# Tutorial building wing or foil (initiation)

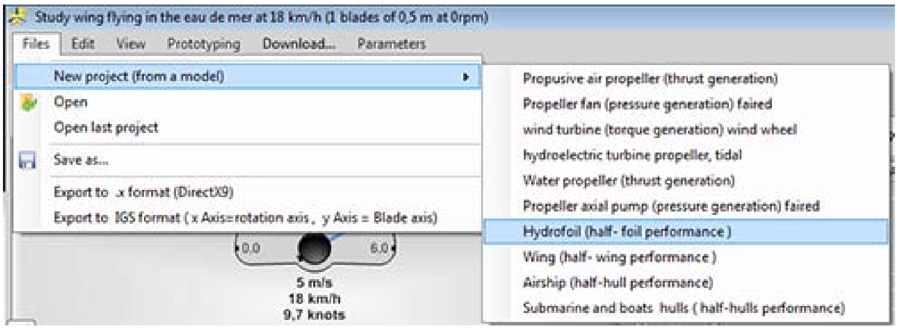
This first tutorial initiation allows take over the HELICIEL software for the design of a simple wing. Force options incidence, twisting, or thickness distribution are detailed in the second tutorial "building wing or foil (deepening)."

- A page about Overview on the wings can be accessed to review the fundamentals to know the design of the wings. Wings, hydrofoils, sails.

The calculation of the performance of Heliciel wings uses the theory of Prandtl lifting line. It is quite possible to design your wing without mastering the mathematical foundations of this method (this is the purpose of Héliciel), but the concepts of speed and induced angles introduced in this method are useful to better understand the results given by héliciel. This method is detailed on page: lifting line theory.

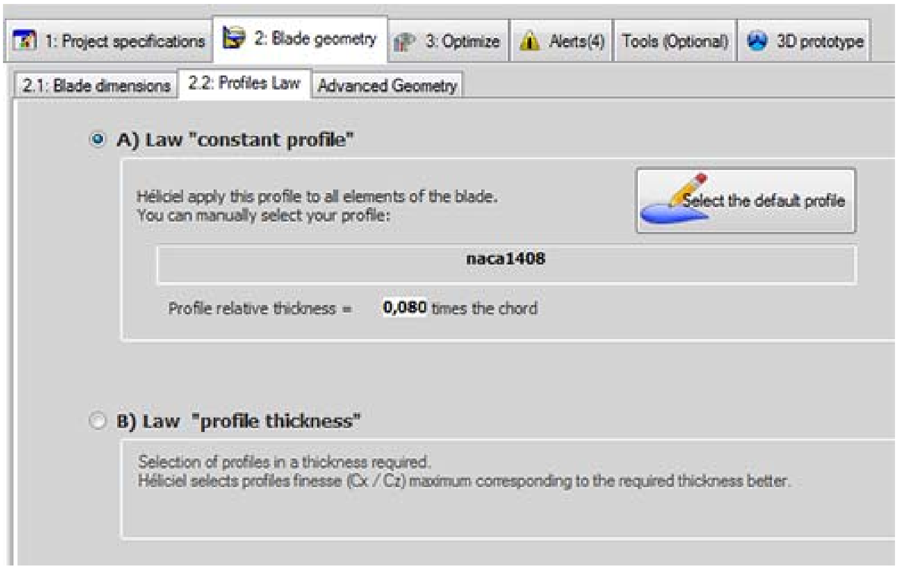
- Whether you want to build a wing or a hydro foil method will be similar. In this tutorial, we will build and model a hydro foil or wing without distinction. The problem of cavitation is a particularity of hydrofoils, it is discussed onpage cavitation.

We will now see how to proceed with HELICIEL to size, test, and edit our plans for wing or hydro foil. To start we open a hydro foil model (or wing) in héliciel::




In this first tutorial to tutorial, we will use the simplest law profile:

- In the Tab2: blade Geometry> 2.2 profiles Law select: A) Law constant profile..




What is the objective, the specifications of our wing or foil? We will take for example a project for human-powered vehicle, a boat propelled by PEDALLING that fly in the water. If this sounds wacky, I invite you to visit the website powered human, to get the number of such projects already completed. This type of project requires a perfect mastery of performance optimizations!!



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To keep things simple we will say that the propulsion power available is 250 watts (that's what an adult can provide steady pace) and the weight of the vehicle and its driver is 100 Kg We say that the lift force equals the weight is about 1000 Newtons. We must therefore make a hydro foil wing that will generate a lift of 1000 Newtons with a propulsion power of 250 W. The objective is to go as fast as possible with the power of 250 W..

- We will proceed by trial length and shapes to find the best compromise.

Héliciel allows calculation of the drag and the lift of a wing half. This is useful for calculating the wings or foils attached to a hull or body because only losses wingtip free side will be calculated. If one wishes to calculate the performance of a free full symmetric wing, we simply multiply the results for a half wing 2. We will assume that we have identified as a technical solution symmetrical wing submerged. We will leave aside the connections to the hull, to focus only on the wing generates lift..

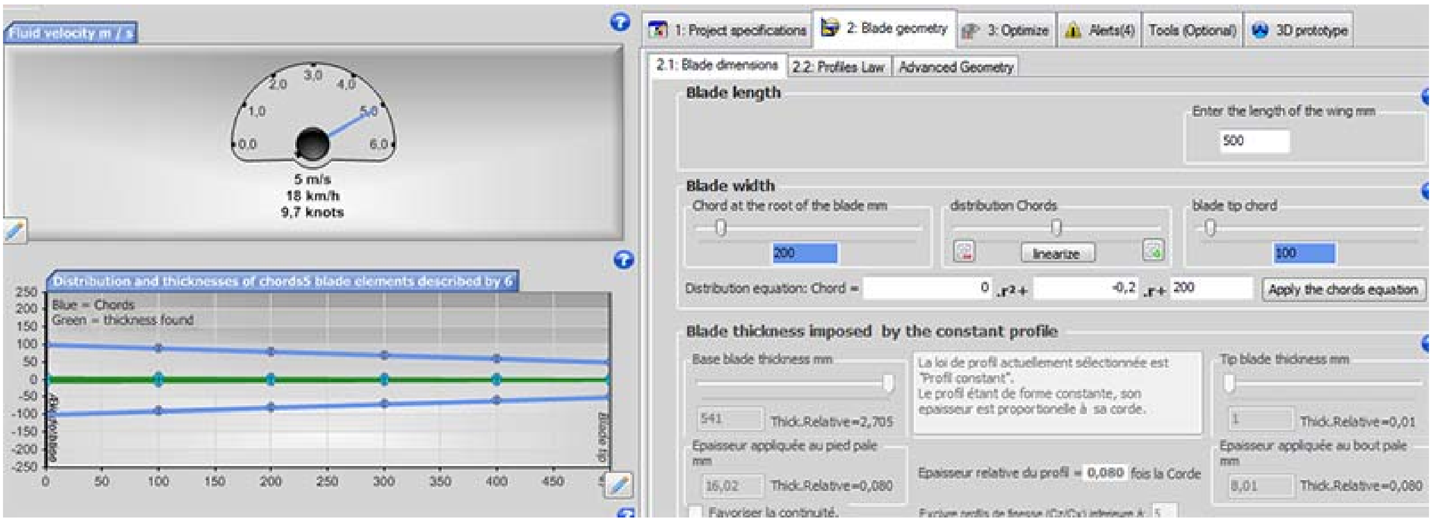
- We'll start with a wing span of 1 meter. As we calculate and model a wing half, our length of foil will be 0.5 meters

Two main unknowns occupy us:

1. The speed to create lift 1000N (500 N for half wing)
2. The power required to produce the lift at this speed

We'll see how easy it is to have these results:

1. In the "1.1Fluide" tab: Check the fluid (sea water 10 °)
2. In the tab "1.2Goal": Check the selection "Foils Wings hull"
3. In the tab"1.3 Operating point": enter the speed **5m/sec**
4. In the tab "2.1Blade Dimensions":
   - Enter the length of half wing or foil : **500 millimètres**
   - Enter the chord at the blade root: 200
   - Enter the chord at the blade tip: exemple 100
   - Click linearize in the distribution of chord (think linearize after each change dimensions or the number of elements!)..
   - Constatez que les épaisseurs de votre foil sont déterminées par la forme de profil




Our half wing or foil is close to be tested, just click on the "rebuild" button in the horizontal toolbar at the top right of the software: 

What héliciel is doing on rebuild?:

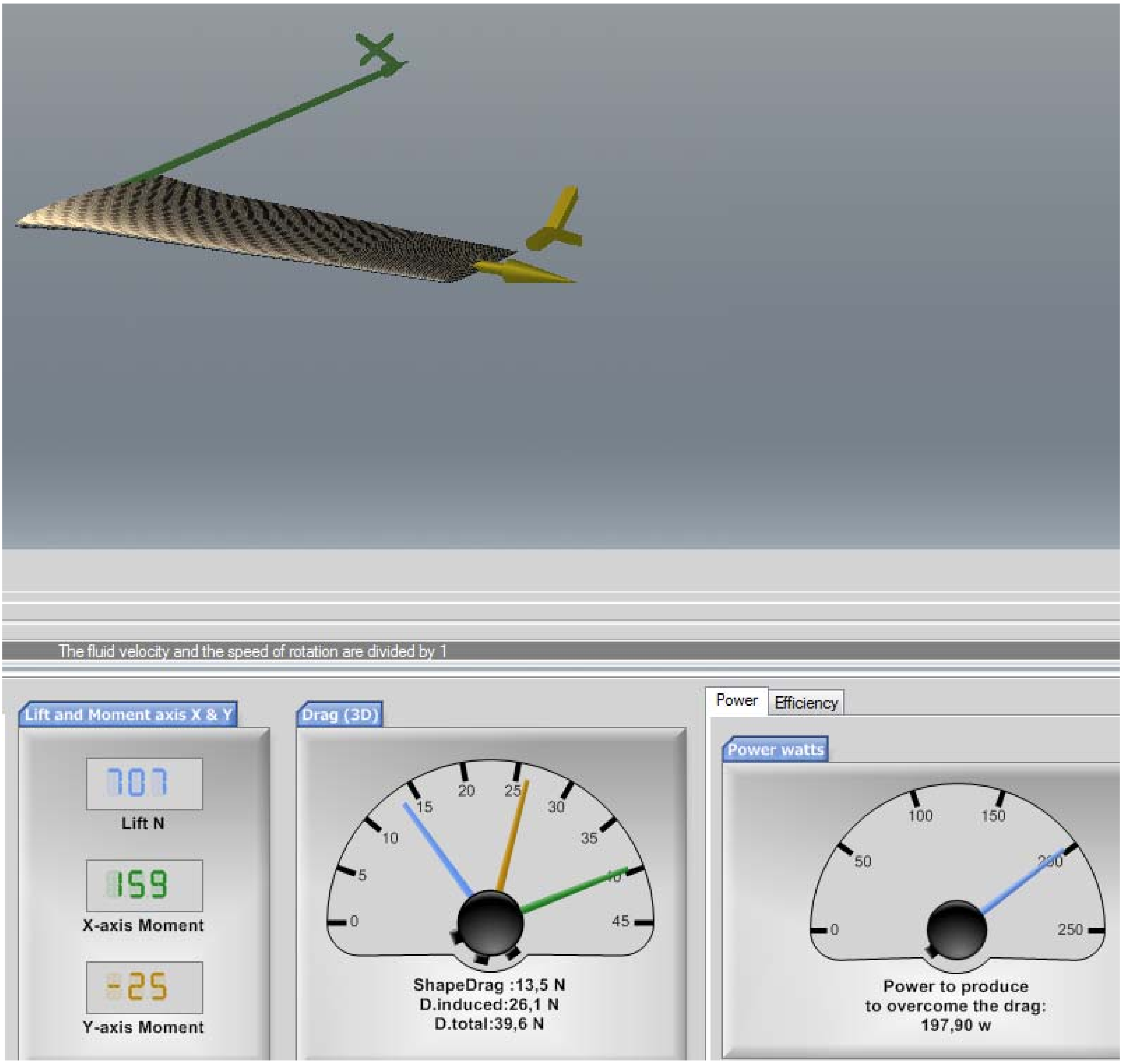
- Heliciel will look in the database performance profiles selected, the angle of incidence providing maximum lift/drag ratio.
- The 3D model is built with the incidence providing maximum lift/drag ratio.
- Drag, lift, power, resistance, and other results are calculated taking into account the phenomenon of downwash

Your foil should look like this (the particles have been activated from the menu of the 3D model):

Une erreur s'est produite.

Impossible d'exécuter JavaScript.

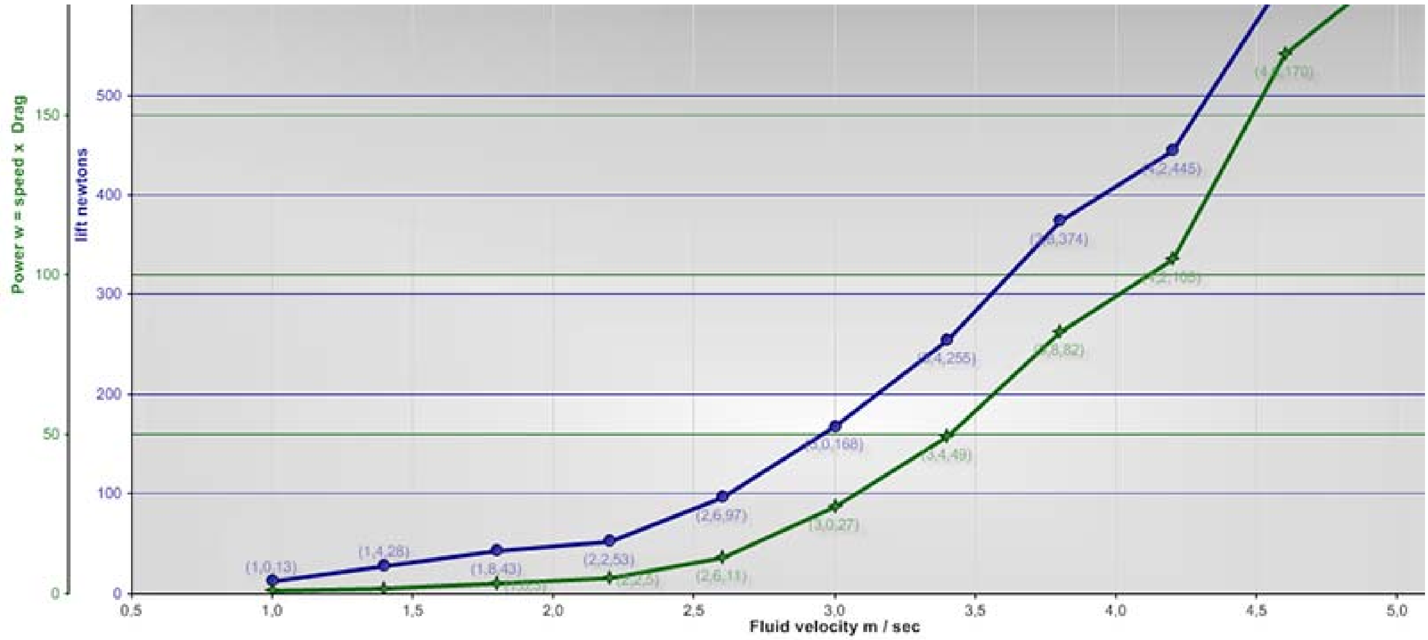
Focus on the outcome of particular interest:




We note that the lift is 707 N for 197 Watts of power. (Total Drag X speed=propulsion powerto provide ) For a wing, the results of the half wing or hydrofoil must be multiplied by 2:

- Full wing lift= 707 X 2=1414.
- Full wing propulsion power to provide =197 X 2=394 Watts

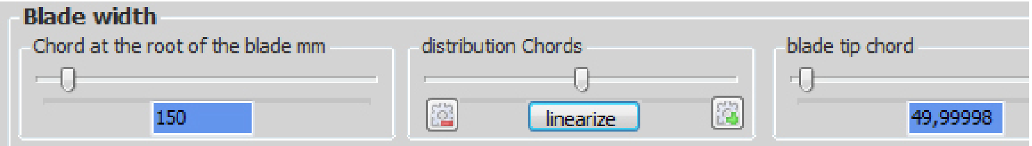
We must carry 500 N per half wing, so we will try to find the speed that gives us 500 N lift. To avoid multiple testing, we will use the "multiple analysis", this feature allows us to edit a curve lift and / or power depending on the speed. The multiple analyzes can be run from the 3 tab: Optimize, or through the Edit menu of the software. Here is the result of an analysis of speed range from 1 to 5 m / sec (select lift and power output in the curves to be displayed)



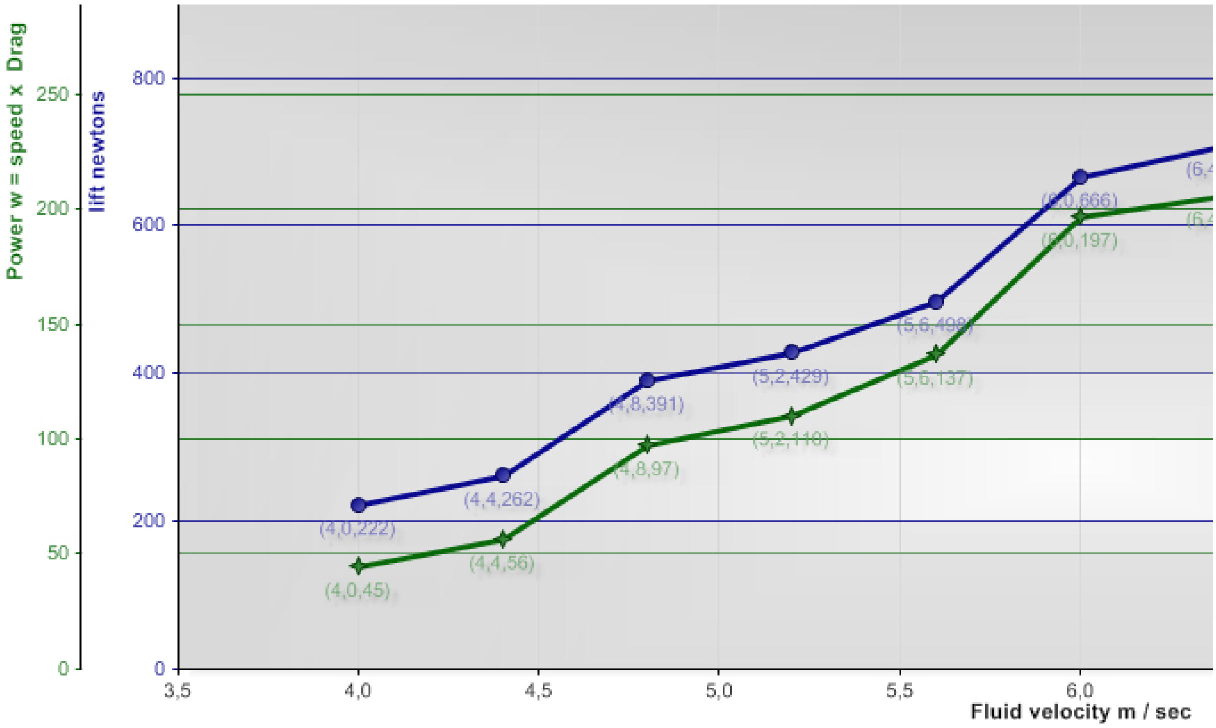

The power curve reached 125 w (Reminder: max power that we can use for each half wing = 250/2) to 4.25 m / sec approximately, and at this speed we read on the lift curve about 500 newtons. speed of 4.25 m / sec will allow us to lift a weight of 500 N x2by consuming 125 w x2. We get to fly at the speed of 4.25 m / sec..

We could reduce the width of our wing or foil to increase its aspect ratio and thus reduce losses wingtip. This will save ratio drag / lift, so the energy available to increase the speed.

In the tab"2:Blade Geometry>2.1Blade Dimensions "we will refine the tip of our wing from 50 to 100 mm and the base of the wing or rotor blade pass from 200 to 150. Do not forget to "linearize" to update the form with the new data:




Rebuild  to update the new geometry and performance to 4.25 m / sec (the reduction surface has reduced lift at 250N ...) and launch a new graphical analysis of 4 and 8 m / sec to find the lift and speed for 125 watt:




note the speed and lift to 125 watts: 5.5m/sec and lift about 430 Newtons ... We gained speed, but the lift is a bit small (we need 500 newtons per half wings ...) it will slightly increase the surface of the foil .. Now it's your turn to play and create the best compromise for your project ......

The plan and profile of the blade can be edited, and wing 3D IGS model can be exported. In this tutorial initiation, we don 'have not used the control of the incidence, or the thickness of the wing as this is the subject of a second tutorial for deepening wing design or foil .

This tutorial does not take into account the fact that with a power of 250 watts to the propeller shaft it is virtually impossible to provide propulsive power of this value. Propeller efficiency and transmission elements decrease the power output. A good hydro foil should therefore have a good propeller to not waste valuable energy of our happy pedaler that sails on the waves while dreaming..