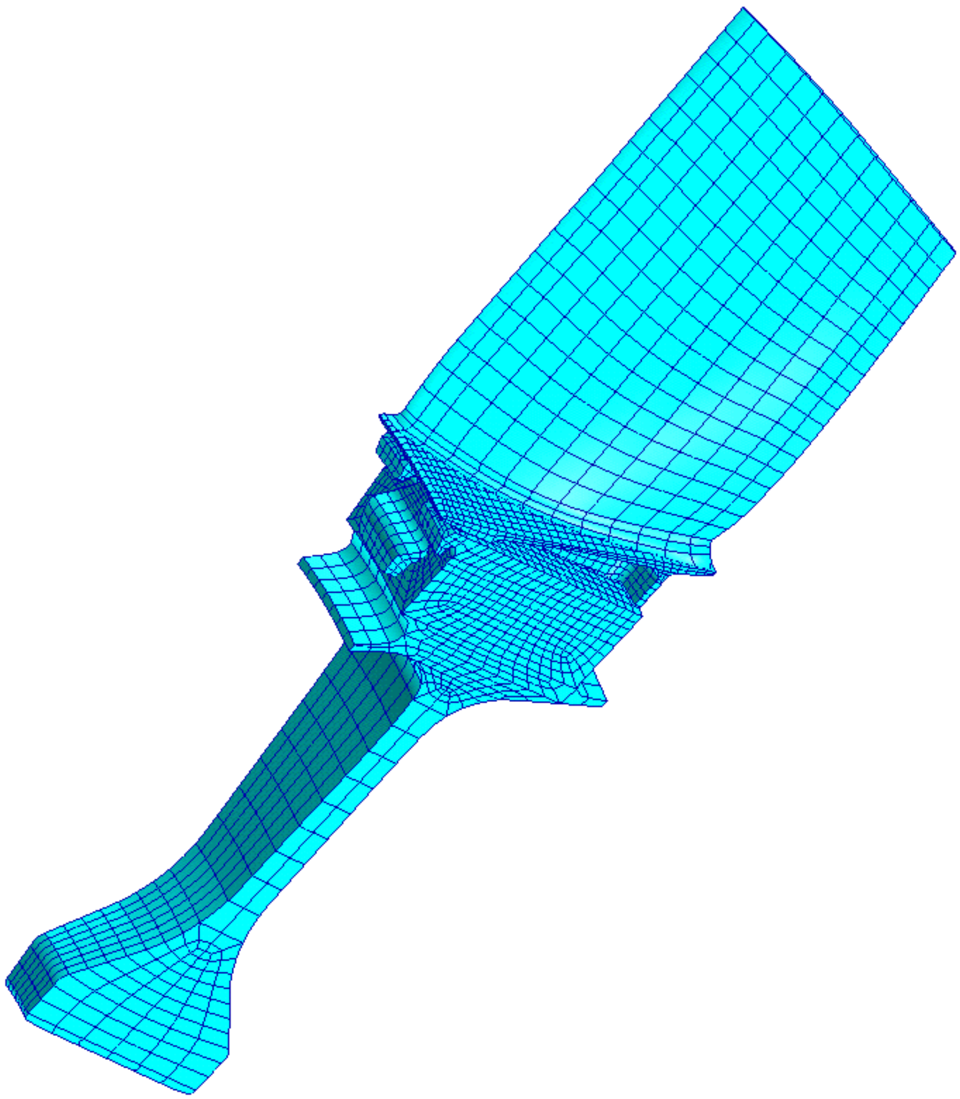
Snecma Blade and Disk Meshing methodology



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MSC World Aerospace Conference
June 7-10, 1999

Summary

This paper will describe a consulting project that MSC France did for Snecma. This project was called time cycle reduction. We aimed at increasing the productivity of Snecma's Design Office by defining the most accurate methodology for meshing a compressor blade and disk using MSC/PATRAN.

Throughout this presentation the detailed process will be developped to explain how the time reduction was obtained.

According to what has already been done, both Snecma and MSC have great hope to enhance our first results by using MSC new tools.

Catia Model

Both blade and disk are part of a Snecma civil engine. Each component of this model is an exact solid made with Catia 4.1.8.

Catia Geometry Access

The Catia direct access option was used in order to import the Catia model into MSC/PATRAN 8.

This method allows the streamlines access of Catia models with features such as:

- ✓ import filtering
- ✓ interactive or batch access

In MSC/PATRAN

We will take some pictures to study the various areas of meshing such as the junction airfoil/platform, the connection blade/disk and the repetitive meshing of the faces of the disk.

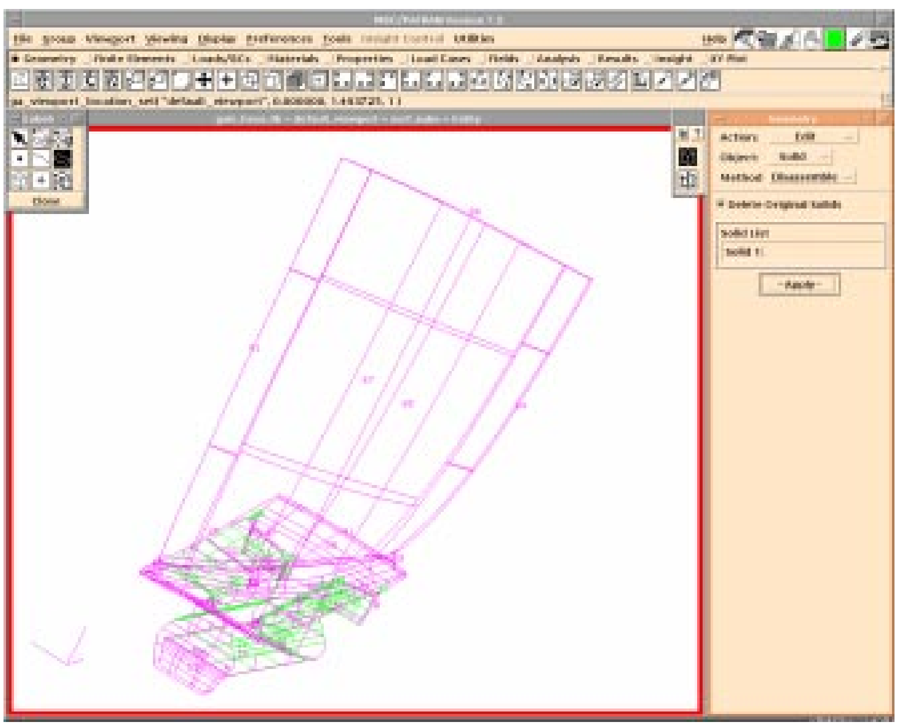
Technical hints

The main difficulty of hexahedral meshing lays with the cutting of B-Rep solids (usually called white solids into MSC/PATRAN). Let us now see how we can disassemble the solids, dress up the airfoil and mesh the dovetail and the disk.

Disassembling of geometric entities (solids and surfaces):

We do not have for the time being any automatic hexahedral mesher. Therefore after the import we first have to disassemble the solids, then the surfaces so as to allow the creation of 5 or 6 faces solids (usually called blue solids into MSC/PATRAN).

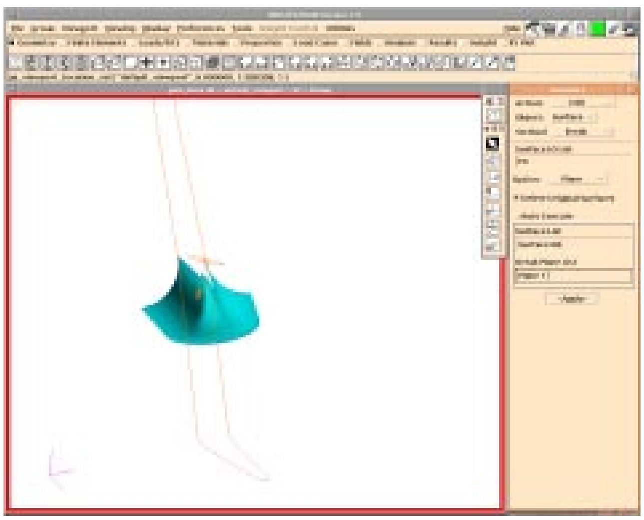
To disassemble the geometric entities we used the sequence “Edit / Solid or Surface / Disassemble” as shown here below:

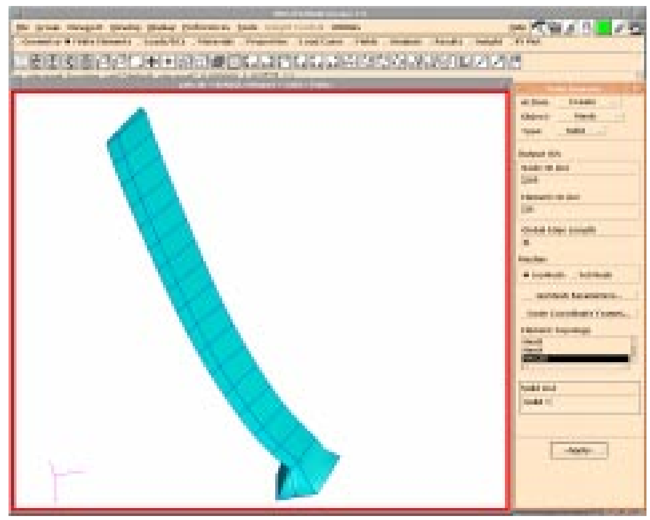


Processing of the trailing edge and of the fillet airfoil/platform:

We now have to process the trailing edge of the blade and to disassemble the trimmed surfaces (usually called magenta surfaces into MSC/PATRAN).

This processing aims at getting back the green surfaces (with 3 or 4 edges) that we will used to create the blue solids necessary to the hexahedral mesher.
As the green surfaces overlap the limits of the structure, we have to resize them to the physical boundaries. We will then use a plane to break neatly the surfaces as shown here below:





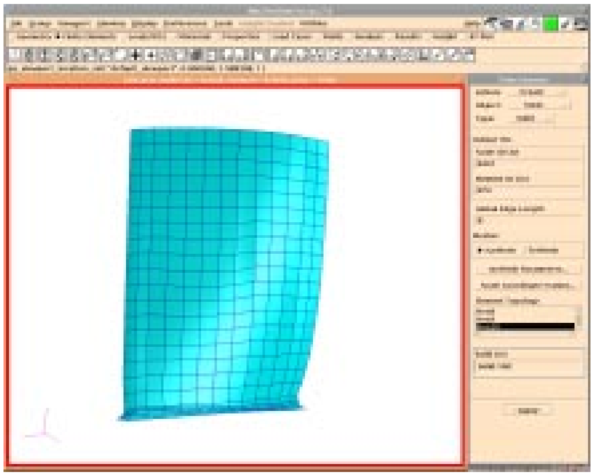
Processing of surfaces   Mesh

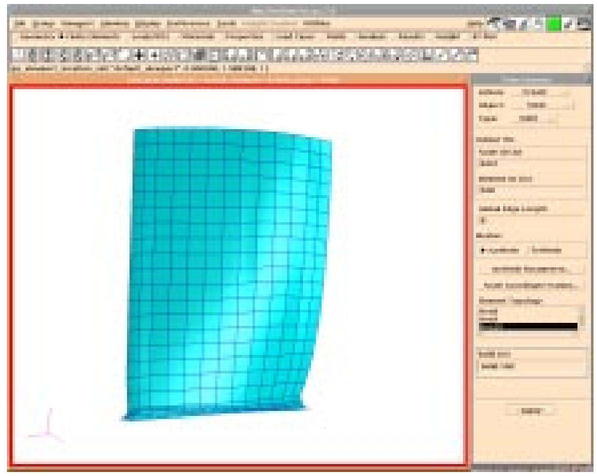
Processing of the airfoil:

The created mesh is frequently disturbed by a bad geometric parametrization. We will avoid it by means of very little distort hexahedral mesh intrados and extrados. It involves the following steps:

- 1) Meshing of one face with quads,
- 2) Smoothing the mesh of the face,
- 3) Repeating the stepts 1) et 2) on the other face,
- 4) Meshing with the loft method which allows the sweepingof the 2D base element to the location of a 2D top element.

To the left here below, you will see the one shot meshing from the solid. To the right here below, you will see the meshing that we obtained from our method (the mesh are better shaped).





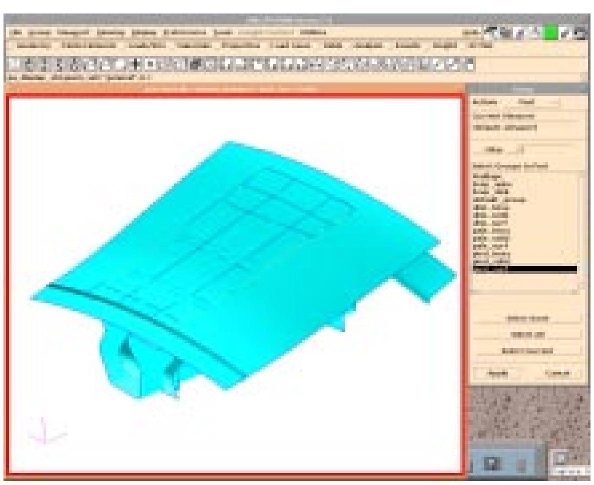
Direct Hex

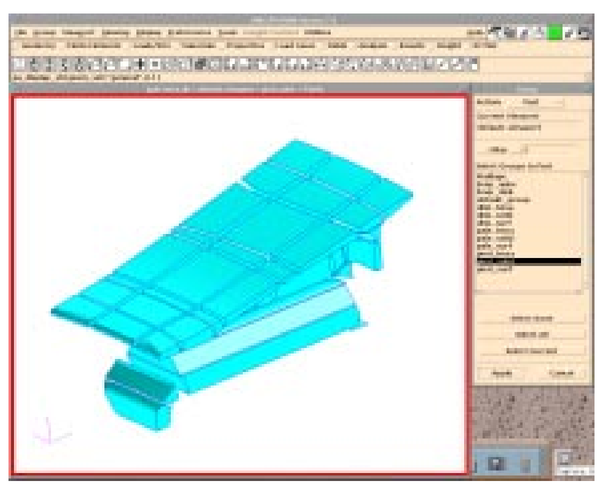
Smoothing of the quads

Processing of the dovetail :

No doubt it is the most time consuming in the creation of the model. We operate the same way for the airfoil as for the dovetail. From the blade that we have previously disassemble, we will go down towards the green surfaces to create finally the blue solids by use of the sequence “Edit/Solid or Surface/Disassemble”.

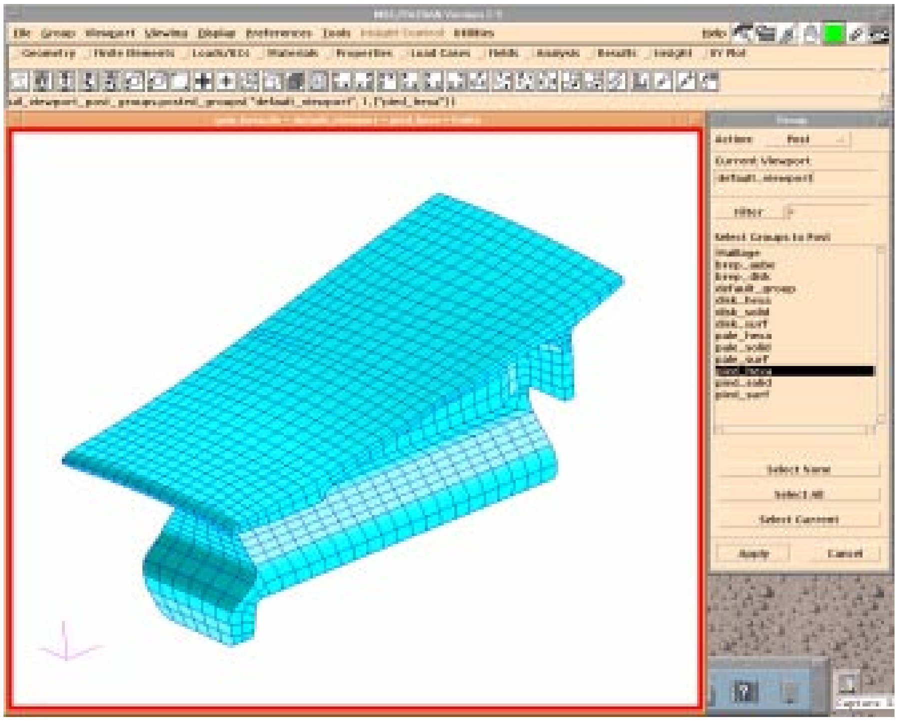
It is very useful to keep the manifold surface on the top of the platform. Thus we will use it to project the edges of the solids of the dovetail. We will make sure to keep the original shape as shown here below:





Projected curves on the platform

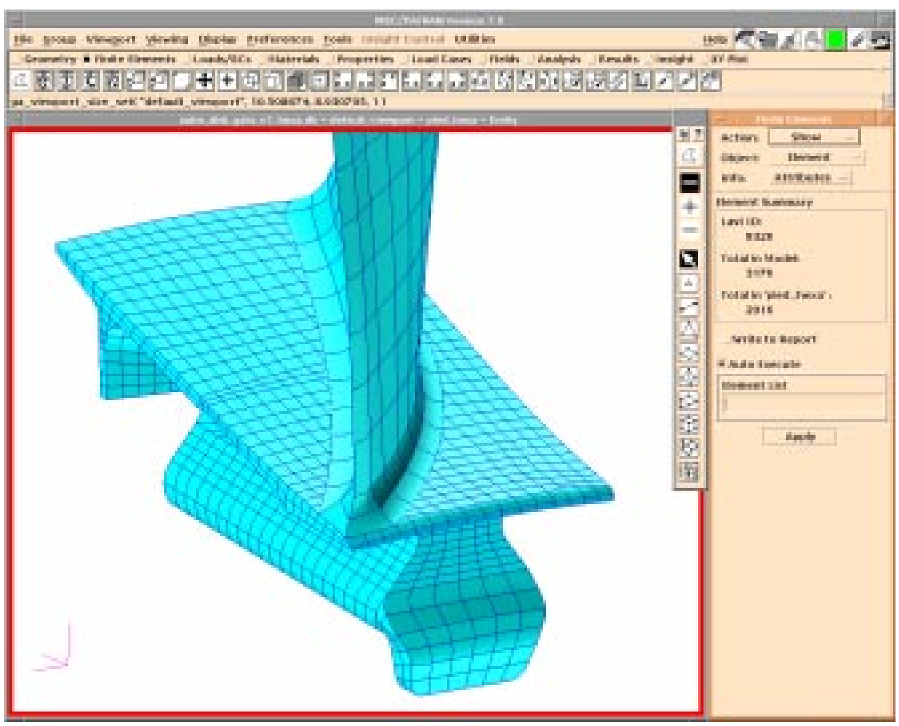
Création of blue solids



Final mesh

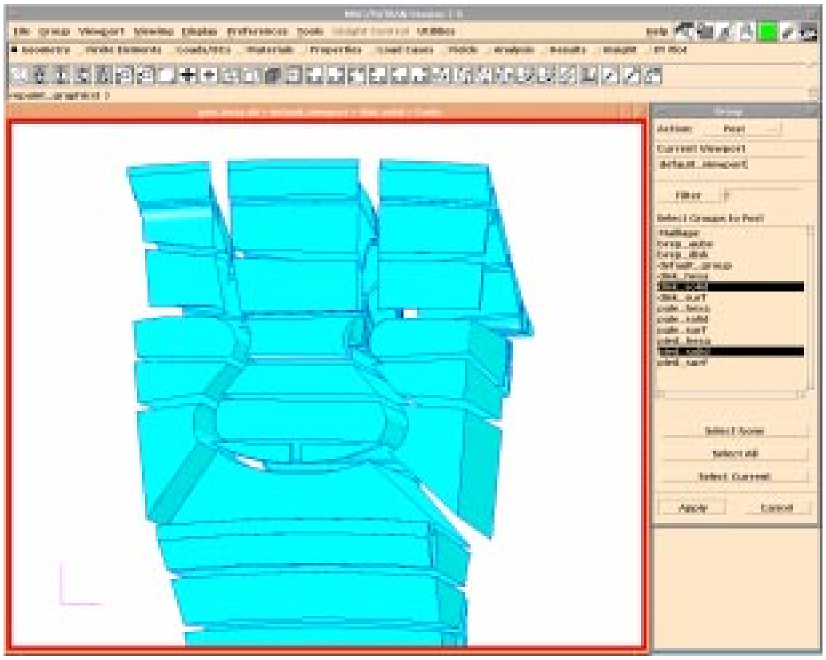
Connection airfoil/dovetail:

To save up time, this connection is realized by appending the airfoil on the blade with the Samcef command .Append.



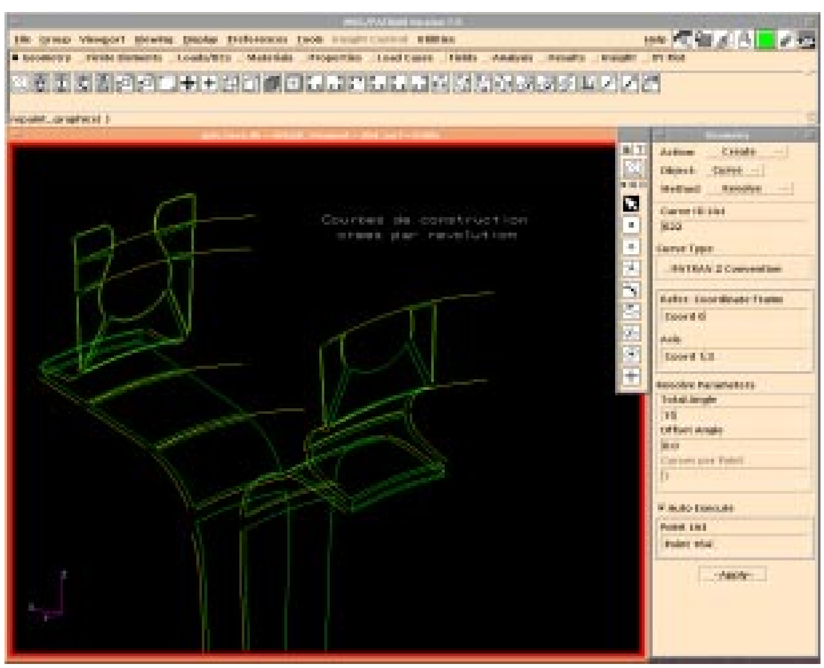
Connection blade/disk :

The most difficult here is to have congruent mesh on both blade and disk. In order to do it, when the solids are created we will use the same edges as those used to create the solids of the blade.

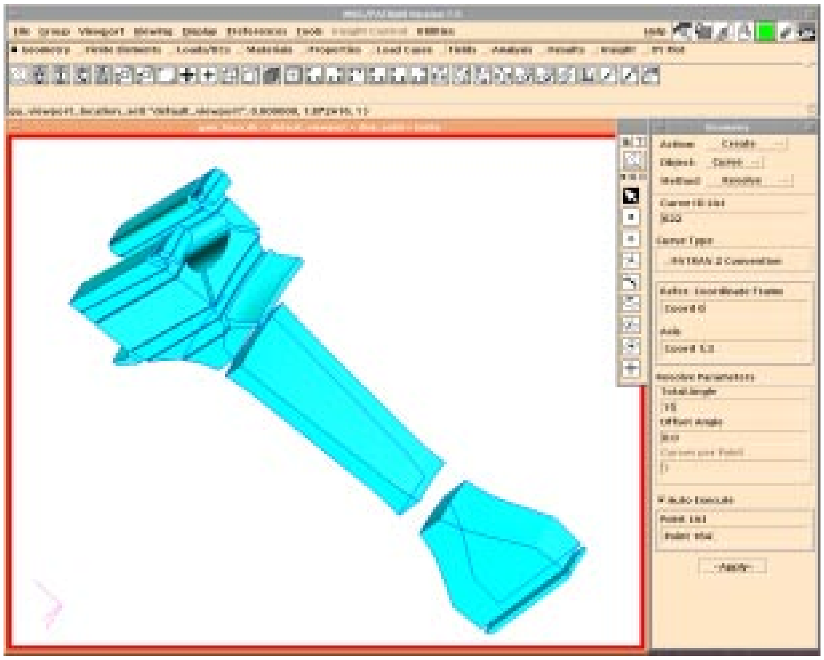


Processing of the disk :

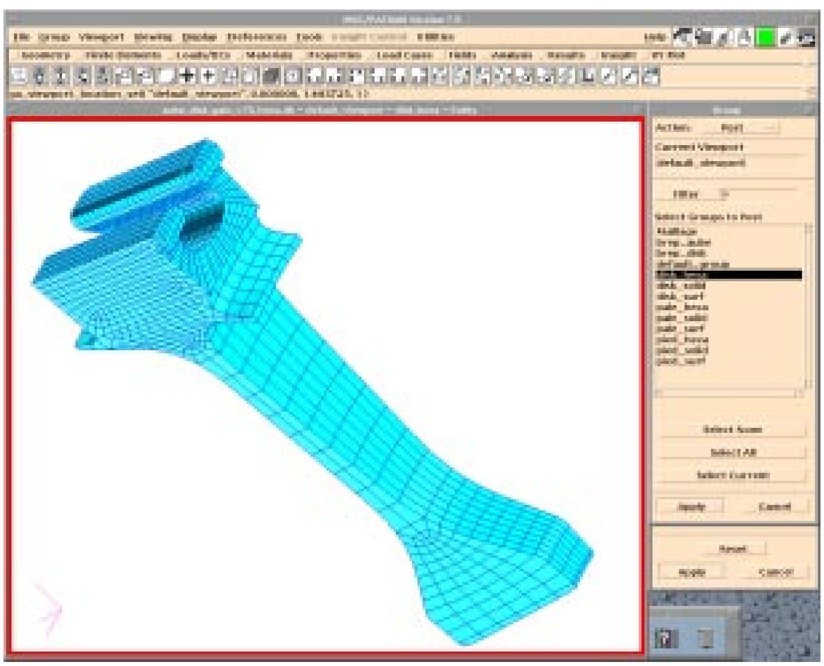
For this last part, we only have to make sure to keep the repetitivity of the disk. Thus each node of one side of the disk will have to meet another node on the opposite surface. The revolve method is used to ensure the perfect repetitivity of the model.



Once the surfaces are created, we only have to use them to create the solids by way of the sequence “Create/Solid/Surface” and we will then have the following model:



Final geometry



Final mesh

According to this methodology the time reduction is about 50%.

Conclusion

In order to help the end user understand fully the methodology as it is explained here above, MSC has developed a new useful software called MSC/Acumen.

The original goal for developing MSC/Acumen was to make MSC/PATRAN usable for the novice or occasional user. The MSC/Acumen environment makes that possible though its extreme ease of use for the end user, based on the options and information presented by the author.

MSC/Acumen applications present a single form interface for the user. It limits the options available to the user to only those provided by the author. The HTML display widget allows for greater explanations at each step to help guide the user. The explanations can be written in a language the end user understands, whether that is a foreign language such as Japanese, or the terminology of a particular technical discipline such as that used in design of airplane wings.

The MSC/Acumen platform software allows for the capture of the expert's knowledge and methods. It has features built in allowing the author to enforce these expert methods and best practices. The author is in control of the options presented to the user, and can use bitmap pictures and text to help explain each step, all on the single user interface form. There are also error checking and work-flow management capabilities available to keep the end user from straying too far from the allowable design space. With all of this control comes a responsibility. The author must provide the appropriate knowledge and information to guide the end user. The author must provide all necessary options for scenarios that the application might cover. The HTML text explanations are written using terms the end user is familiar with. A great amount of trust is placed in application author to insure that simulations performed by non-experts will result in the same fidelity and accuracy that the dedicated experts provide. This requires a high level of professional practice for MSC/Acumen authoring.

A foretaste of what has been done with MSC/Acumen for the Snecma blade and disk meshing methodology in French …

… the best is kept for the MSC Worldwide Aerospace Conference !