ODEON Import of CAD files in the DXF format – problems and solutions
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Import of DXF files into ODEON is an area under continuous development. We do acknowledge that 3D CAD files in this format are being more frequently used than ever and it is our aim that this facility should work as smooth and safe as possible. By making use of architects drawings many misinterpretations can be avoided and a lot of time spend on remodelling can be saved. Be aware though that importing a nice looking drawing is not as straight forward as it may seem - therefore you should always check that the imported geometry appears as desired.

Automatic import
Many geometries may contain several thousand surfaces – therefore it is virtually impossible as a user to manually check that geometries are consistent, even so there may be cases where geometries do not import as you desire – in the following we'll give a few examples on problems that may exist and the solutions we have implemented in the DXF import routines of ODEON 9. This document is not intended as a manual for DXF import – for this purpose please consult the ODEON user's manual.
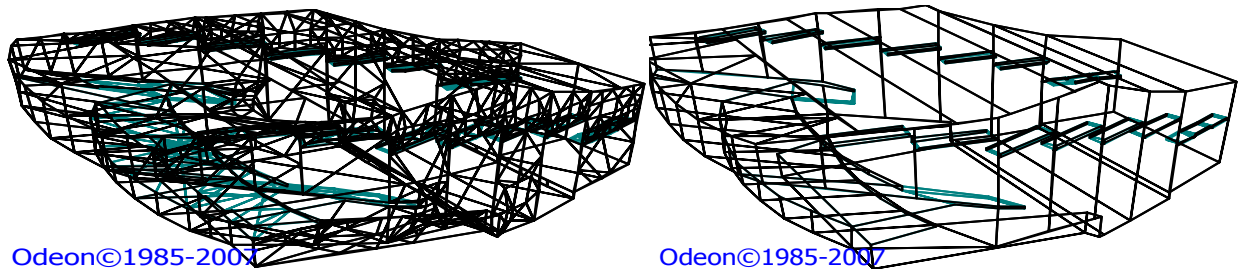

An example of ODEON doing its magic on an imported geometry. On the left; the geometry before ODEON applies it *Glue surfaces* algorithm, on the right the useful geometry which has been enhanced for calculations as well as for visualization. The processing has reduced the number of surfaces from 1362 to 209.

DXF format is a container format
A first thing to be aware of concerning the DXF format is that it is only a container for whatever data the user and /or the exporting CAD program desired to store there. Having a DXF drawing file is absolutely no guaranty that the geometry is a valid 3D surface model. First of all it may not be 3D at all, secondly it may not be a surface model and even if these fundamental requirements are fulfilled there may be dozens of other problems, for example some surfaces may be invalid, i.e. hold no area or they may be duplicated, in case the CAD operator was too fast on the *Ctrl+C* keystroke.

Another problem in the DXF format is that the same surface(s) may be described in several ways; this may depend on the actual CAD software used as well as on the CAD operator. This may work perfectly well as long as the surface is intended only for visual purposes for use internally in the CAD program or for printouts – but as we shall see in the following example, it does require some post processing before it is suitable for ODEON or other programs which uses the geometry for technical calculations.

Next page is shown a box which was modeled using the *Box* statement in a CAD program. When this box is saved to the DXF format it is saved as a so called *PolyFaceMesh* – this is not a problem; ODEON can import it, and applying the ODEON *Glue surfaces* algorithm, the 12 triangles are reduced to 6 larger rectangles which are better suited for printouts and - more importantly - better suited for the diffraction algorithms used in ODEON (the *Reflection Based Scattering method* [1]).
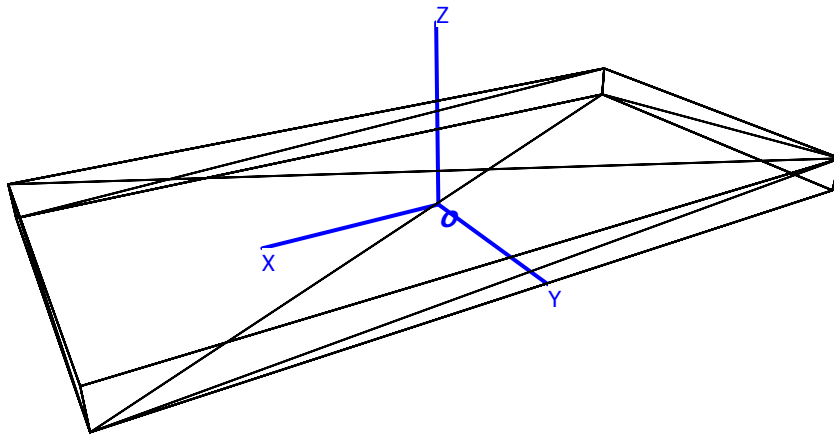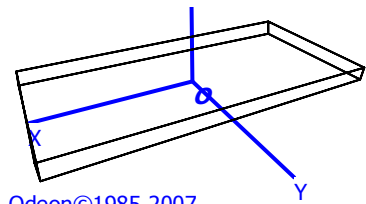
***Step 1***. A box which is made from 12 triangles and with some height can easily be imported by ODEON and ODEON can automatically convert it into 6 more useful rectangles.

So far no problems

A special problem appears when trying to import a box or an extrusion which has been assigned the height zero. In some CAD programs this is the only way to create a single flat surface; other programs allow such surfaces to be generated whereas others restrict the user in generating such a surface. In the cases where a box with a height of zero is in fact generated, 12 triangles may be exported to the DXF file. One might say that such a surface should just not be present in a DXF file intended for ODEON, however it is close to impossible to find and correct such a problem in the CAD program before exporting – in many cases we are talking geometries with thousands of surfaces.

Therefore when ODEON tries to import such a geometry, several problems have to be fixed; first a number of surfaces which are irrelevant because they hold no area have to be removed – this is a fairly simple task for ODEON, compute the normals of the surfaces, discard of the surfaces which have a normal of length of zero - well again thing are slightly more complicated than they might seem at first glance, a surface may have a valid normal and still hold no area, we want to discard such surfaces too.
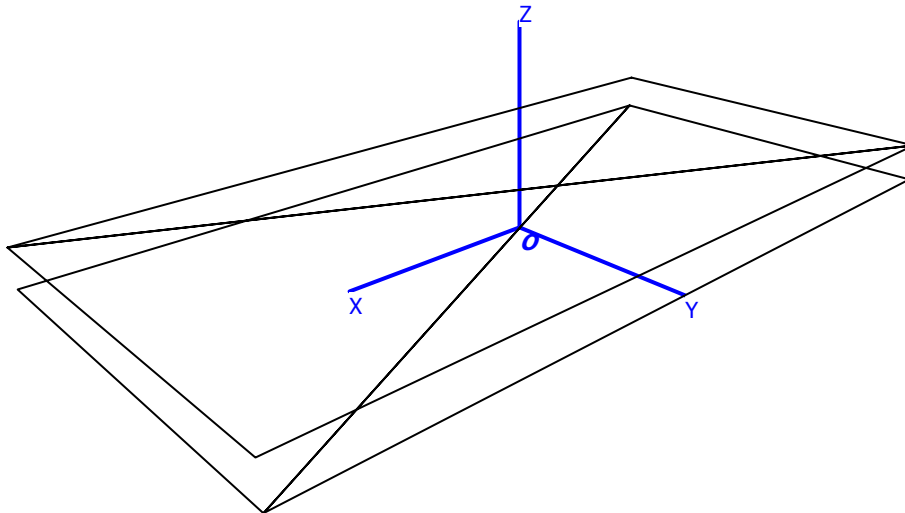
Step 2 After this operation we may end up having 4 triangles. These triangles are displayed with some distance between each other in the Z direction – but for now, imagine that they are in the same plane.

When applying the *Glue surfaces* algorithm of ODEON to such a collection of surfaces the poor result is in fact that the surfaces may cancel out! Add the lowest two joining triangles and we get a rectangle, but adding jet a triangle to that one we end with a triangle, and adding the last triangle and PUF! We end with two points, the surface is gone. This effect is not an error; indeed it is used actively in some solid modelling programs; add a small surface inside a larger one and you get a large surface with a small hole, see appendix A for an ultra short description of the *Glue surfaces* algorithm.
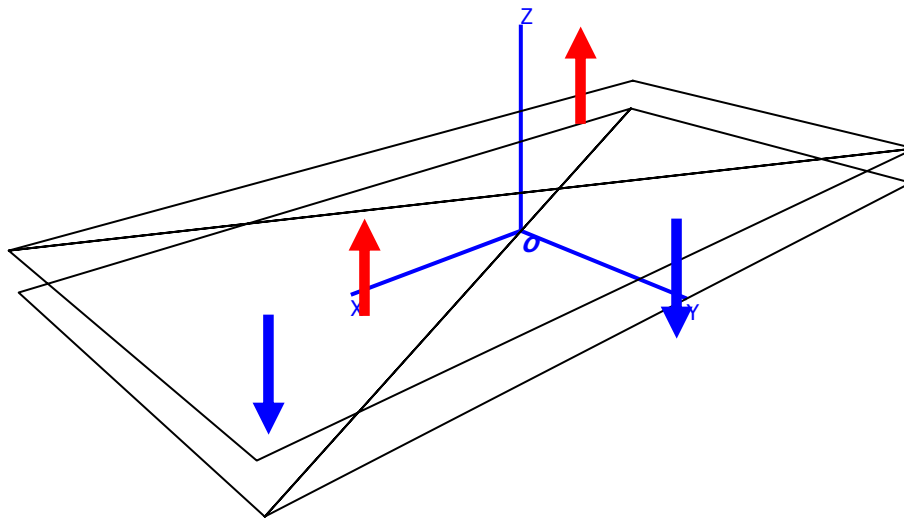
Step 3 Using surface normals in order to avoid surfaces from cancelling out.

So instead of adding all surfaces into one we study the orientation of the normals of the 4 triangles (defined by the order of the points in surfaces) and only if they have the same orientation the surfaces are added together. As a result we end up with two copies of the same rectangular surface.
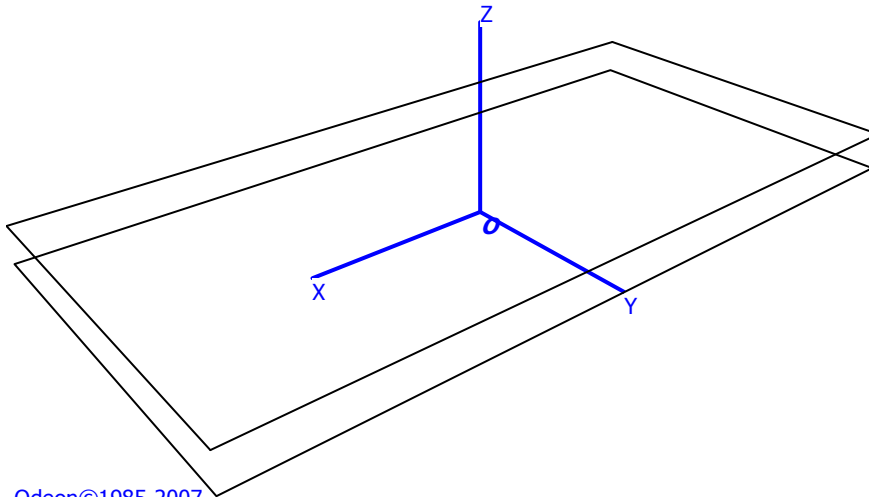
Step 4 We have obtained to identical rectangles – but we only need and we only want one. Having doublets can make it difficult to make sure that correct materials are assigned to the surface in ODEON – Assigning materials to a number of surfaces you may ask yourself: I changed the material of surface 3 but did I remember to deal with surface 4556 as well? We need to get rid of doublets.

So we just need to remove the doublet
In case the first surface is composed from point 1,2,3,4 then we just need to check if one of the following combinations are present 1,2,3,4 – 2,3,4,1 – 3,4,1,2 – 4,1,2,4 – 4,3,2,1 – 3,2,1,4 – 2,1,4,3 or 1,4,3,2 and remove the duplicate – finally we have filtered our surface info correctly.
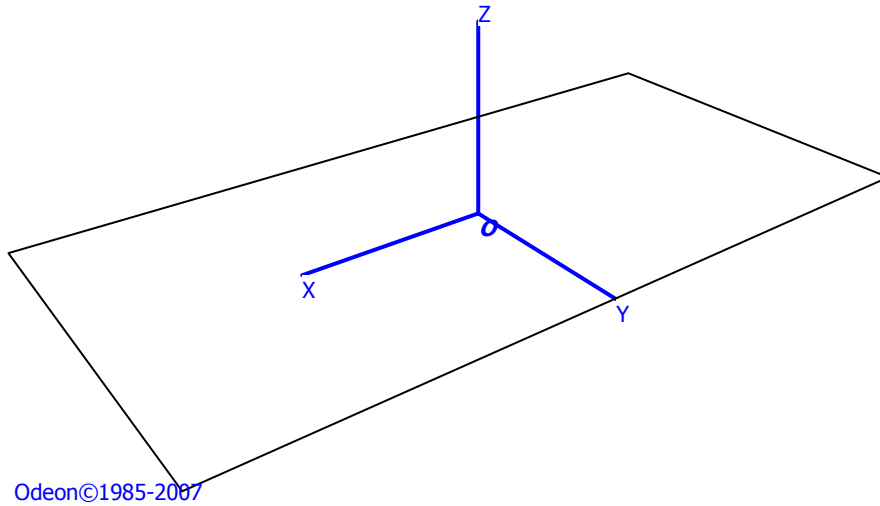
Step 5 Finally we managed to build the one rectangle we want from the 12 triangles in the input file.

We have investigated the import routine on one tricky surface. Keep in mind though that a geometry imported from a DXF file is likely to consist of thousands of polygons, some of them being much more complicated than a rectangle. Without an intelligent handling of the input data as in ODEON, loads of manual work is needed in order to make the model useful for calculations – in come cases it is completely unrealistic to do that by hand.

We have demonstrated one of many filters in ODEON's import routine, which aims at making geometries useful that would otherwise be useless. A number of other filters exist and thanks to these, in most cases the geometries can be imported and used directly for calculations in ODEON without further editing.

Another example – making imported geometries work with OpenGL
Another *DXF* filter which was added to ODEON 9 are aimed at making surfaces display correctly in the *3DOpenGL* display; in cases of surface with complex shape, such as surface with holes in them – some extra points are inserted at a few carefully chosen positions on the edge. These points help *OpenGL* to render the surfaces correctly for visualization purposes in the *3DOpenGL* display.
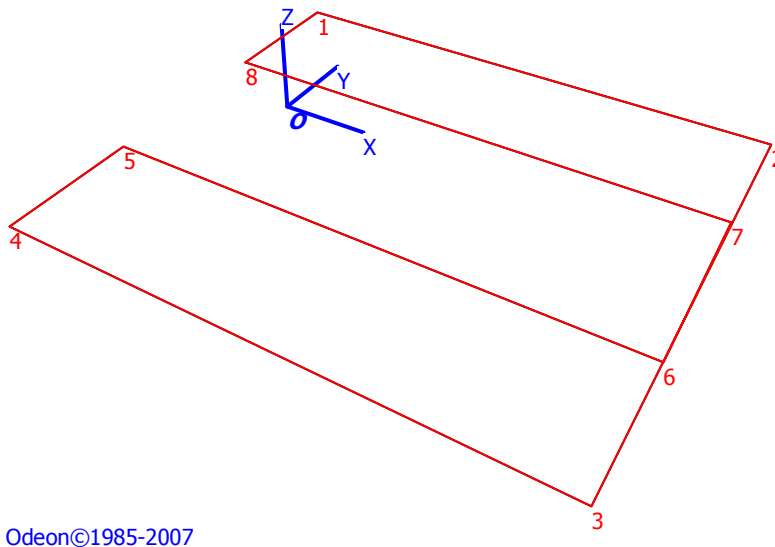
The sequence of point in the surface is 1, 2, 3, 4, 5, 6, 7 and 8. ODEON automatically extends this sequence to 1, 2, 7, 6, 3, 4, 5, 6, 7 and 8 thus improving the probability that *OpenGL* (which is usually implemented on you graphics card) will manage to render this surface correctly.

If you have purchased ODEON 9.0 – then congratulations we hope you'll enjoy using it.

And if you should after all experience an import problem, bear over with us, we are doing our best to find valid medicine – some diseases are though quite difficult to cure.

3DStudio files
To further support the use of CAD models, generated in external programs, we have added direct support for the .3ds format which is used by numerous 3D modelling programs.

References
[1] Claus Lynge Christensen, Jens Holger Rindel, A new scattering method that combines roughness and diffraction effects. Forum Acousticum 2005. Budapest, Hungary. Available for download at: http://odeon.dk/publications.htm.

Appendix A: Glue surfaces algorithm
Some of the main aspects of the ODEON gluing algorithm are outlined the figure below. Do notice that the figure uses some very simple shapes as examples and that it simplifies the problem to two dimensions. One of the main problems is that surfaces should only be added together if they are close enough to be in the same plane in the 3D space – other problems are such ones as mentioned in the technical not which this appendix is a part of.
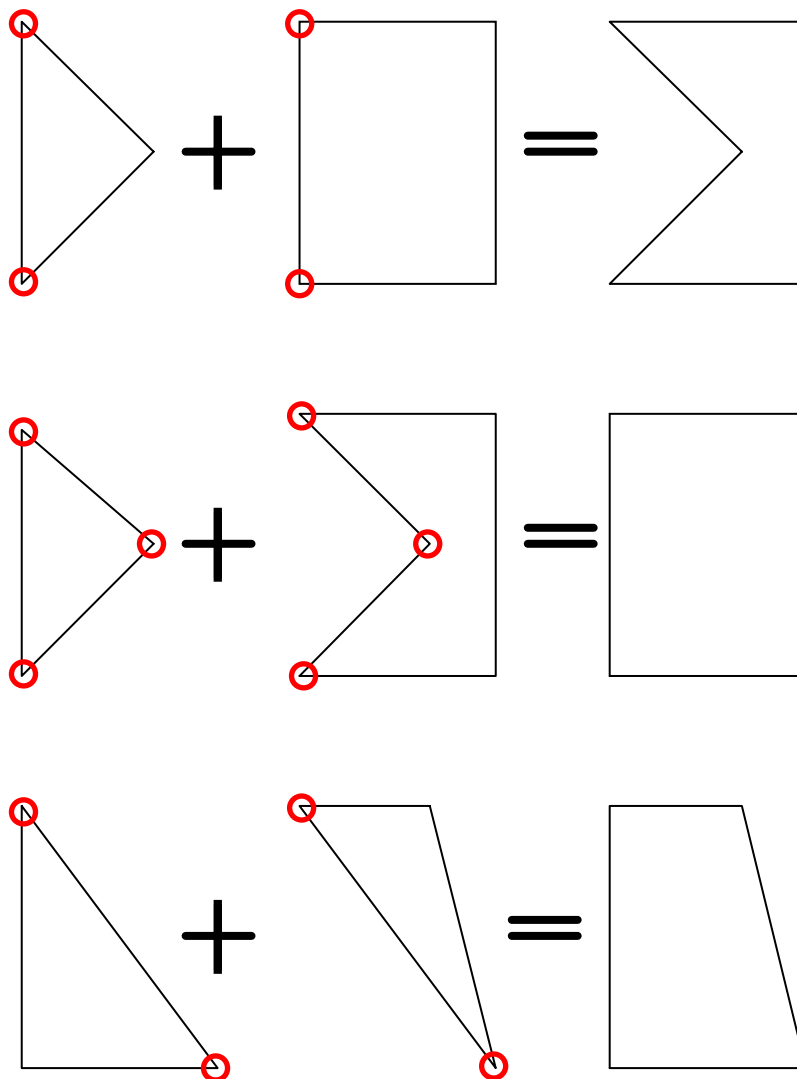
Summarizing the Glue surfaces mechanism in three examples
Bottom
Additive surfaces; two triangles which doesn't overlap has two points in common – one point is added to the original and the area increases.
Middle
Additive surfaces; a triangle and a five point surface which doesn't overlap have three points in common – one point is removed and the area increases.
Top
Subtractive surfaces; a triangle which overlaps a rectangle and have two points in common – one point is added to the original and the area decreases.