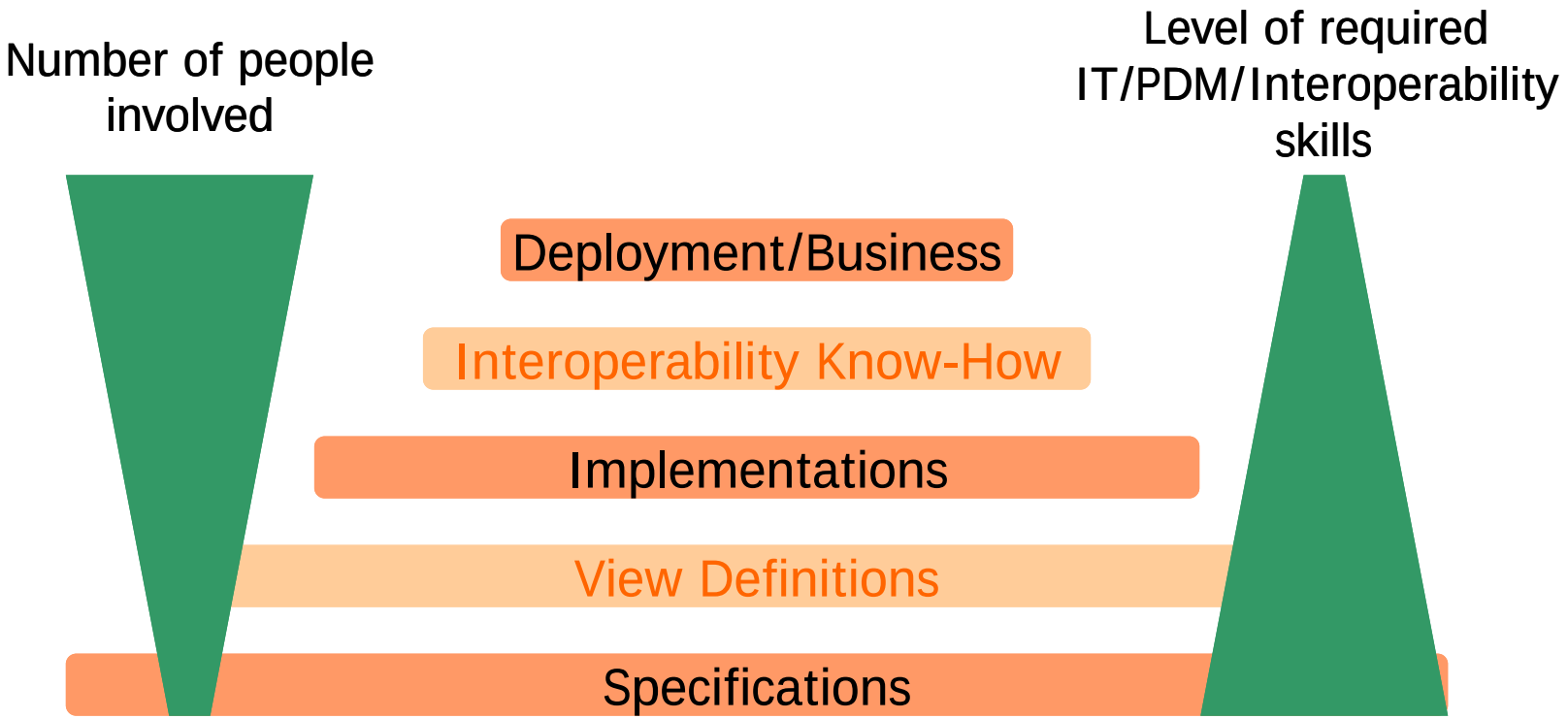

(ABS)
IfcRoot
(ABS)
IfcObject
RelatingObject
(INV) IsDecomposedBy S[0:1]
RelatedObjects S[1:?]
(INV) Decomposes S[0:?]
(ABS)
IfcRelationship
IfcProject
(ABS)
IfcProduct
(ABS)
IfcRelDecomposes
(ABS)
IfcRelConnects
IfcRelAggregates
(ABS)
IfcElement
(ABS)
IfcSpatialStructureElement
RelatingStructure
(INV) ContainsElements S [0:?]
IfcElementCompositionEnum
CompositionType
IfcRelContainedInSpatialStructure
RelatedElements S[1:?]
(INV) ContainedInStructure S[0:1]
IfcElectricalElement
IfcDistributionElement
IfcTransportElement
IfcEquipmentElement
(ABS)
IfcBuildingElement
IfcFurnishingElement
IfcOpeningElement
IfcSite
IfcBuilding
IfcBuildingStorey
IfcSpace
TYPE IfcElementCompositionEnum =
ENUMERATION OF
(COMPLEX,
ELEMENT,
PARTIAL);
END_TYPE;
Some of the details omitted !



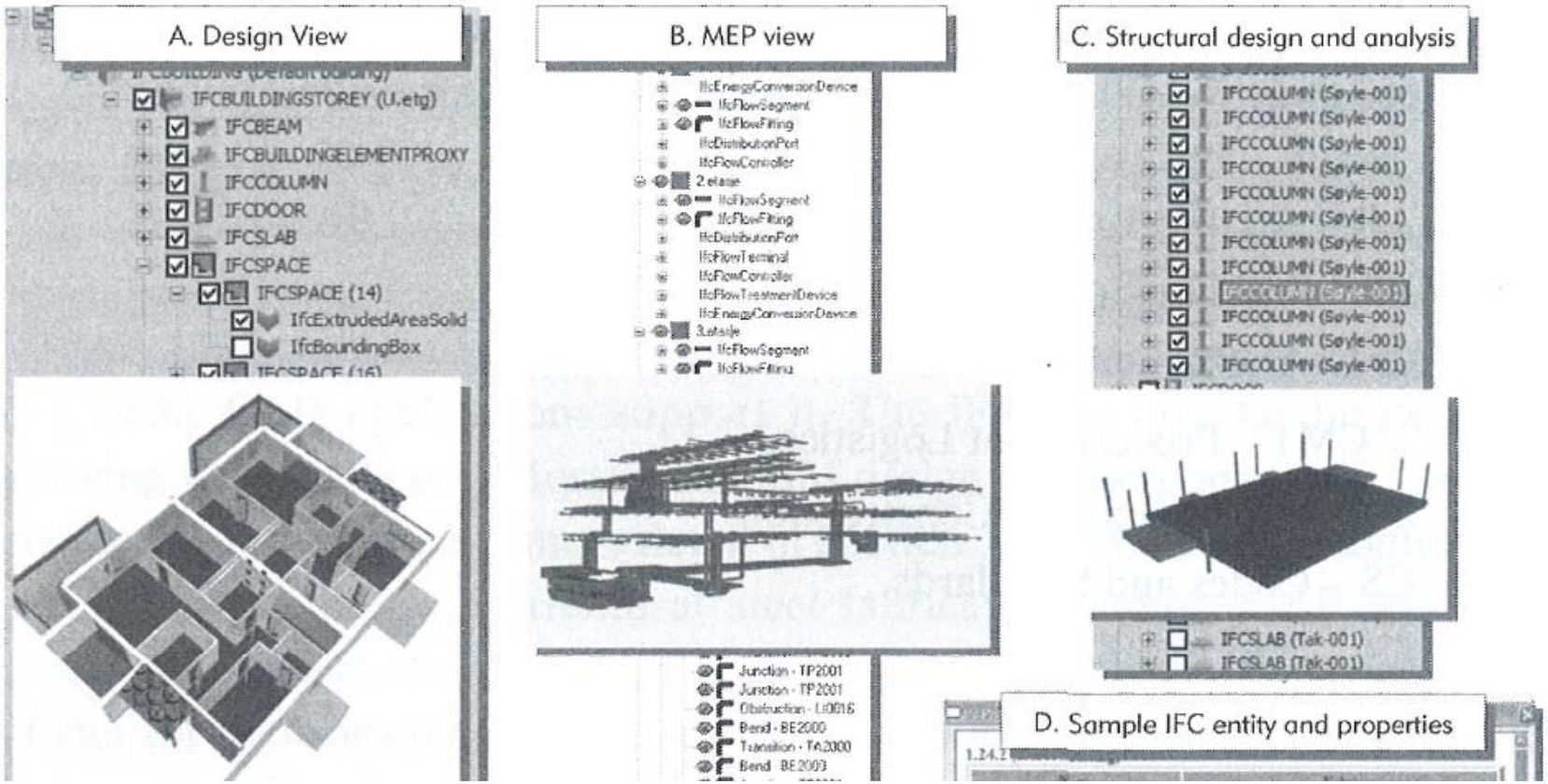

Industry Foundation

# *"The Interoperability Pyramid"*

## *(Jiri Hietanen - 2003)*



# Model view definitions (MVD)

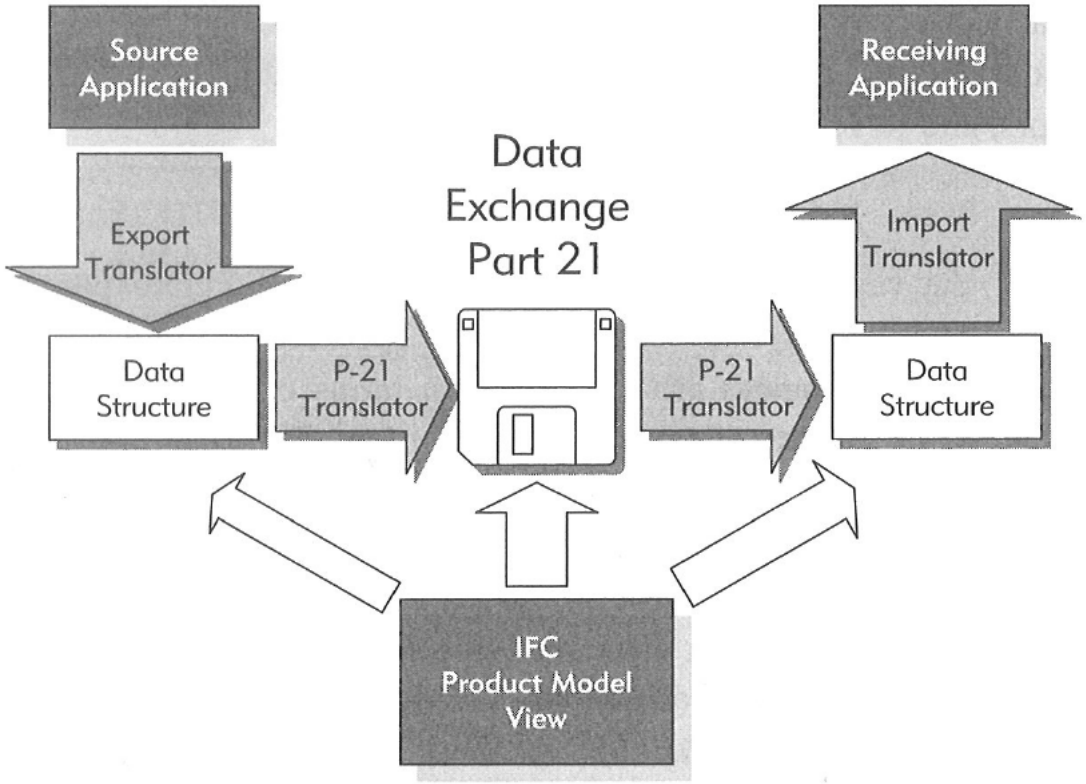



Exchange Requirements defined in Information Delivery Manual (IDM)

Read more:
http://www.iai-tech.org/products/ifc_specification/ifc-view-definition/summary

# Exchange between applications

Direct, proprietary links between specific tools
Proprietary file exchange formats
**Public product data model exchange formats**
XML based formats



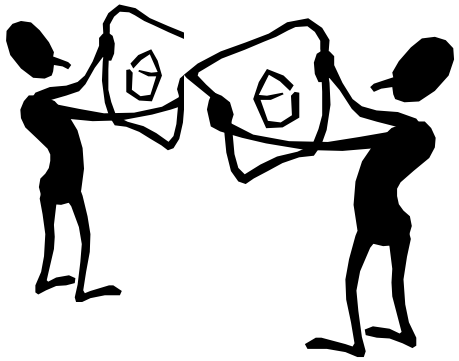
## XML and building models

- gbXML (Green Building XML)
  - Energy analysis, mechanical equipment
- aecXML
  - documents, participants, activities, not geometrical or analytical model
- IFXXML
  - subset of IFC model
- BLIS-XML
  - also subset of IFC developed in BLIS project 2002

## Building Model Repositories
## Model Servers

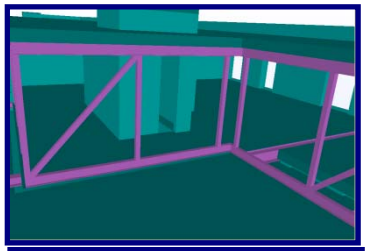
- Document management systems, project webs
  - basically for managing files

- Building model repositories, model servers
  - manage building objects

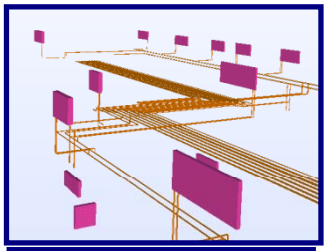


Coordination
through
drawings

Architecture

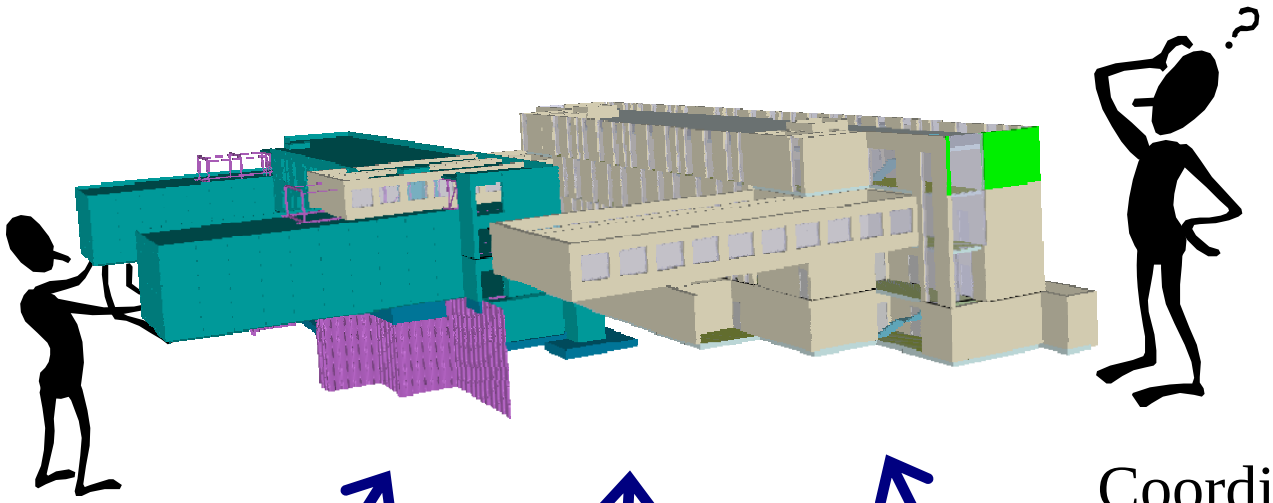


Structural

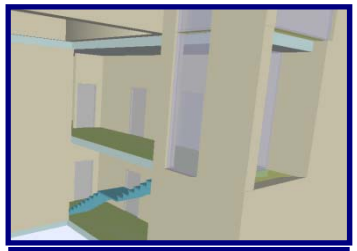


Heating

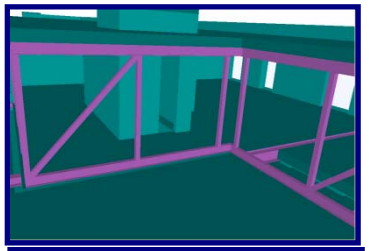
Discipline
models



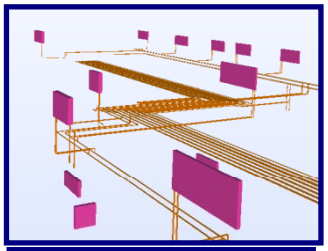
Coordination through aggregate models



Architecture

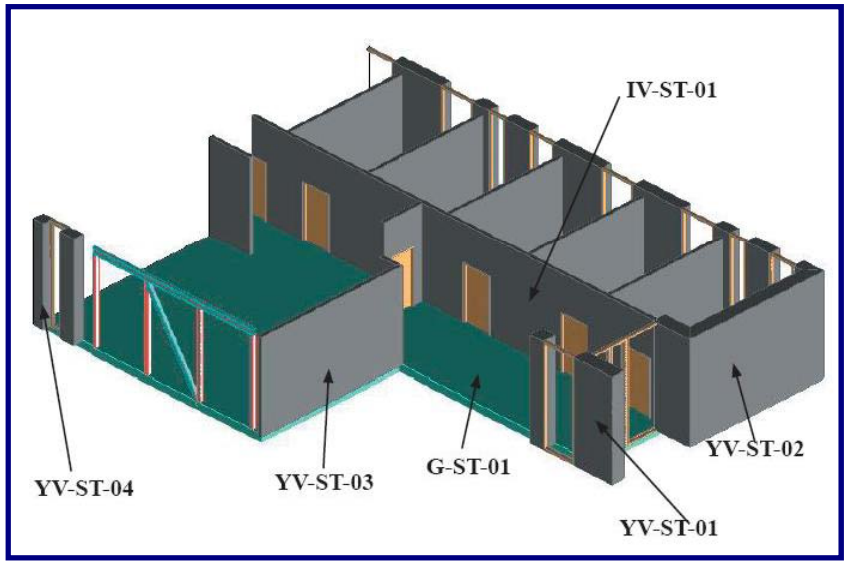


Structural

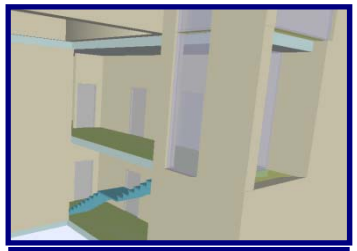


Heating

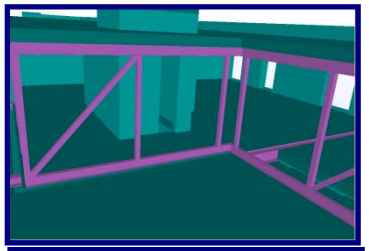
Discipline models




Shared model on model server



Architecture



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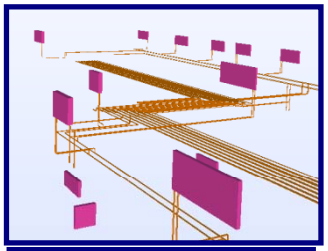

Heating

Discipline models

END

http://it.civil.aau.dk