Original post : http://feaforall.com/cad-model-simplification-for-fea-analysis/

FEA basics – CAD model simplification for FEA analysis

April 21, 2013 by Cyprien 24 Comments (Edit)

Today's subject: CAD model simplification for FEA analysis. Why do you need to simplify your model? How can I do that?

The **most simple** workflow for FEA analysis is:

1. Import CAD model

2. Mesh the model

3. Assign boundary and loads

4. Perform analysis

Unfortunately, all may not go as smoothly as we want…

– The CAD model may be **extremely detailed** (the dream of the CAD designer and the nightmare of the CAE Engineer), and lead to very complex or impossible meshing.

– The CAD model may contain *small edges*, *doubled edges* or *very small faces* which make the meshing nearly impossible.

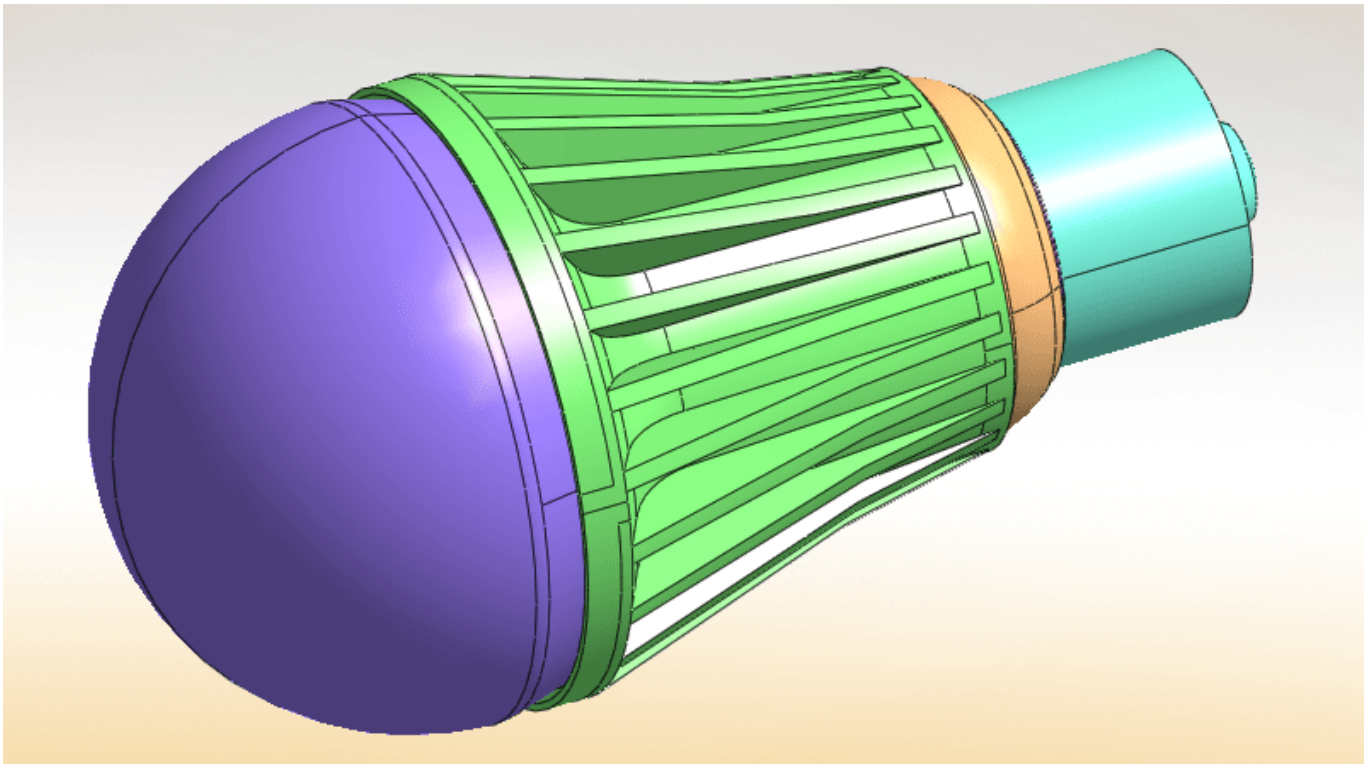
And if you need a more deep explanation:

The CAE engineer wants to get accurate results using a solver which converge as fast as possible. Even if the relation between Mesh quality and accuracy is not as clear as we usually think (see this blog post for more info), a poor mesh will lead to poor convergence of the solver and decrease the accuracy of the results.

Another reason to simplify the CAD model is to get a model more easy to compare with Theory, because theory always considers very simple

models. If the model used from the beginning is very complex, there is no way to validate and compare results with theory.

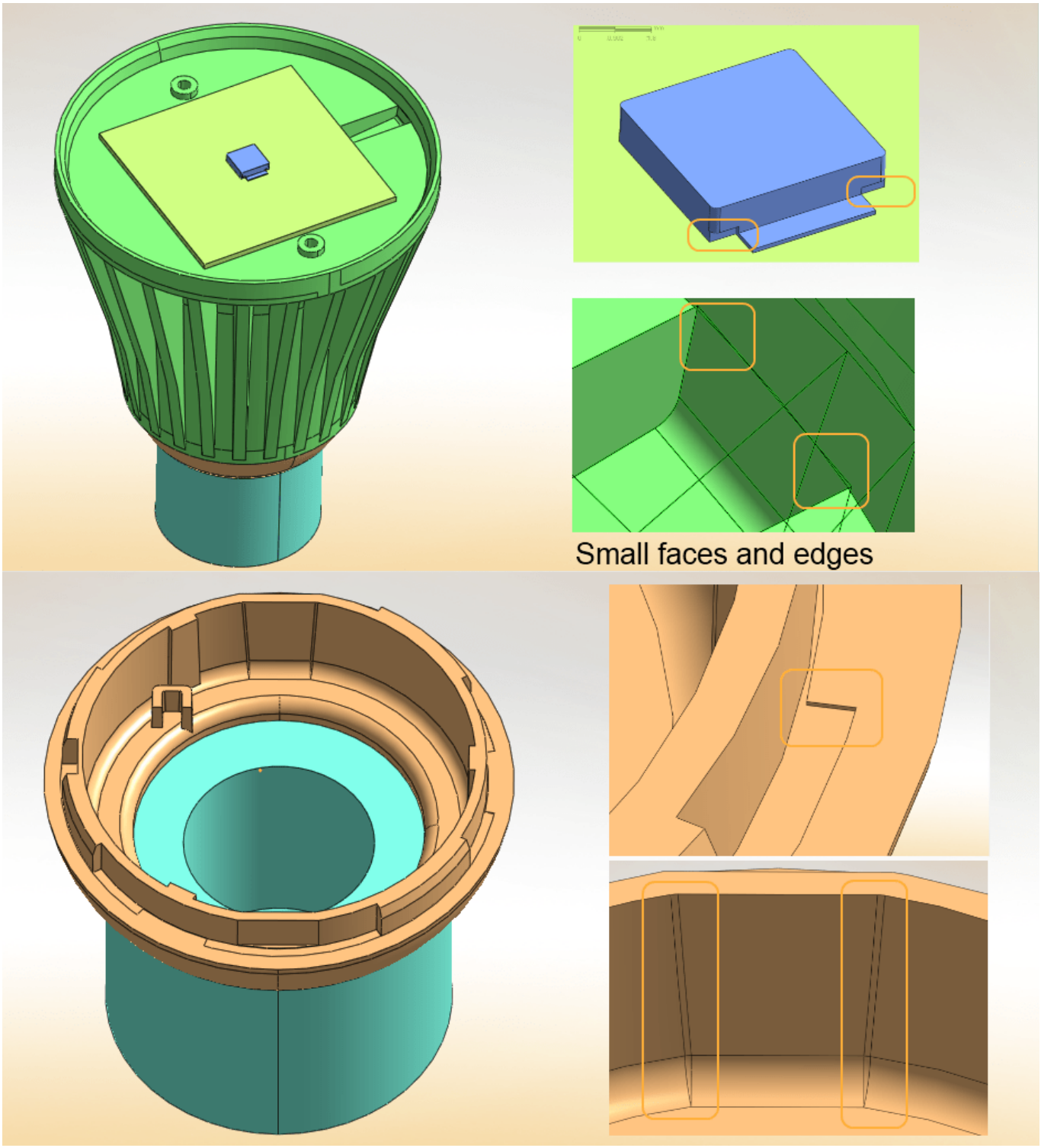
I will give an example to explain more in details the need to simplify the model:



This is the CAD model of a LED lamp, and i want to perform a **CFD thermal coupled analysis** on it. To perform this type of analysis, I need to analyze solid parts and fluid parts together in CFD. The contact between fluid and solid is done using CFD contacts which are quite sensitive to the mesh quality.

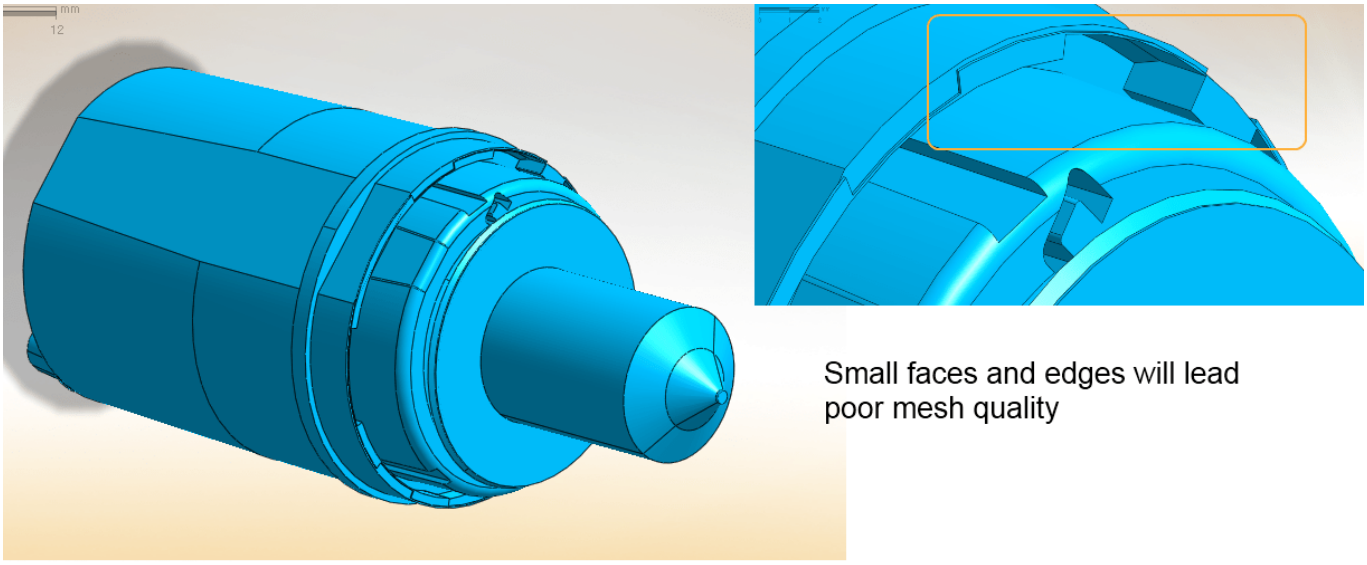
So, to perform this analysis, I need to mesh the model with very good mesh. The criteria I usually consider is the simpliest. The aspect ratio should be under 8 (aspect ratio is the ratio of the biggest edge on the largest edge of one mesh element).

The first step is to inspect the CAD model to verify is it is “proper” or not for the FEA analysis:

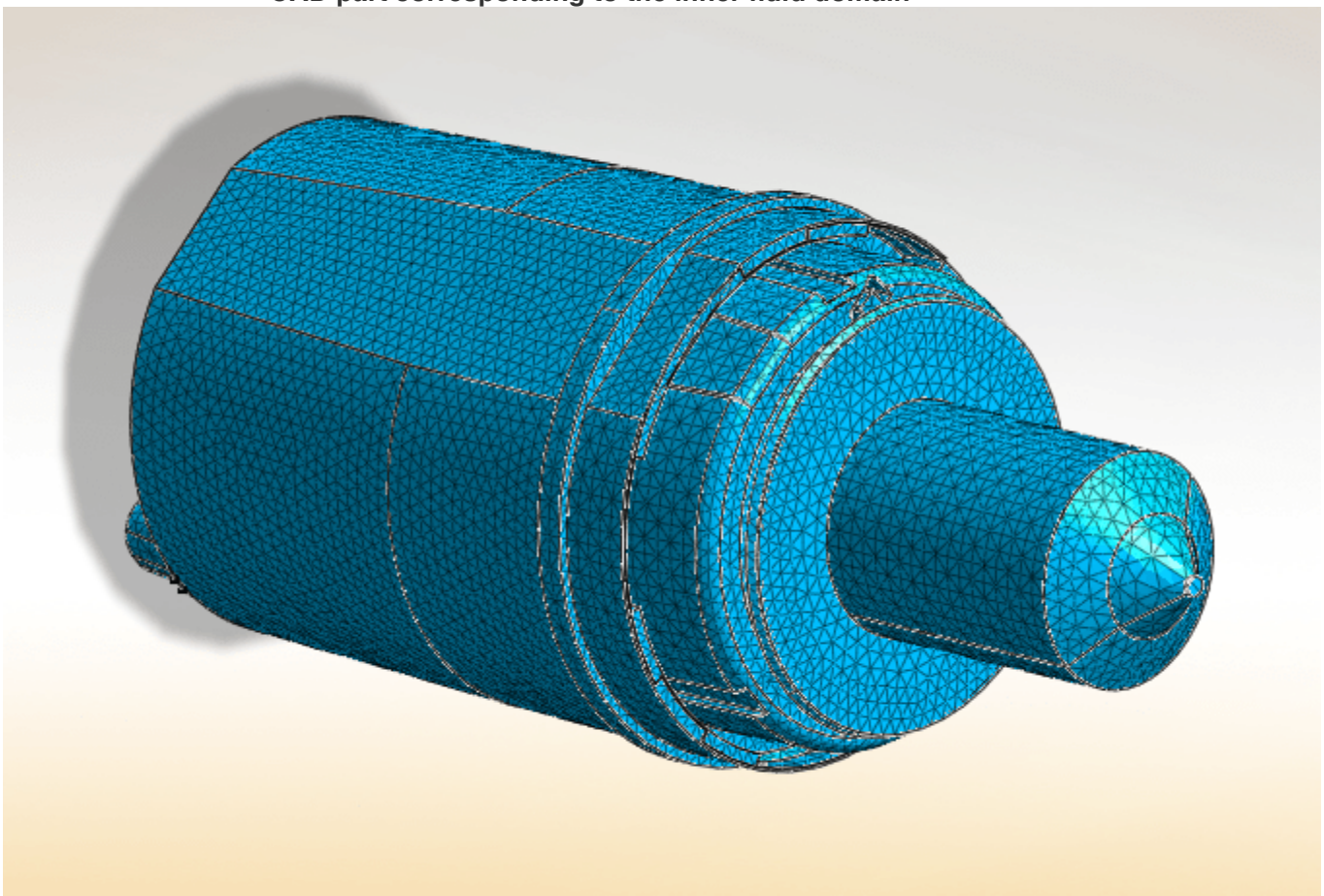


After inspection, several parts contain small edges and faces which may lead to poor mesh.

The quality of the mesh in the fluid domain is even more important than in the solid parts. Let's take a look at the inner fluid domain (the air contained in the LED):

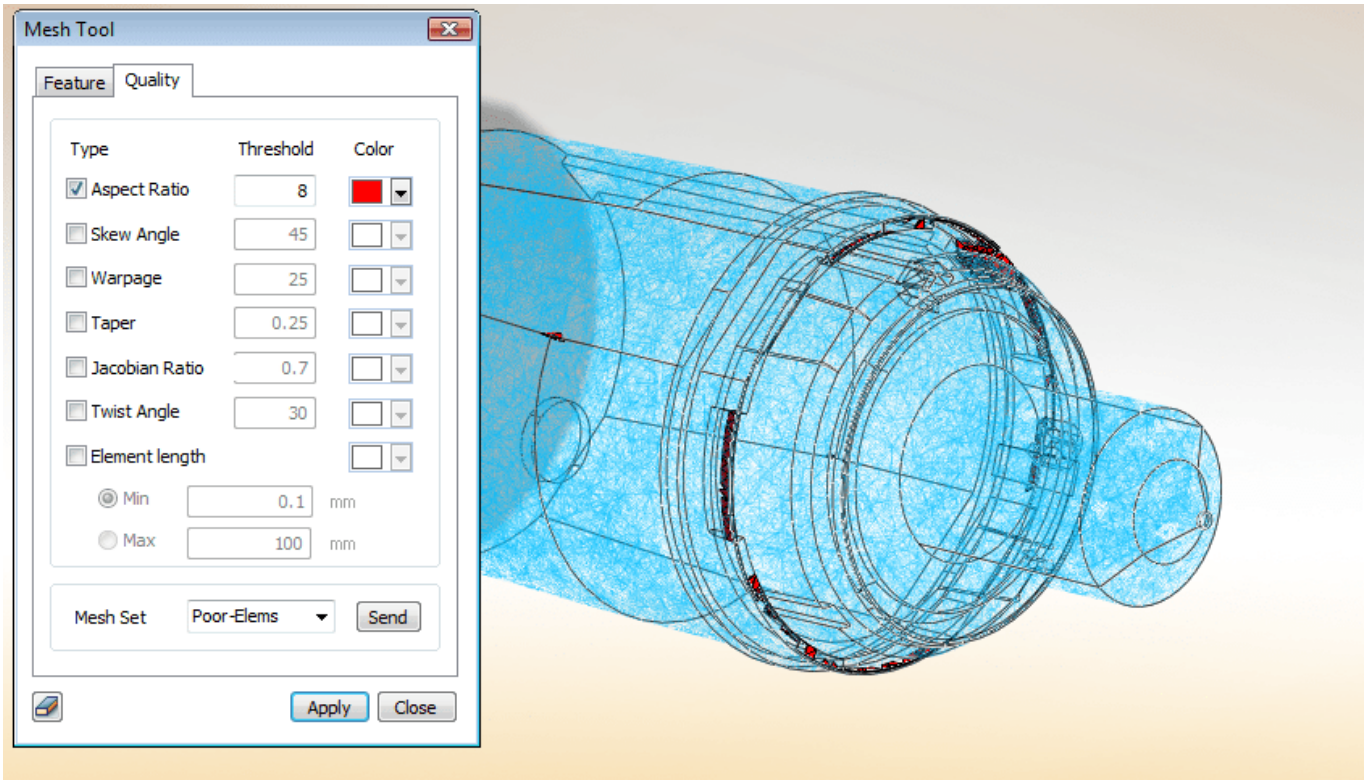


CAD part corresponding to the inner fluid domain



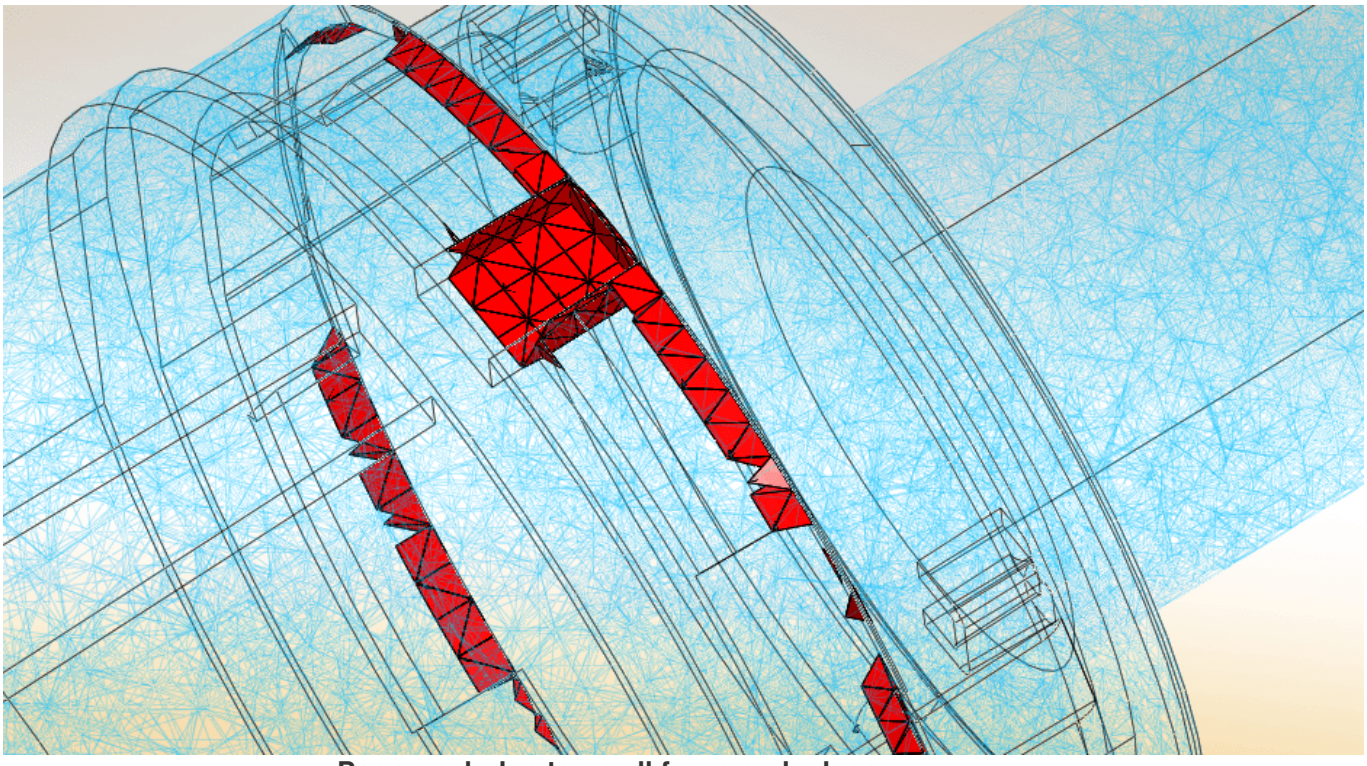
inner fluid domain meshed (mesh size 1mm)

The mesh "seems" good, but we should be aware that the mesh quality is not something that can be checked so easily. **Mesh quality check has to be done to confirm if we can use this mesh or if we need to remesh it.**



Mesh quality check (Aspect Ratio < 8)

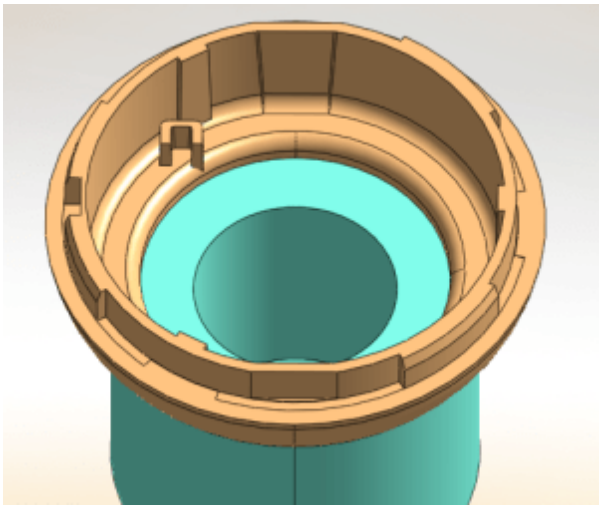
Let's see closer:



Poor mesh due to small faces and edges

These **small faces** will lead to **divergence of the temperature** around them at CFD contact between solid and fluid parts.

We have only one way to remedy to that, the model need to be simplified…

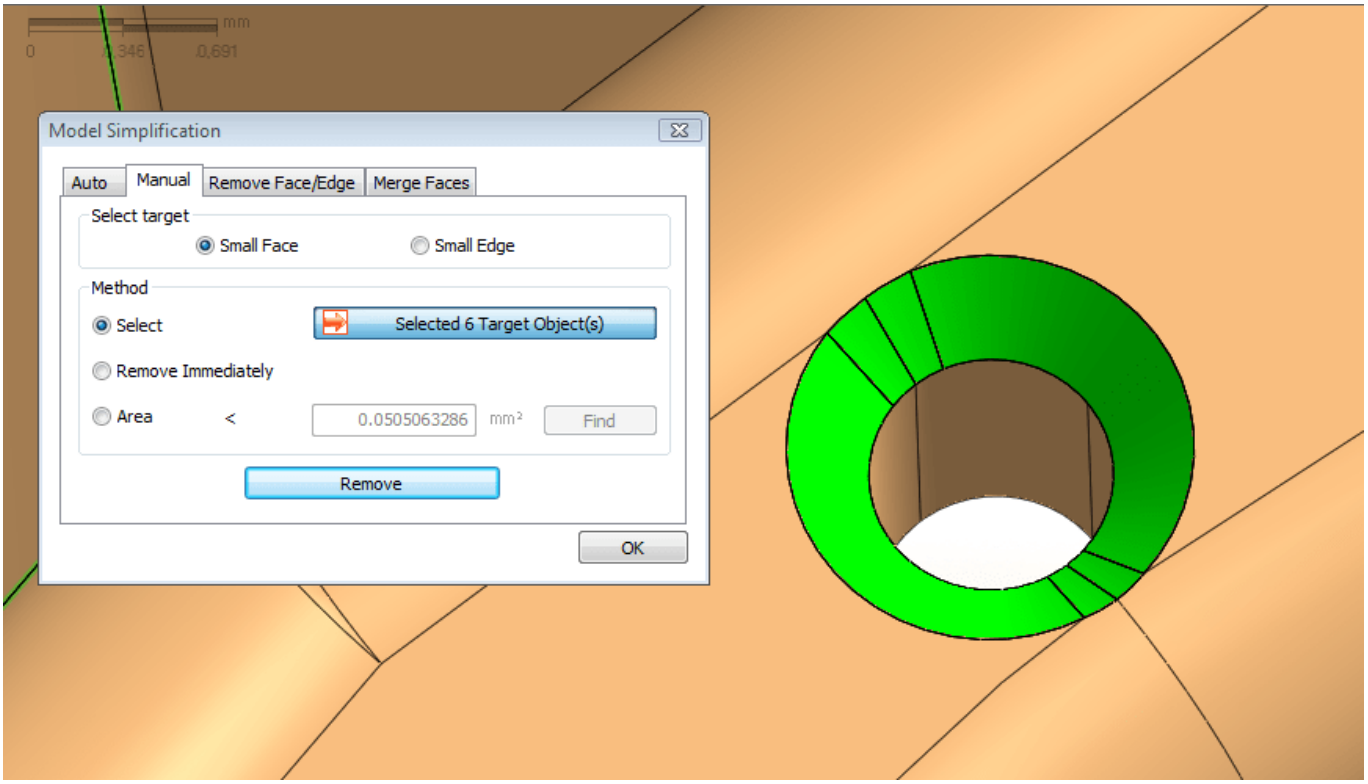


Part to simplify

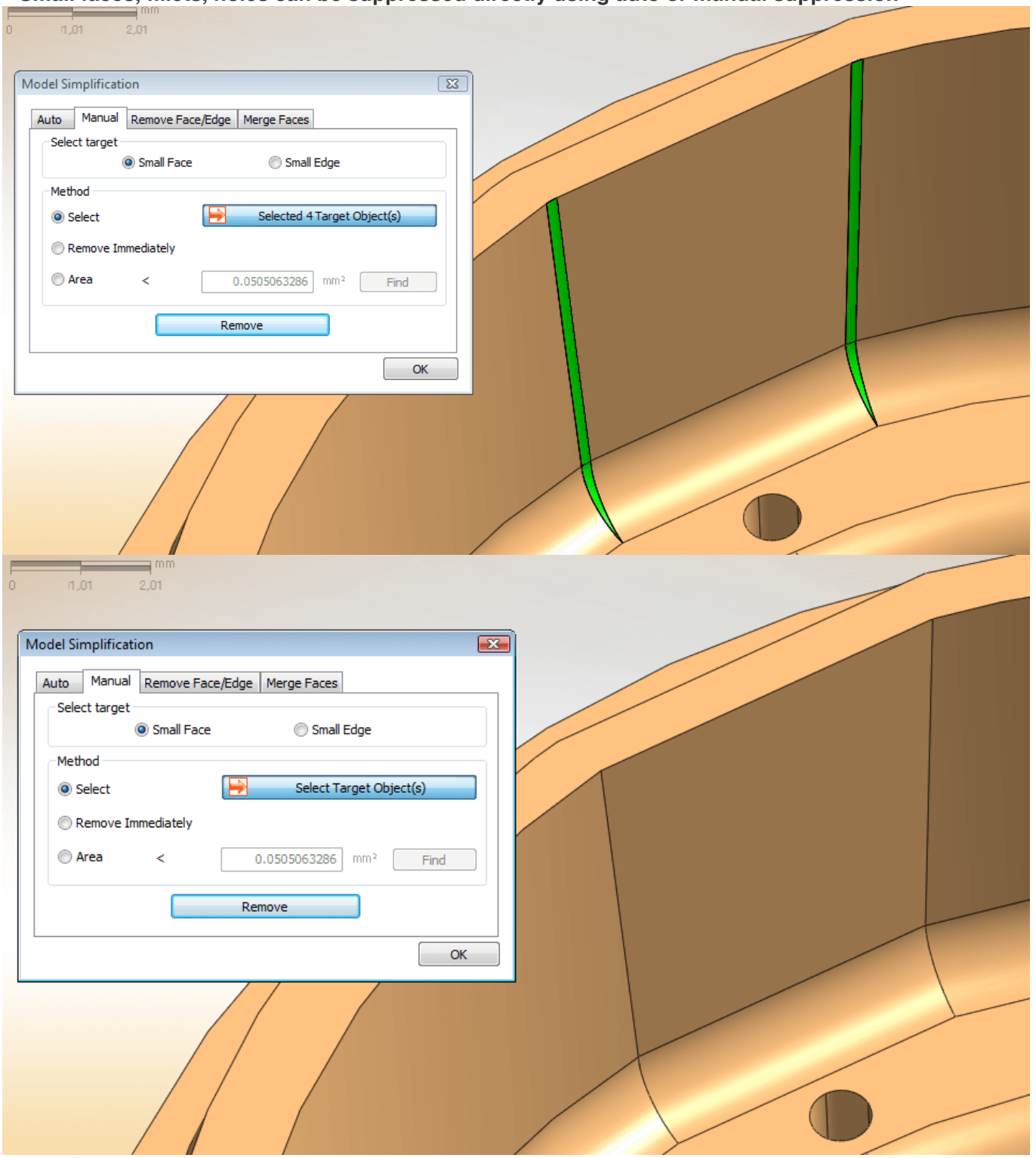
The best way to do is not to simplify the inner fluid part, but to simplify the solid part which causes the small faces in the inner fluid part. after simplification, the fluid part can be generated again using simple boolean operations.

I will show here a few methods that can be used to simplify the part.

1. Use the simplification tools provided in your CAE software:

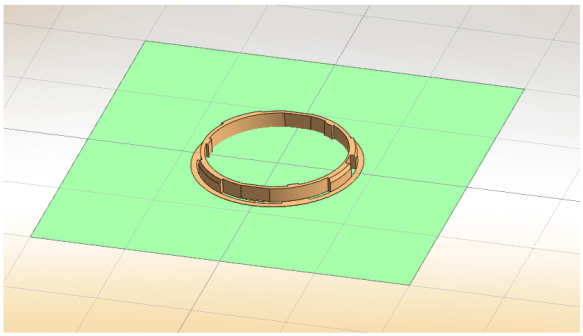


Small faces, fillets, holes can be suppressed directly using auto or manual suppression

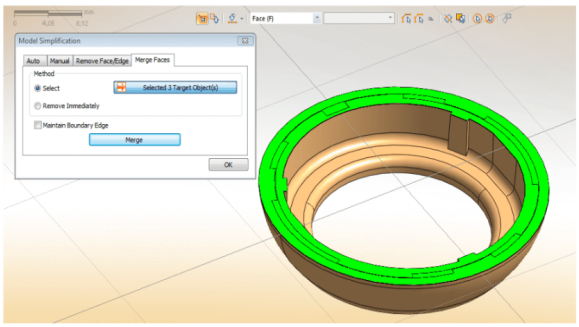


2. When model cannot be simplified using simplification tools, the best way is to come back to your CAD software to do the simplification job.

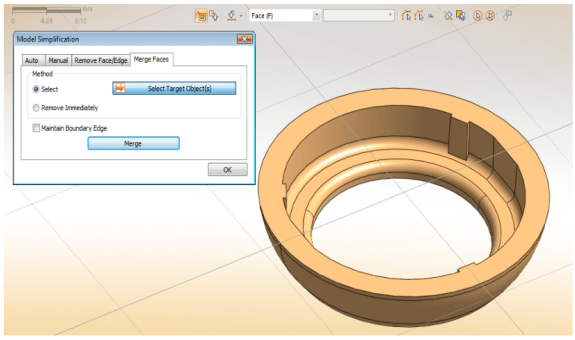
If you don't have CAD software, you still have a way to **simplify your model using simple boolean operations**:



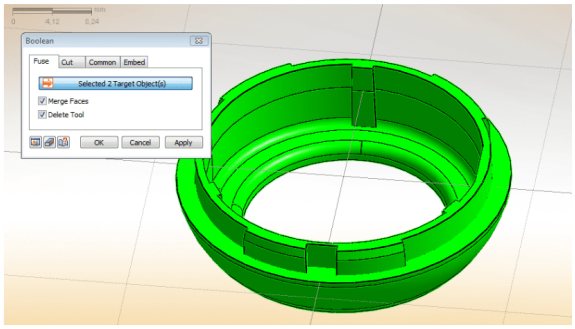
1. Divide the part using a cuting plane



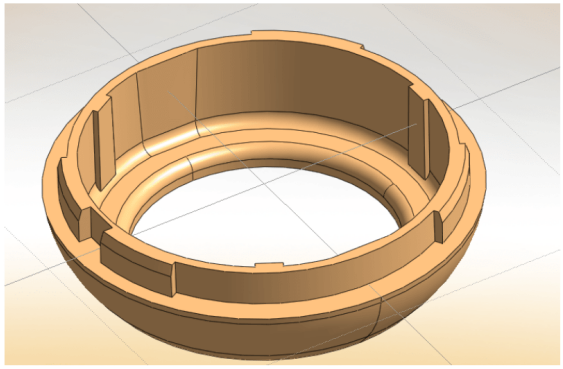
2. Merge the faces of the solid



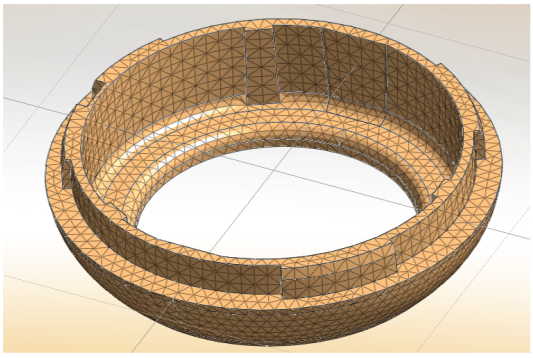
3. Clean small faces



4. Fuse the 2 parts again



5. Simplified part



6. Simplified part after meshing

Simplification method using boolean operations

Actually, this is a method I invented myself, I don't know how other CAE perform this kind of simplification… I guess using CAD is still the best way… If you have such experience of model simplification, let me a

comment in the section below ! Thanks in advance to share your own experience ;-)

See you next week for another FEA interesting subject !

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