HYBRID MODELING OF COMPLEX SURFACES USING CATIA V5

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Abstract: The paper presents problems with modeling of solids in the CATIA software package. The construction of complex surfaces is much easier when using a solid model defined previously. The lack of some tools in the workbench (especially those related to the parametric description) makes difficult a rigorous modeling of the surfaces constrained by boundary conditions or correlations between the vertex positions. Due to these drawbacks, the software package seems inaccurate and unstable.

Key words: solid model, CATIA, surface modeling, parametric description.

1. GENERAL TOPICS

An object bounded by complex surfaces can be generated in two ways by CATIA:

- Using instruments specific to solid modeling
- By generating a solid having a simple shape and some NUPBS (Non-Uniform Polynomial B-Spline) surfaces and using them to cut a geometric feature having a geometry conveniently defined.

The first method allows an easier construction, but the model may show fillet imperfections that could be unacceptable in some applications. Figure 1 presents the result of the modeling process when using this method.

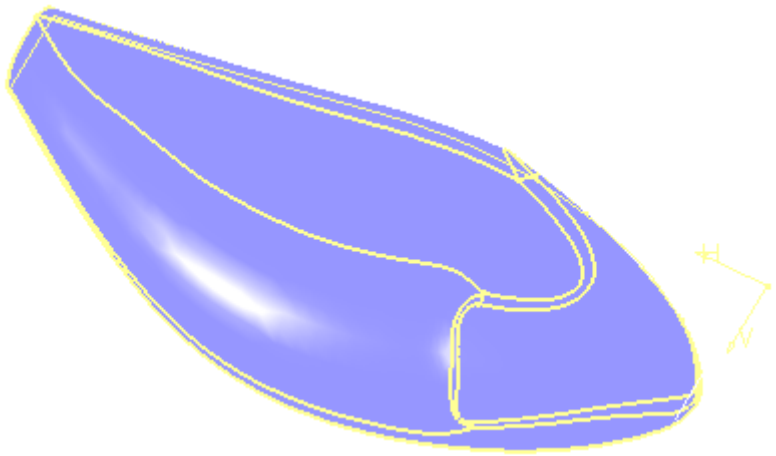

Fig. 1. Model obtained by solid operations.

In order to use the second strategy, a good knowledge of the basic properties of B-Spline surfaces and their exploitation is needed. The modeling process is usually more difficult than in the first situation.

2. HYBRID MODELING

We intend to modify the solid model defined previously in order to obtain a B-Spline surface meeting the smoothness restrictions. By using the tools included in the FreeStyle Workbench, we try to generate a surface close to the boundary of the solid model, but having a better smoothness.

The process usually starts by generating a patch having – on one of the projection planes – dimensions correlated to the ones of the surface that should be obtained. The software package presents the characteristic mesh and allows modifying the number of vertices along the directions u and v. The developer of the package has limited the number of vertices to 6 (Fig. 2). Due to this fact, more complex surfaces should be divided in simpler patches.

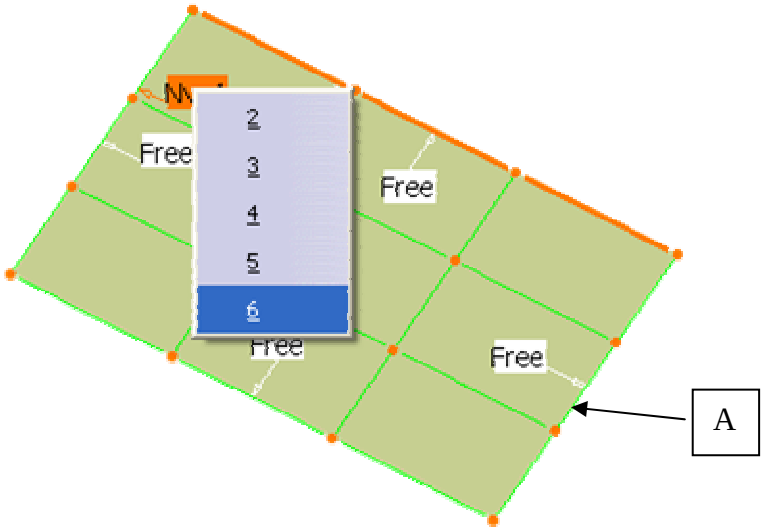

Fig. 2. Generating a B-Spline patch.

The modification of the patch can be made by moving the vertices in such a way that the surface gets closer to the 3D model. A good knowledge of the B-Spline surface behavior is needed in this stage. Figure 3 shows the patch in the process of its construction. The vertex displacements are made in order to achieve the following objectives:

- Suppressing edge A (Fig. 2) by concatenating the vertices belonging to the characteristic mesh. Due to the fact that this option does not exist and we have no possibility to enforce the superposition of the points belonging to A onto a vertex constructed previously, this operation has lead to difficulties.
- Moving the vertices located on the second row on a plane perpendicular to XOY that should also contain the degenerated edge A.

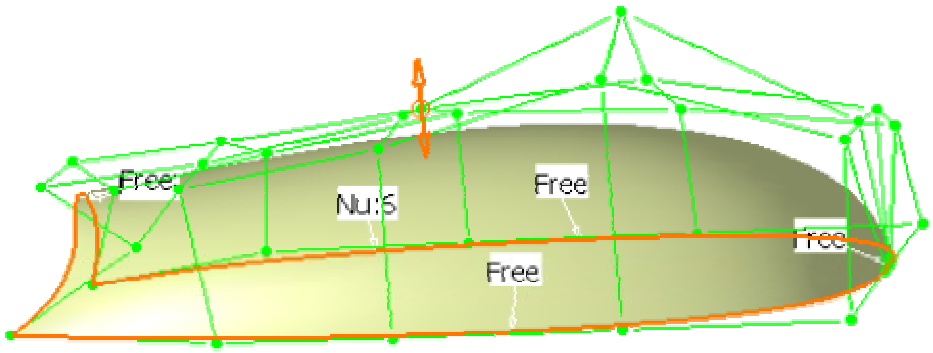

Fig. 3. Surface modeling by moving the vertices of the characteristic mesh.

- Modifying the positions of the vertices belonging to the next rows of the characteristic mesh to get a better approximation of the solid model. If the solid model is permanently present on the screen during this operation, the effects of each vertex displacement can be easier evaluated (Fig. 4).

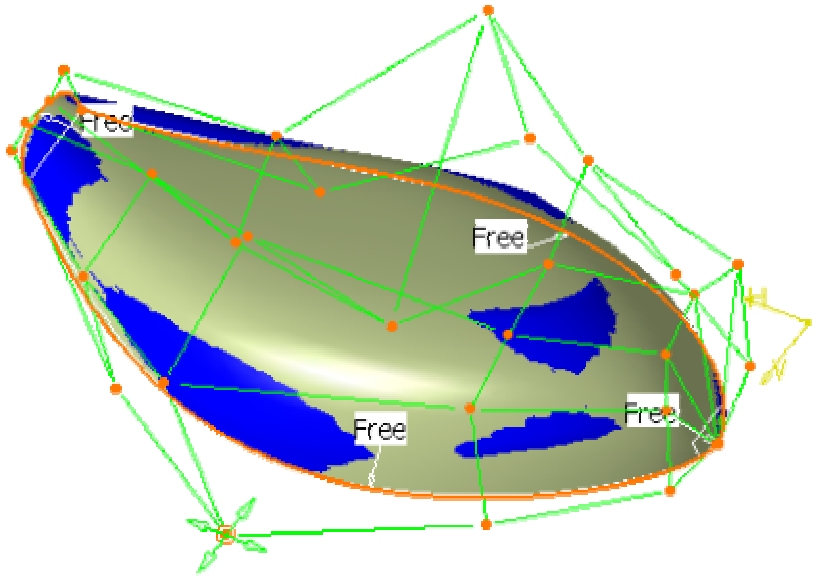

Fig. 4. Interpenetration of the surfaces when adjusting the position of the vertices.

The final result of the modeling process is presented in Figure 5.

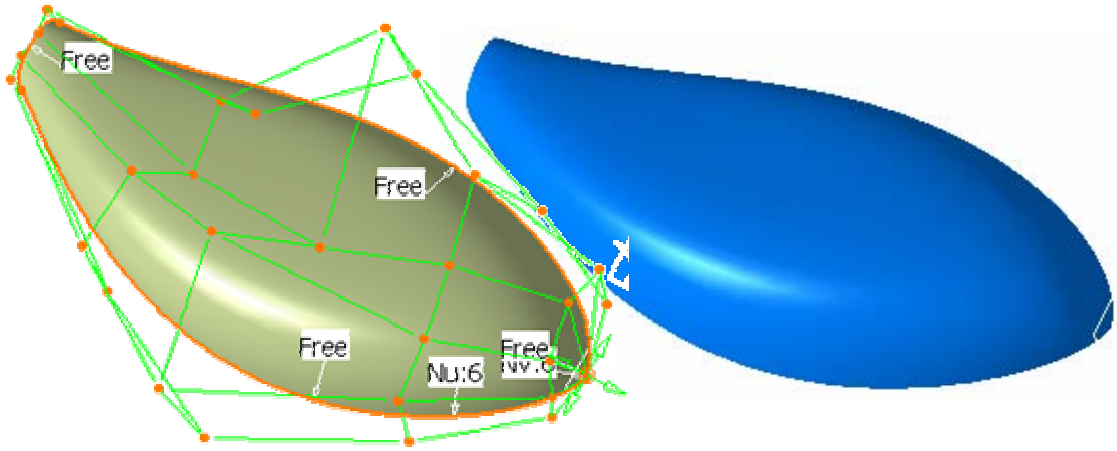

Fig. 5. NUPBS surface and the solid model obtained after sectioning a 3D feature.

One may notice a better smoothness of the 3D model obtained in this way.

3. CONCLUSIONS

The construction of complex surfaces is much easier when using a solid model defined previously. The lack of some tools in the workbench (especially those related to the parametric description) makes difficult a rigorous modeling of the surfaces constrained by boundary conditions or correlations between the vertex positions. Due to these drawbacks, the software package seems inaccurate and unstable.

4. REFERENCES

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