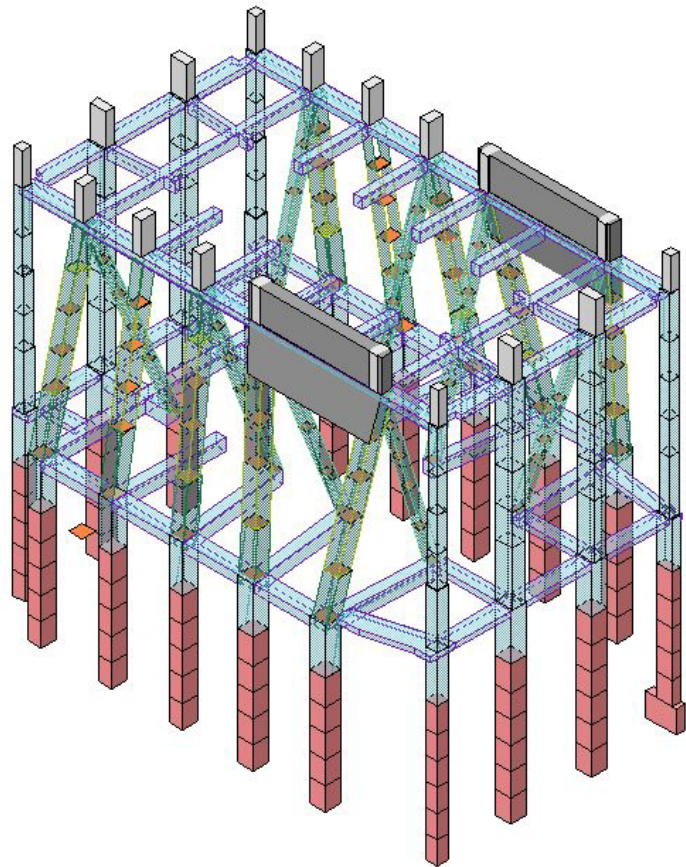


Design Collaborati on using IFCs



GGraphisoft

ArchiCAD IFC Reference Guide, version 1.0

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project (e.g., between ArchiCAD and MagiCAD) were not used by the project team. Furthermore, today some of the links (e.g., between RIUSKA and CFX) are IFC-compliant. *Diagram and text by courtesy CIFE, Stanford.*

ArchiCAD has been a major supporter of this project; ArchiCAD users have designed and documented the work. **ETC**

The object integrated model, ArchiCAD's innovative concept for over 18 years, puts in place a strategic foundation for a new paradigm of facility development based on the management of information. IFC based exchange now extends this concept to allow many more of the project development participants to create & share comprehensive project information. In contrast with the legacy 2D drawing approach based on a proprietary vendor format, the IFC technology eclipses both of these technology and market limitations by defining an innovative open standard for the description of AEC objects globally available to all in the construction industry

Companies that have products supporting the IFC protocol enable you to rethink the way you solve common business problems. The benefits can be any one of the following examples:

- access object data for improved design and coordination in ArchiCAD – getting a building service engineer's HVAC ductwork or water piping layout as 3D objects is one such example.
- export your design for analysis by another specialist package – such as a thermal analysis enabling better understanding of your building performance, or advanced visualization, analysis of the logic of the design etc
- export a model for costing, estimation bidding or procurement – the integrated nature of the IFC information makes your database more valuable because your information is easy to access and analyze by such packages as costing applications
- your model is the definitive source of data for construction planning solutions such as form working applications which identify formed surfaces in the model, apply standard components for formwork assembly access etc and then derive a list of parts and construction schedule.
- extend further your service benefits to clients or users by easily exporting your facility data can into their business systems.

Many more opportunities exist to leverage IFC object data for improved design quality, reduction of errors, better coordination and new services to owners and other partners in the development process. See the **IAI Implementer Support Group** website <http://www.bauwesen.fh-muenchen.de/iai/ImplementationOverview.htm>

for descriptions of currently available products.

ArchiCAD's virtual building technology and IFC interface enables you to integrate and coordinate information from these sources; it extends the potential of the Virtual Building concept into real object collaboration with your project partners; and it will improve your level of service and competitive edge in the market place.

We welcome your feedback on several levels – how we have engineered the IFC interface, how you are able to apply it to your business and as this is a partner to partner application, how you make it work in your project team environments. *Please contact your distributor with any problems or project feedback.*

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Introduction

About this Guide

This IFC Reference Guide provides technical explanations of the operations of the IFC Add-Ons for ArchiCAD.

IFC Add-On

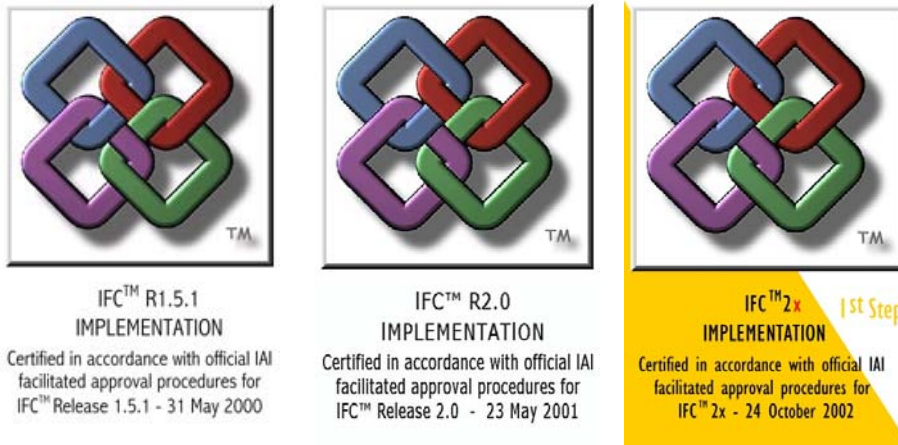
IFC import/export Add-Ons are available for ArchiCAD releases 6.5 and 7.0.

The IFC Add-Ons must be in the directory: [ArchiCAD folder]\Add-Ons\Import-Export.

Note: For Macintosh users the Add-On uses memory comparable to approximately 2-4 times the size of the IFC file.

Version Support and Releases

ArchiCAD is certified as follows:



For latest update on IFC capabilities refer to the Graphisoft website
<http://www.Graphisoft.com/support/IFC>

Current availability is:

IFC Version	Certifi-cation	Add-On			
		Windows		Macintosh	
		ArchiCAD 6.5	ArchiCAD 7.0	ArchiCAD 6.5	ArchiCAD 7.0
1.5.1	21 May 2000	IFC_151.apx	IFC_151.apx	IFC_151 In/Out	IFC_151 In/Out
2.0	25 May 2001	IFC_200.apx	IFC_200.apx	IFC_200 In/Out	IFC_200 In/Out
2x	24 Oct 2002	NA	IFC_2x.apx	NA	IFC_200 In/Out

Table 1: IFC Add-Ons

The IFC Integrated Object Model

What is an IFC?

IFC stands for “Industry Foundation Classes”, the set of internationally standardized object definitions for use in the Construction Industry developed by the International Alliance for Interoperability (IAI).

The business objective of the IAI, through its chapters established in some 11 countries around the world (refer <http://iaiweb.lbl.gov/>) is:

To integrate the AEC/FM industry by specifying Industry Foundation Classes (IFC) as a universal language to improve the communication, productivity, delivery time, cost, and quality throughout the design, construction, operation and maintenance life cycle

Inter-operability Definition

The IFC concept is based on the idea of objects (or *elements* in ArchiCAD terms) brought together in an integrated model (ArchiCAD’s *virtual building*). These objects are defined to support the whole lifecycle of facility development from inception through design, documentation and construction, then facility management and finally demolition and or disposal.

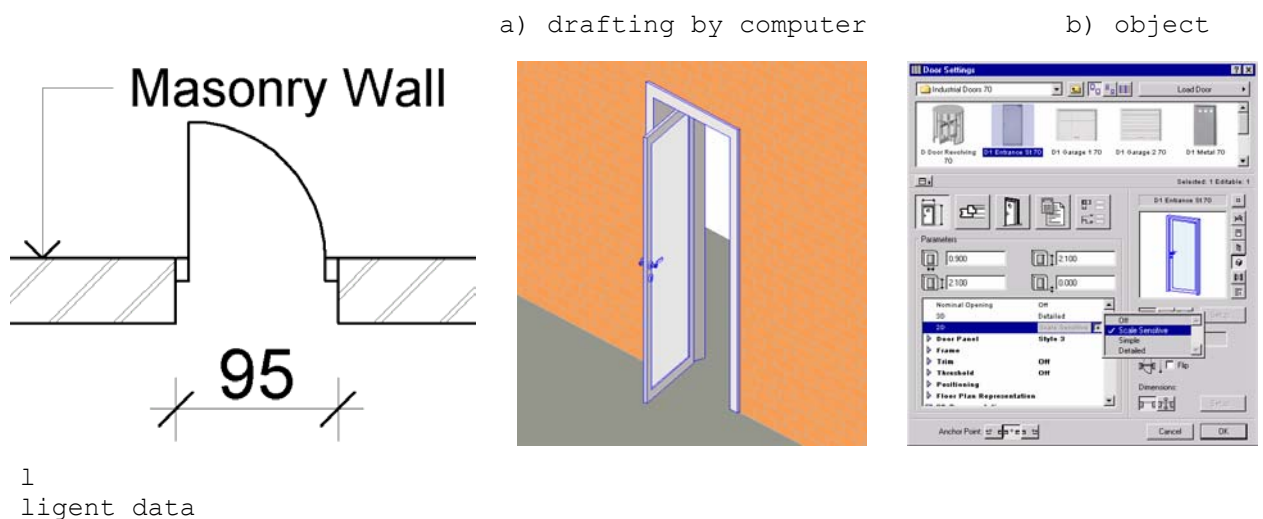


Figure 1: Evolution of 2D graphics to Object integrated models

IFC is to “Project Model” exchange (wall, door, window) what DXF is to graphic entity exchange (line, arc, circle)

IFC is available to all participants in the Construction Industry, for use globally, including use by all construction industry software vendors. IFC offers a higher-level “common language” for the sharing of intelligent objects between disciplines across the building lifecycle

Why use IFC?

In each project, the CAD Manager, with the Project Leader and the party with whom the exchange is to be made, should review why information needs to be shared, what is to be

exchanged and how.

Why would you choose IFCs instead of traditional techniques such as 2D files in DWG/DXF or DGN format?

The principal benefit of IFCs is their object description – not only does the IFC protocol preserve the full geometric description in 3D, but it also knows its location and relationships, as well as all the properties (or parameters) of each object such as finish, serial number, material description, thermal conductance, cost etc. For ArchiCAD users this offers great potential to access the accurate geometry of building service systems and structural elements, ie to improve the information to be coordinated in the model, rather than relying on the incomplete functions of current 2D CAD.

Tip: Note that Graphisoft's GDL object browser technology also allows information to be saved and transmitted in IFC format. See **Accessing GDL Product Data** below

Always remember that a combination of techniques may be more useful than sticking to one solution only. Choose what suits the project resources, skills available and the specific task in hand.

Planning an IFC Exchange

The first action is to determine that your partner and his software application has an IFC translator. Having validated this, the next important step is to select an appropriate version that both partners can support and understand the functionality offered by that version. ArchiCAD's support of the IFC protocol offers the following IFC compatibility:

IFC Version	ArchiCAD Release	Notes
1.51	6.5, 7.0	The first release of the IFC translator. This version supported the concept of building carcass.
2.0	6.5, 7.0	Substantial extension of functionality over 1.5.1. Increased scope for sharing: <ul style="list-style-type: none">• architectural design model for cost estimating,• HVAC design for cost estimating,• architectural design for thermal load calculations and/or HVAC system design• client brief / space layout for architectural design Additional concepts are provided for special transfers
2x	7.0, 8.0 ¹	The IFC2x platform release will be stable until at least 2005 to allow the industry to deliver mature interface support. Additional capabilities on top of the IFC2x platform may be introduced, but the solutions remain downward compatible, so that previous IFC2x files can be still read by the enhanced IFC2x interfaces.

¹ No commercial release for AC8 until 2003. Contact your distributor for details

Table 2: IFC versions and ArchiCAD support

Determining the Scope of a Transfer

Who are the parties to the transfer and what information should be transferred? Is it one way or two way? How are versions to be managed? While it would normally be preferable to use the latest IFC release, it may be that the one partner has a limited choice only. Once these preliminary decisions have been made, consideration needs to be given to specifying the detailed content of the exchange.

¹ Versions for all three IFC releases will be available
2nd Qtr 2003

This task is really no different to planning a .DWG or .DGN transfer. except now the quality and richness of object information can radically improve the information to be shared and indeed lead to a re-think of the processes involved in design collaboration and estimation for example

Views

IFC cover a diverse range of information within building construction and the model does not distinguish who should be exchanging that information or at what point in a project the information is being exchanged.

Software applications are more usually concerned with specific requirements and should not have to implement or use every class that is contained within the IFC model. Therefore, subsets of the model are defined that, when isolated from the complete IFC model, still act as a coherent model. These subsets are called views.

Views are used to support the many different data needs of say architect, structural engineer, HVAC engineer or cost estimator for example.

IFC Version	View	ArchiCAD Functionality
1.5.1	CAD view	The following entities are supported: Beam, Building, Building Storey, Column, Door, Floor, Opening Element, Project, Proxy, Roof Slab, Site, Space, Space Boundary, Wall, Window. This entity set is comprehensive enough to underpin a wide range of data sharing needs, based on the carcass of a building.
2.0	BLIS ¹ view set	Four focused processes are supported: <ul style="list-style-type: none"> • Architectural design >> Quantities take off / cost estimating • HVAC system design >> Quantities take off / cost estimating² • Architectural design >> Thermal load calculations / HVAC system design • Client brief / space layout >> Architectural design <p>See the BLIS reference below for detailed description of the view definitions and objects included.</p>
2x		Currently under development but will include all the views above

¹ BLIS is a worldwide consortium of AEC application developers dedicated to developing IFC compliant products. See their website <http://www.blis-project.org/> for more information.

²This view is not supported by ArchiCAD

Table 3: IFC Views

In the case of the ArchiCAD IFC Add-Ons the default scope for export is to include everything.

Note: ArchiCAD does not support the IFC 2.0 BLIS view for HVAC system design to Quantities/cost estimating

More selective functions are provided in the export settings of the Add-Ons to filter the export of data from ArchiCAD. See **Customizing the IFC data – Filter** below.

Set up a Pilot or Test.

Once the full scope has been agreed, test the process by doing a pilot. This activity ensures that both parties get what they expected, so that when crucial deadlines occur, the process can be confidently undertaken. The following guidelines may assist you and your team:

- Start with very simple examples
- Validate at both ends
- Progressively expand data set to the full level
- Document procedures at both ends

Report to Project leaders in all disciplines so that they understand and agree to the process, resources and timetables

Note: Remember that sharing information is both a technical task and a management process.

Useful links for Using the IFC Exchange Protocol

To check current versions of **Graphisoft translators** refer to <http://www.graphisoft.com/ifc/>

To understand more about the **International Alliance for Interoperability** (IAI), the worldwide chapters and the IFC development process see <http://iaiweb.lbl.gov>

To understand more about the **BLIS project** and definition of IFC 2.0 BLIS views see <http://www.blis-project.org/>

To join the Graphisoft **IFC User group** see <http://www.graphisoft.com/support/IFCuser>

To find out the current availability of **IFC compliant applications**, IFC development tools and forthcoming products see <http://www.bauwesen.fh-muenchen.de/iai/ImplementationOverview.htm>

Working with the IFC Translator

IFC Exchange Processes

IFC Objects versus 2D Drawings

In relation to the currently common DWG import/export there is a very important difference involved with IFC exchanges. In the DWG 2D case, exchange is predominantly by *layer* i.e. the information to be sent is represented by layer naming conventions which defines the class of usually 2D data being exchanged. This data is not integrated – in fact no building model exists; it is only by visual inspection that coordination of information becomes possible.

In the case of an IFC exchange *objects* are being transferred, and these objects are related to the building model both geometrically in 3D space and by relations such as the room on the 3rd Floor, part of a network etc. Objects actually have much more information defined within them – all the parameters defined in the IFC model specification and in ArchiCAD's case many other attributes that describe the object in increasing detail that makes them useful and easy to use.

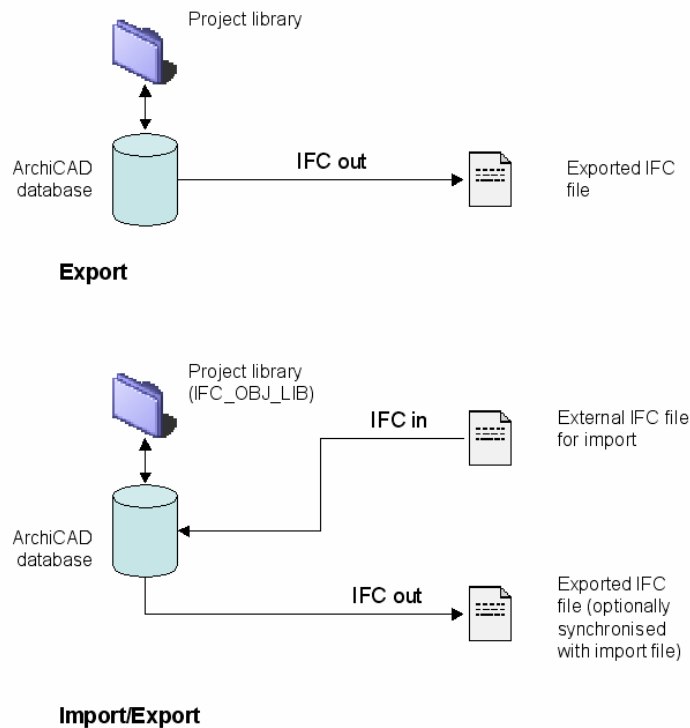


Figure 2: IFC Exchange Processes

Figure 2 shows an overview of the processes involved in importing and exporting an IFC file. In this new paradigm, layering is merely a way of ordering and presenting objects, not a proxy for defining information. When undertaking an IFC exchange we must consequently manage the transfer at the **Object level**. It is important that you understand the requirements for synchronization of objects between you & your partner's databases so that you can manage the versioning of data and audit this process.

IFC Object Identifiers

The IFC model tracks objects involved in organization to organization exchange by an identifier, the Global Unique Identifier GUID. For every object created, a GUID is

assigned that stays with the object for its life. If the object is deleted its GUID is “deleted“ too.

Initiating an IFC Export

In this first case, the user, say an Architect, has decided to issue an IFC file to one of his service engineering consultants. A first consideration is how the translator interprets door and window objects. ArchiCAD has a powerful parametric and intelligent element types for doors and windows; their behaviour is connected to the wall elements they are placed in. The IFC model does not yet support the same level of functionality and as you might expect anyway, all CAD vendors have slightly different approaches to the implementation of these elements as well as other parts of the model. Accordingly, you must understand how the IFC definition relates to ArchiCAD, as these objects have unique considerations involved.

We recommend you use the special library objects for IFC doors and windows, for if you use another door or window object it will be transformed into a proxy object (a general purpose object that carries almost any information a sender wants to exchange) and importantly, will not be recognized when re-imported into ArchiCAD.

The standard IFC door & window types are:

ifcDoors	ifcWindows
IFC_DOORDBLSWING,	IFC_WINDOWAWNING
IFC_DOORSGLSWING,	IFC_WINDOWCASEMENT
IFC_DOORREVOLVING,	IFC_WINDOWDOUBLEHUNG
IFC_DOORROLLUP,	IFC_WINDOWFIXED
IFC_DOORSLIDING	IFC_WINDOWPIVOTING
	IFC_WINDOWSLIDING

Table4: ArchiCAD IFC Door & Window Library Objects
(see Appendix A & D for more details)

These objects have the pre-defined parameters expected and supported in the IFC model and the GDL objects created by the Add-On have these (and other useful) parameters included. These objects are created normally when you import a new IFC file (but see below for extended options). The Add-On also has a facility to create these objects in your current library (see **Customizing the IFC data – Create IFC library** below). This latter method will ensure your normal project library for instance, includes these objects at project initiation, thus setting the database up for its later IFC export. See **Appendices B & C** for detailed descriptions of these objects. **Appendix D** sets out the Property Sets associated with each ifcObject.

So, having set up as above, the current ArchiCAD database is now saved in the appropriate IFC version format (see **Exporting & Importing IFC Files – Save As IFC file** below) and with any options defined (see **Customizing the IFC data - Options** below) an IFC file is created.

Importing an IFC file

In this second case, you have been sent a file for the first time on your project. Open the file selecting the appropriate IFC version format, and select a location for the library of IFC objects that will be created (see above). You can either use the default name (IFC_OBJ_LIB) and location for the folder or, specify a unique name and location (ie Projects/P20642/Libraries/P20642_IFC.lib).

Tip: It is recommended your IFC library be always located in your project specific directory, rather than allowing it to default to the current ArchiCAD library folder, where it may be merged with other project IFC library folders of the same name.

Note: Importing an IFC file into ArchiCAD *always* creates a new .pln file. See **Using IFCs on Projects** for techniques to manage IFC exchanges in a working environment

Exporting a modified imported IFC file

In this third case, you have edited the database created by the import and now want to send back a revised IFC file to your project partner.

A number of decisions must be made about the following:

- treatment of object identifiers (GUID)
- update of the IFC building elements

Updating IFC Building Elements

If you make changes to the imported elements, for example you change the width of a wall, it will be reflected in the exported model – that is the same object has a different width. If you keep the original wall the GUID will remain the same; if however you delete the wall and replace it with an identical one, a new GUID is created with the new wall building element.

The synchronization of objects is achieved by “referring” to the IFC file that was responsible for the initiation of the database; ie in the case of an imported file, that file, in the case of an exported file the first or most recent file produced.

By choosing the relevant IFC data file, the Add-On is able to reference the object data in the two locations (ArchiCAD and IFC file), carries out a synchronization based on their GUIDs and creates a new export file as follows:

- if the GUID exists in both sources, update the data in the IFC file with the information from ArchiCAD
- if the GUID does not exist, create new objects for the IFC file
- if an object remains in the IFC reference file, but is not in the ArchiCAD data, show those objects as deleted.

Several refinements of this process are possible. See **Exporting & Importing IFC Files – Save As IFC file** below for more information about managing IFC file synchronization.

Archiving IFC Data

After exporting an IFC file it is recommended to save the .pln file to ensure that the future exports have the same GUIDs for the building elements. Using an archive (extension .pla) will gather all the IFC data and library objects consistently.

For IFC 2.00 translations there is also a special XML file created (see **Customizing the IFC Data – Edit selected item IFC properties** below) for storing property data. This should also be included in the archive.

IFC Based Design Collaboration

Introduction

IFC development has made considerable progress since the publication just early 2002, of Graphisoft's **IFC Reference Guide**.

Since that time two new developments have occurred – the implementation of the IFC2x version of the standard (adopted by ISO, October 2002, **PAS 13974**) - by a significant group of vendors, and the completion of the IFC 2x2 model, for release at the IAI International Summit in Washington DC, May 2003.

The distinguishing feature of the 2x2 release is its support for all the key building engineering services:

- structural load calculation
- steel and reinforced concrete structures
- electrical services in buildings
- piped services
- facility management²

This new model underpins the design resolution and coordination of building services with the main (architectural) building model.

IFC 2x also provides many improvements over all previous releases of the IFC standard (see **IFC Reference Guide** for more detail on releases IFC 1.51 and 2.0).

² Note there are many more features in the 2x2 extension.
See ??

Using IFC data in a Working ArchiCAD Model

As some client groups (such as large contractors and facility owners) are now requiring IFC model based data instead of drawing data, a method for the construction of the model integrating all object discipline information is needed.

Note: There are some major limitations with this in respect of preserving IFC GUIDs but as a pragmatic solution for a working architect they will operate satisfactorily (given the limitations expressed below) until IFC server capability with the implementation release of ArchiCAD's IFC 2x2 addon.

Importing an IFC into ArchiCAD creates a new database on *every* import. Clearly this does not support the production of a live working database, if every import creates a new database. Here we assume that the IFC imports are coming from other discipline partners in the project – structural and building service engineers.

In this discussion the assumption about the database is that it is the design building model, where an architect is working with his consultants to produce a final building model for documentation, estimation and/or construction.

The ArchiCAD solution relies upon hotlinks (see **ArchiCAD Reference Manual** pxx). In this discussion we will not go into the details of hotlinks, merely to show how they are used to support IIFC based design team collaboration.

Below we discuss only one floor but it works for multiple floors in the same (a 3 floor file) or in separate files (a one floor file).

Hotlinking is widely used to subdivide especially large databases into more manageable portions.

Step 0. Design the Project Database.

The ArchiCAD model(s) need “designing” themselves, best left to your CAD manager or appropriate building model expert.

The database design needs to take into account all the normal communication and functional aspects for a project – in this case it will also certainly require a CAD layering conventions and as IFC object libraries will be used, coordination of library or product data. Defining a project standard for this at the commencement of the project will save the team considerable frustration (rather than leaving it to a crisis), and will also make the project proceed more efficiently and quickly.

Another benefit of the hot linked database method is its documentation role – a unified mode, regularly copied from the working model can be used as the documentation issue database, with its own documentation data also hot linked. (See Section xx **Managing Documentation from a Hot linked Model** below).

Step 1. Build the Project Model using hotlinks.

The essence is that you should have from your master project file (say called **Project.pln**) a hot linked .pln file called say **HVAC.pln**. Create as many of these discipline files as needed, noting that they also can be hot linked if desired. The rule for amalgamating files is that for each discipline there must be one final file each.

Step 2. Export an IFC file of the layout of the floor

The purpose of this is to provide a building model on which the engineer can develop his engineering proposal. The file is created by using a filter for the say "visible on current storey" and including the layers of the general "floor plan" content. We have called this *Project_DESIGN.ifc*.

If DDS is willing here (I hope they are the very vendor/user you are working with) send him this file and get him then to send back to you an IFC file of his design.

The IFC data should have all the physical layout details to allow the discipline engineer to correctly design (fit) into the Architectural geometry. In this first description of the process we will focus on the geometry of the model components. Later we will discuss the use (or not) of PSET data to support design processes for the external consultants.

Step 3. Create the Engineer's Design .pln Files

We assume you have now received back from the engineer his initial engineering service proposal in IFC format, based on the export you made from the Architectural model.

Open ArchiCAD, and import the IFC engineering file; save a new .pln file (in an appropriate directory – created above in Step 0). for the previously created **HVAC.pln**.

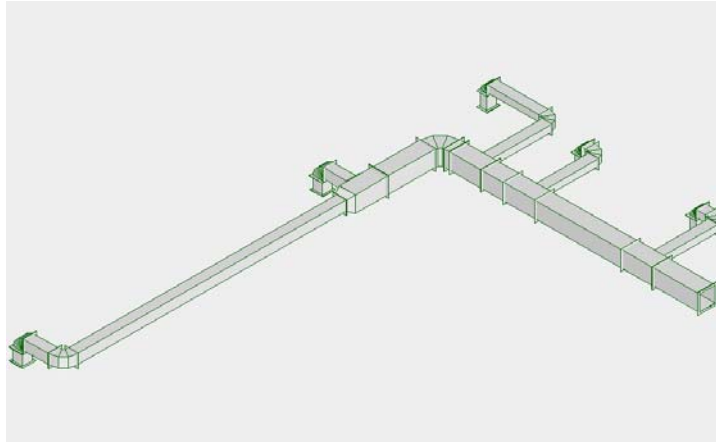


Fig 1: HVAC layout Ground Floor (as imported from IFC file)

Open now **Project.pln**, (check that you may have to update your hotlinks) and you should see (depending on your layering convention) the HVAC data in correct location.

It is so easy to manage the hotlinks that this is not required So actually an easier technique is to unlink the last engineering model and put in the new one (which should have a version suffix say to identify the specific version of the file. Even on a complex database this management would more than be acceptable.

A project convention can be easily conceived blending current practice for shared 2D databases but modified to do this much more effective 3D collaboration.

Another benefit is that the hotlink is not editable in the master file; this is actually just exactly what we want for projects that include multi-disciplinary data where the modifications of the respective discipline is only done by that engineer. Of course the model manager can edit the discipline .pln file, but the work practice should be to not permit this. In the shared working model it cannot happen because the hot linked pln file prevents it.

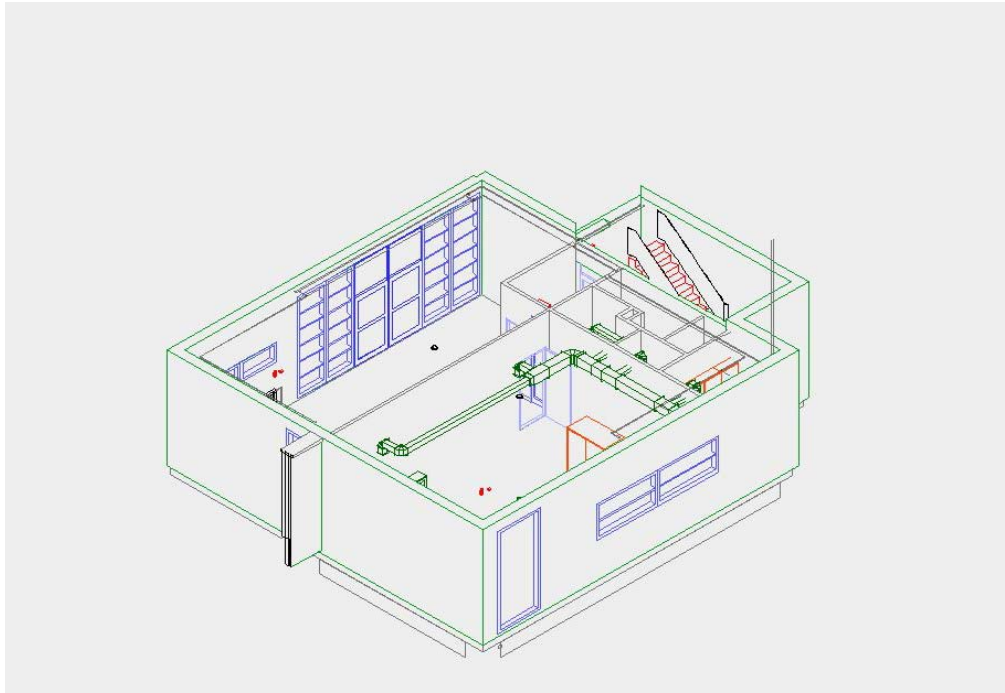


Fig 2: Project Model layout Ground Floor (Hot linked HVAC file)

The architect can issue (as he does in the 2D world - an updated plan - but now it can be a new layout model including the current discipline data showing clashes etc.

I think as well you can have DWG files using this mechanism so blending different file formats (and of course 3D objects vs 2D graphics).

Controlling Versions of the Model

This technique is perfect for options and version control. The respective converted IFC files or their .pln versions are a record of what was issued and received and can be recreated for version management and auditing.

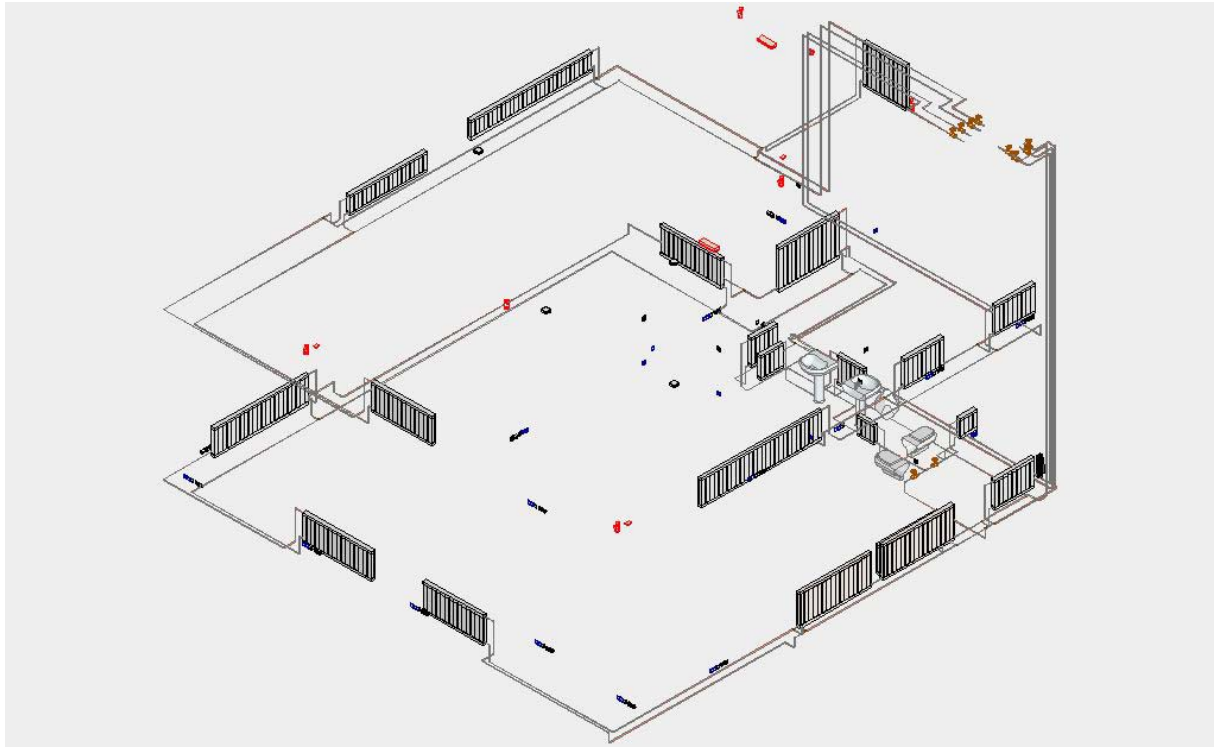


Fig 4: Heating System layout All Floors (single model)

Exchanging Product Information

Conclusion

I would appreciate your feedback on this. I have my test database here and could ftp it to you if you wanted it (120 Mb).

Reservations, etc at present:

merging into a full model import is now possible

we have not tested the implications of partial exports of the model and tracking GUIDs, but preliminary tests show there is much to fix if we were to do this. There are indications that we may be able to manage this but it might be better to wait for the IFC Server development, probably available in beta form about Oct 2003

library management is unclear; each IFC import creates a library. The library needs to be part of the master library for the whole database.

testing has been in principle so getting a user to participate in this in Norway would be very feasible using DDS and/or Olof Granlund

a well managed directory, model naming and layering convention needs to be set up (for which we are very confident this can be done)

the project model can be divided into smaller architectural components with smaller hot linked associations for sub-team development, the manner that FK used on Eureka.

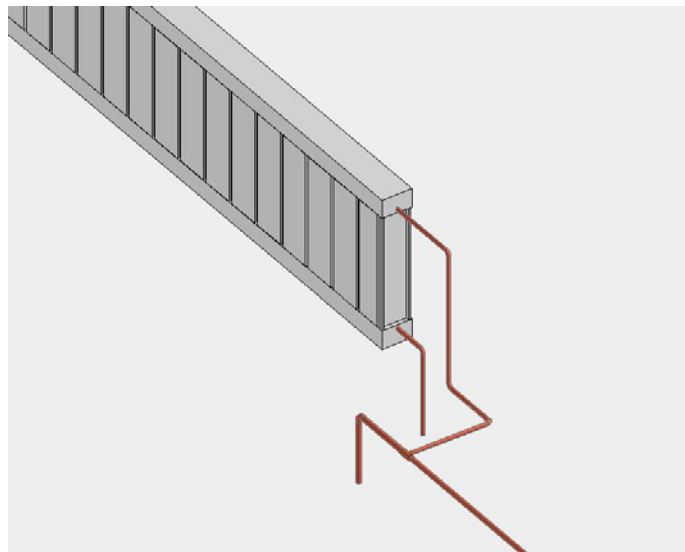


Fig 4: HVAC layout Ground Floor