



Propeller & Wing

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## Performance and modeling of an existing propeller: Reverse engineering

Héliciel has several design methods adapted to different case of propellers studies:

- The user default design, to create an optimum propeller, by entering the fluid speed.. The rotation speed can then be imposed or calculated. The construction of the propeller blade at "optimum twist"  is then made, by adjusting the twist to provide the maximum profile lift/drag ratio, taking into account the calculated induced velocities.
- A calculation of performance "offdesign"  is then available to evaluate the performance of the propeller when it operates outside its operating point design ....Design phases are then defined by the specifications of the propeller.. For more on the design phase of the optimized propeller for a given operating point.
- Heliciel also offers a way "reverse design" which is actually a performance calculation "off design", but for modeling and quickly calculate the performance of an existing propeller.

Reverse engineering mode, we will describe here,allows to enter directly pitch of the profiles (angle between the chord and the plane of rotation), to select the profiles of the blade, and define the dimensions of the chords for each element:



N°	Radius	chord mm	Profiles imposed forced	Forced profiles	pitch angle	Relative Pitch P/D
1	310	400.00	n0009sm	Select profile foot	30.60665	0.288
2	648	340.00	n0009sm	Select Profile No. 2	13.76169	0.249
3	986	280.00	n0009sm	Select Profile No. 3	7.229972	0.196
4	1324	220	n0009sm	Select Profile No. 4	4.307888	0.157
5	1662	160	n0009sm	Select Profile No. 5	2.818198	0.129
6 tip	2000	100.00	n0009sm	blade tip like Profile 5	1.672282	0.092

Mode, reverse engineering, is designed for testing the performance but also the reproduction of an existing propeller. You can then modify certain parameters to create a new propeller, derived from model. When you enter data pitch and geometry found on the propeller, the 3D model of the propeller may be created, you can also edit 3D files igs or solidworks for designing your prototype propeller .....

### Example of use of reverse engineering method

To begin we will select a default project that best fits our project for this example, we will take a boat propulsion propeller:

Modeling aerial propeller in heliciel



Modeling boat marine propeller ineliciel



Modelisation helice ventilation dans heliciel



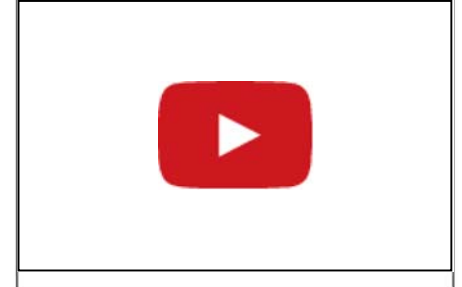
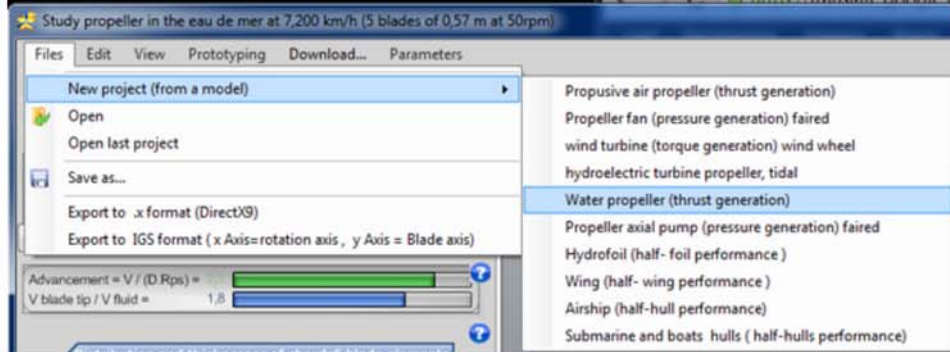
Modeling propeller ventilation in heliciel



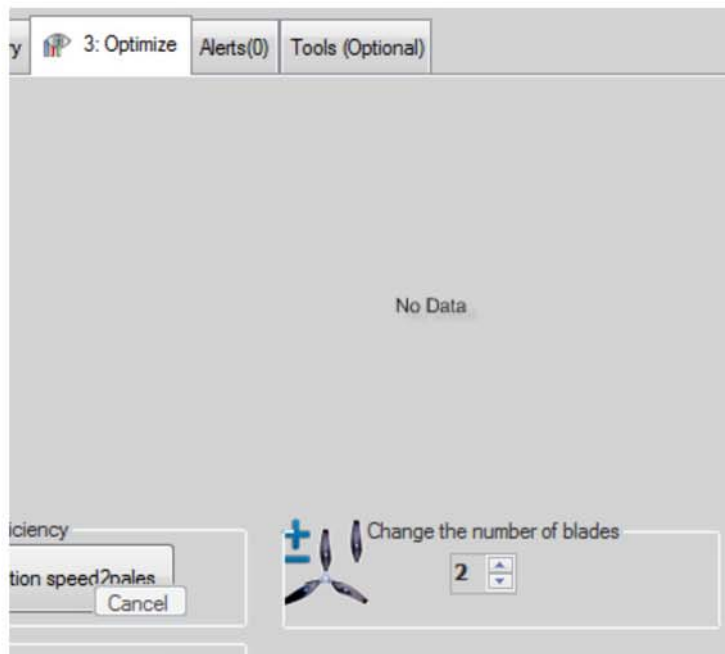
tidal turbine modeling in heliciel



Kaplan propeller modeling in heliciel



Then under the tab optimize, we set the number of blade to match to our existing propeller:



In the Geometry tab we select the "Reverse Engineering" mode:



When moving in reverse engineering, some functions are not available (such as the choice of law in profile, or thickness of the profiles) because the profiles will be selected and manually forced.

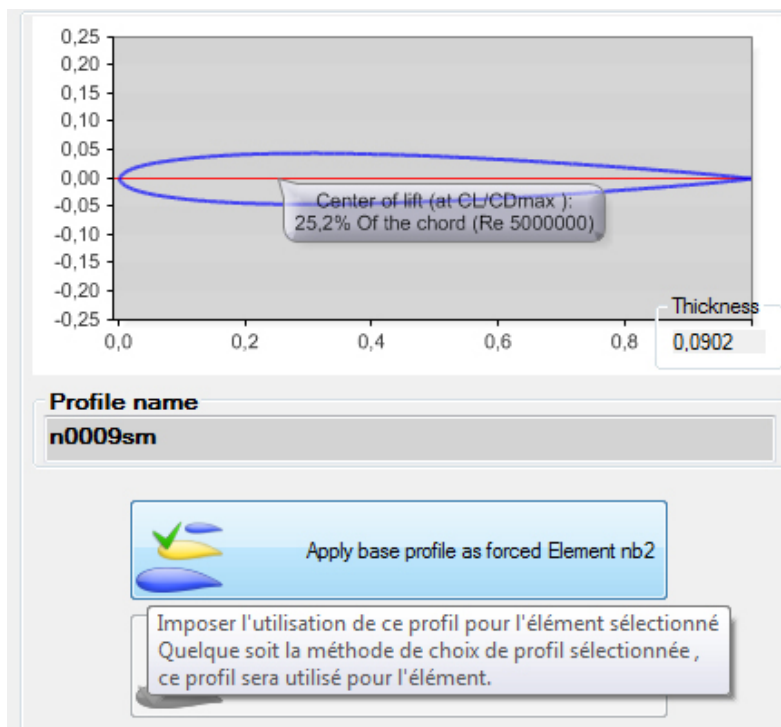
As for the other way of design, the dimensions of the chords and the length of the blade are controlled in the upper part of the blade dimensions tab. Enter the radius blade tip found on the propeller, and adjust the slider to the radius at the blade root.

Then adjust the chords at tip and blade root, and use the cursor "distribution chords" and buttons to adjust the intermediate chords in order to correspond (at best) to your existing propeller.

Now you can select the profiles of each of the elements describing your blade: Buttons "choose profile" select the respective element and displays your database.

N°	Radius	chord mm	Profiles imposed forced	Forced profiles	pitch angle	Relative Pitch P/D
1	3			Select profile foot	30.60665	0.288
2	648	340,00	n0009sm	Select Profile No. 2	13.76169	0.249
3	985			Select Profile No. 3	7.229972	0.196
4	1324	220	n0009sm	Select Profile No. 4	4.307888	0.157
5	1662	160	n0009sm	Select Profile No. 5	2.818198	0.129
6 tip	2000	100,00	n0009sm	blade tip like Profile 5	1.672282	0.092

Select the desired profile from your database and then click "apply as basic profile forced to the element"



The pitch input column is filled by default with the optimum pitch calculated during the last reconstruction of optimum twist. It is in this column that you can impose the pitch corresponding to the pitch of your choice made on your existing propeller. Retro engineering mode allows, mixing methods, starting for example by calculating the optimum twist in the normal mode, then move in reverse engineering, to change the pitch of some elements .....



1: Project specifications
2: Blade geometry
3: Optimize
Alerts(0)
Tools (Optional)

2.1: Blade dimensions
Advanced Geometry

### Blade length

Base blade radius = 15,5% Of the blade tip radius

Radius mm: 310

Enter radius at blade tip mm: 2000

Diameter mm: 4000

### Blade width

Chord at the root of the blade mm: 399,9999

distribution Chords: linearize

blade tip chord: 100,0001

Distribution equation: Chord =  $1,525879E-11 \cdot r^2 + -0,1775147 \cdot r + 455,0295$  [Apply the chords equation](#)

N°	Radius	chord mm	Profiles imposed forced	Forced profiles	pitch angle	Relative Pitch P/D
1	310	400,00	n0009sm	<a href="#">Select profile foot</a>	30,60665	0,288
2	648	340,00	n0009sm	<a href="#">Select Profile No. 2</a>	13,76169	0,249
3	986	280,00	n0009sm	<a href="#">Select Profile No. 3</a>	7,229972	0,196
4	1324	220	n0009sm	<a href="#">Select Profile No. 4</a>	4,307888	0,157
5	1662	160	n0009sm	<a href="#">Select Profile No. 5</a>	2,818198	0,129
6 tip	2000	100,00	n0009sm	blade tip like Profile 5	1,672282	0,092

☒ Reverse engineering (be)
[Performance testing \(reverse engineering\)](#)
0.9
Nb Blades

When your blade definition is complete click "performance testing (reverse engineering)". Heliciel reconstructs the 3d model to pitch defined, then re calculating the performance of your propeller. You can change the rotational speed and velocity of the fluid, then repeat the test to find new performance to other operating points.

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