SCIENTIFIC BULLETIN OF
THE „POLITEHNICA” UNIVERSITY OF TIMISOARA, ROMANIA
Transactions on MECHANICS
BULETINUL ŞTIINŢIFIC AL
UNIVERSITAŢII “POLITEHNICA” DIN TIMIŞOARA, ROMANIA
SERIA MECANICA
Tom 52 (66) ISSN 1224 - 6077 Fasc. 1, 2007

CAD MODELLING OF AN AXIAL BLADE TURBINE USING AUTODESK INVENTOR

Dorian NEDELCU
Universitatea “Eftimie Murgu” din Reşiţa, Facultatea de Inginerie, P-ţa Traian Vuia No. 1-4, Reşiţa, +40-0255-219134
E-mail: d.nedelcu@uem.ro, România
Ioan PĂDUREAN
Universitatea “Politehnica” din Timişoara, Facultatea de Mecanică, B-dul Mihai Viteazu No. 1, 1900 Timişoara, tel. +40-256-403681, E-mail: padurean58@yahoo.com, România

Abstract: *The axial blade turbine is a very complex geometry, which must be generated in a CAD software for the final blade drawing and for finite elements resistance calculus. As a CAD software was chosen Autodesk Inventor [4]. There are described step by step the procedure of axial blade CAD modeling.*

Keywords*: CAD, modeling, blade, axial, turbine, Inventor.*

1. Introduction

Usually, there are known or can be obtained, from hydrodynamic calculus, the 3D coordinates of blade profiles, disposed on cylinders at given radius, figure 1.

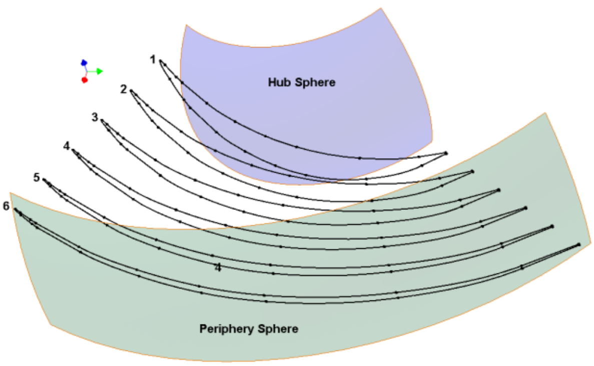

Fig. 1 Blade profiles disposed on cylinders

The purpose of CAD modeling is to obtain the blade as a solid object and not as a surface, because solid model of the blade can be used later for finite elements resistance calculus in a FEM software.

In Autodesk Inventor solid object can be created with **Loft** command, based on any number of closed loops, which may be curves in 2D sketches or 3D sketches. The problem is complicated by the following considerations:

- every profile of the blade is disposed on cylinder at given radius;
- the blade must be extended to the hub and to the periphery, which are sphere surfaces.

In Autodesk Inventor, the **Loft** command based on a combination of 3D closed loops disposed on mixed sphere and cylinders surfaces will not generate a valid solid.

The paper will continue with necessary steps that will lead to a valid solid of the blade.

2. Coordinates of blade profiles

In Autodesk Inventor the 3D coordinates of the blade profiles (X, Y, Z) can be manually input one by one, can be imported from Excel by command **Import Points** or from other CAD software. In this example, the incomplete blade is defined by 6 profiles, figure 1. To complete the blade we need to obtain the blade sphere extension to the hub and periphery.

3. Blade's surfaces creation

Based on open loops profiles, with **Loft** command, one only surface can be created. But for a better precision there will be created the three surfaces presented in figure 2:

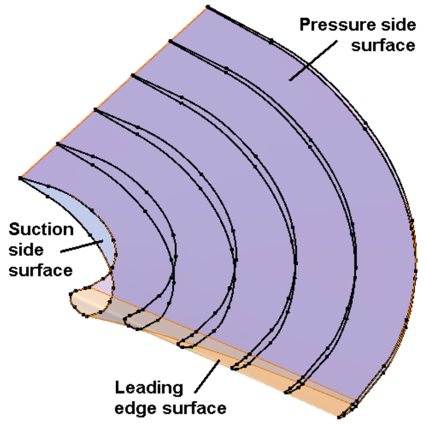

Fig. 2 Surfaces of the blade based on cylinders profiles

The **Loft** command require the selection of the 6 loops and will generate the corresponding surface. The command will be applied three times, to create the suction side surface, pressure side surface and leading edge surface. Of course, every profile must be previous divided in three curves corresponding to those three zone.

4. Extensions of blade's surfaces

The previous surfaces must be extended to the hub and periphery direction to obtain the surfaces of the complete blade. This action will be made with Autodesk Inventor command **Extend surface**, applied to three surfaces for hub extension and three surfaces for periphery extension, figure 3.

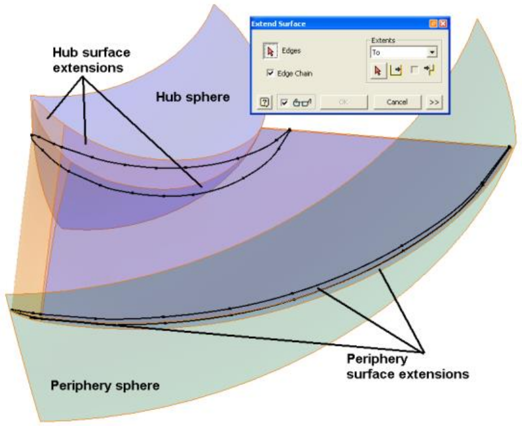

Fig. 3 Extensions of blade's surfaces

The intersections between hub/periphery sphere and the three blade surfaces will generate two curve disposed on hub/periphery sphere and, of course, the corresponding extended surfaces. The surfaces extensions will be not separate entities, but will be integrated in the initial surfaces, so finally, we will obtain three surfaces, which describe the complete geometry of the blade, from the hub to the periphery.

5. Intersections of the blade surfaces with radial planes

First step is to generate the radial plane at imposed angle. The radial plane can be generate by **Work Plane** command. Next, the **3D Sketch** command will be executed, with the radial plane selected as plane sketch. To find intersection curves, the command **3D Intersection Curve** will be executed between the following pairs of surfaces:

- plane radial and hub sphere;
- plane radial and periphery sphere;
- plane radial and every of the three surfaces: the suction side surface, pressure side surface and leading edge surface.

The **3D Intersection Curve** command require the selection of the two surfaces and will generate the intersection curve between them.

Finally will be generated four intersections curves which form a closed loop, figure 4.

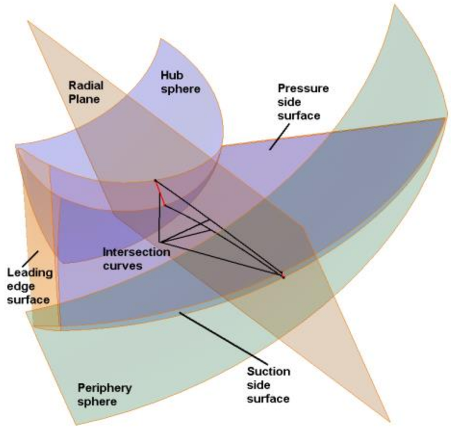

Fig. 4 Intersection curves for radial plane

This steps will be applied for a imposed number of radial planes, figure 5. Because the leading edge of the blade is a complex surface, the number of radial plane is increased in that area. The surface corresponding to trailing edge of the blade is generally included in a radial plane.

Now the complete geometry of the blade is described by a number of closed loops, every closed loop obtained as a result of intersection between radial plane and blade surfaces.

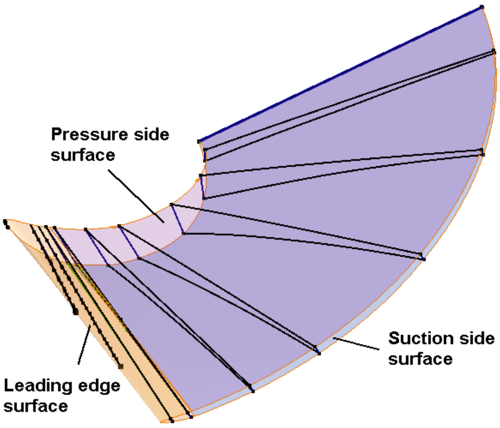

Fig. 5 Intersection curves for multiple radial planes

6. The solid model of the blade

The **Loft** command create solid entities based on any number of closed loops, which may be curves in 2D sketches or 3D sketches. The previous closed loops, disposed in radial planes, will be the source of solid representation of the blade.

The **Loft** command require the successive selection of the closed loops and will generate the solid entity. During the command execution Inventor will provide a preview of the solid for selected loops, figure 6. The final result is presented in figure 7.

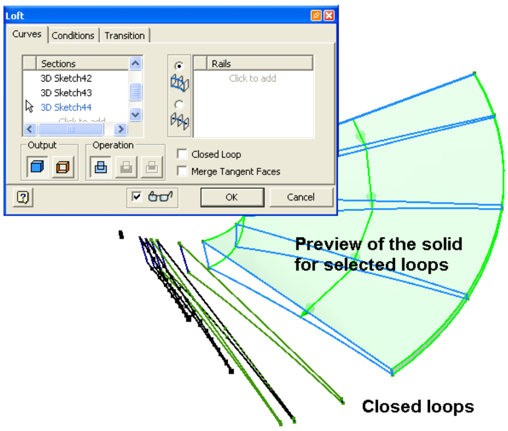

Fig. 6 Preview of the solid for selected closed loops

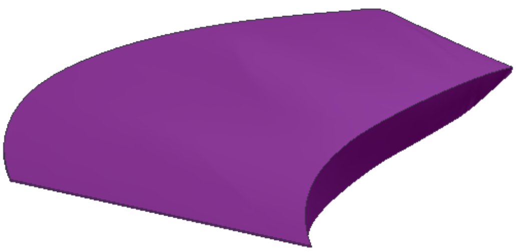
Fig. 7 The solid model of the blade

7. The axle pin of the blade

To attach the axle pin to the blade sheet it is necessary to define the median sketch of the axle pin. The **Sketch** command require the selection of the median plane and the axle pin contour can be draw with the tools from **2D Sketch Panel**, figure 8.

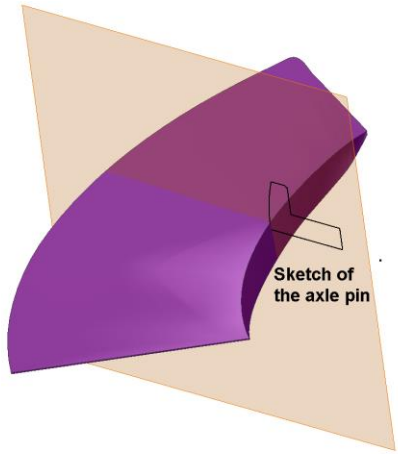

Fig. 8 The blade sketch of the axle pin

The **Revolve** command will be used to generate the solid representation of the axle pin, figure 9. The command require selection of the closed contour which will be rotated and selection of the rotation axe.

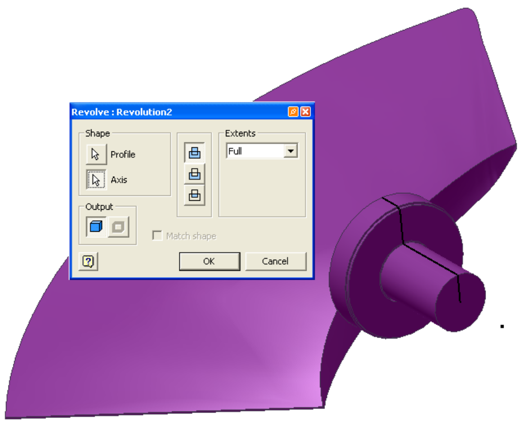

Fig. 9 The blade with the axle pin attached

8. The catch holes of the blade

To create catch holes of the blade it is necessary to define the sketch of those holes. The **Sketch** command require the selection of the sketch plane and circles corresponding to holes can be draw with the tools from **2D Sketch Panel**, figure 10.

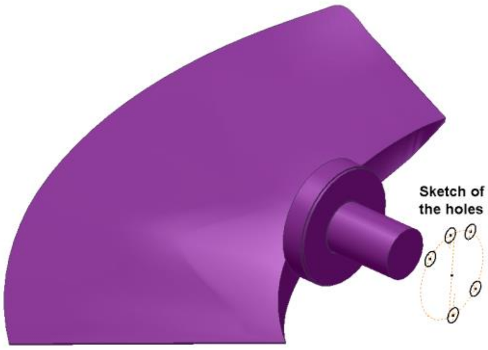

Fig. 10 The blade sketch of the catch holes

The **Extrude** command will be used to generate the catch holes. The command require selection of the closed contour which will be extruded and of the **Cut** command option. Figure 11 and 12 show the final solid and wireframe representation of the blade from two points of view.

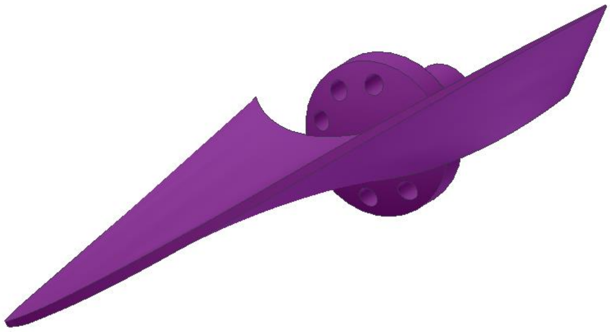

Fig. 11 The solid representation of the blade

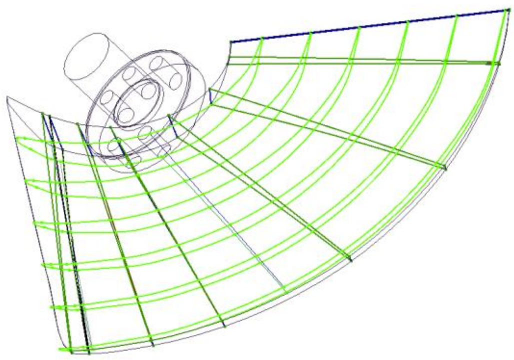

Fig. 12 The wireframe representation of the blade

References

1. **Nedelcu, D., -** *Modelare parametrică prin Autodesk Inventor*, Editura "Orizonturi Universitare", Timişoara, 2004.
2. **Nedelcu, D., -** *Aplicaţii 2D / 3D de proiectare asistată de calculator*, Editura "Orizonturi Universitare", Timişoara, 2003.
3. **Pozdîrcă, A., Albert, K., Cheţan, P.** – *Inventor – Modelare parametrică*, Editura Universităţii "Petru Maior", Tărgu-Mureş, 2004.
4. **Autodesk** – *Getting Started*, Autodesk Inventor Manual, 2002.

MODELAREA ASISTATĂ DE CALCULATOR A UNEI PALETE DE TURBINĂ AXIALĂ UTILIZÂND AUTODESK INVENTOR

Rezumat

Geometria unei palete de turbine axiale este deosebit de complexă. Pentru calcule de rezistenţă cu elemente finite, geometria paletei trebuie generată ca reprezentare solidă. Lucrarea prezintă procedura utilizată pentru generarea unei palete de turbine axiale, utilizând programul de proiectarea asistată de calculator Autodesk Inventor.

Referenţi ştiinţifici: Prof. dr. ing. Mircea POPOVICIU
Prof. dr. ing. Victor BĂLĂŞOIU