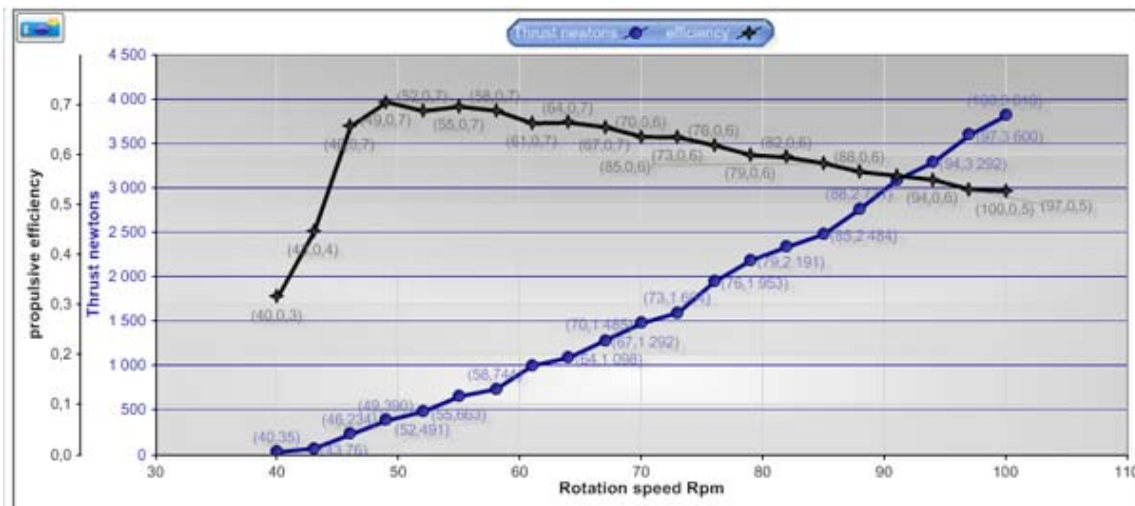


Analysis of multiple operating points of the propeller, wind turbine, tidal or kaplan turbine, fan



The optimization of the propeller through the analysis of its performance at multiple operating points. The operating point of a propeller, Whether in turbine or propulsion way, is defined by the rotational speed and the speed of the fluid. The propeller must of course be created with a twist corresponding to a nominal operating point.

- Fluid velocity, for a boat, is the cruising speed, for a wind turbine, it is the wind speed the most often encountered, and for a fan, that it is the velocity whose achieving the desired flow rate.
- The Wanted speed is one where the engine or generator offers its best performance (if possible otherwise a gearing can be applied).

So Heliciel creates twisting adapted to the operating point, it is sufficient to use the "build optimum twist" function:

- Re build the optimum twist:



In reality, the propeller does not always work at the nominal operating point of the "design". it must be possible to determine the performance of the propeller when it leaves its point of design. Heliciel allows you to change the speed or velocity of the fluid, and test performance by keeping the twist, you are then in "off-design":

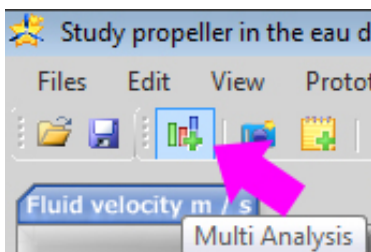
- Calculate off design performance.



L' analyse multiple permet de tracer des courbes et de collecter les performances "hors design" d'une géométrie d'hélice fixée. Cette géométrie peut avoir été donné par la fonction Re construire le vrillage optimum ou bien être déterminé en mode rétro-conception (modélisation d'une hélice existante).

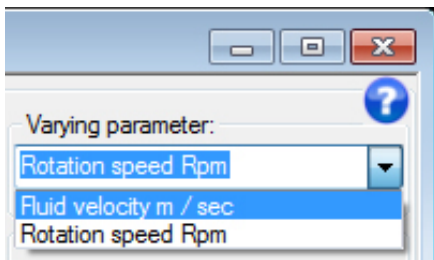
- **The multiple analysis:**

To display the interface of multiple analysis click on "multiple analysis" in the toolbar:



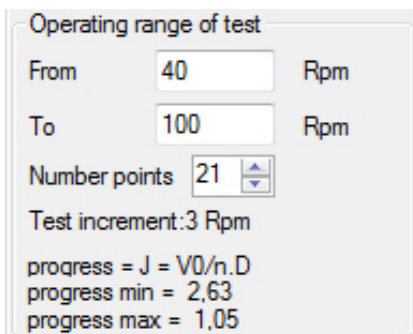
Or under the tab 3:Optimize, use the "multiple analysis" button

- **Determine the varying parameter:** The operating points are determined by the fluid velocity and speed of rotation, varying parameters of the analysis are: the rotational speed, and the fluid velocity:

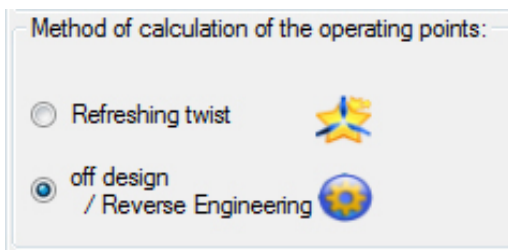


Selection parameter varying

- **Determine the range of test:** The varying parameter is tested within the allowable range. The test range is divided into the chosen number of test points.

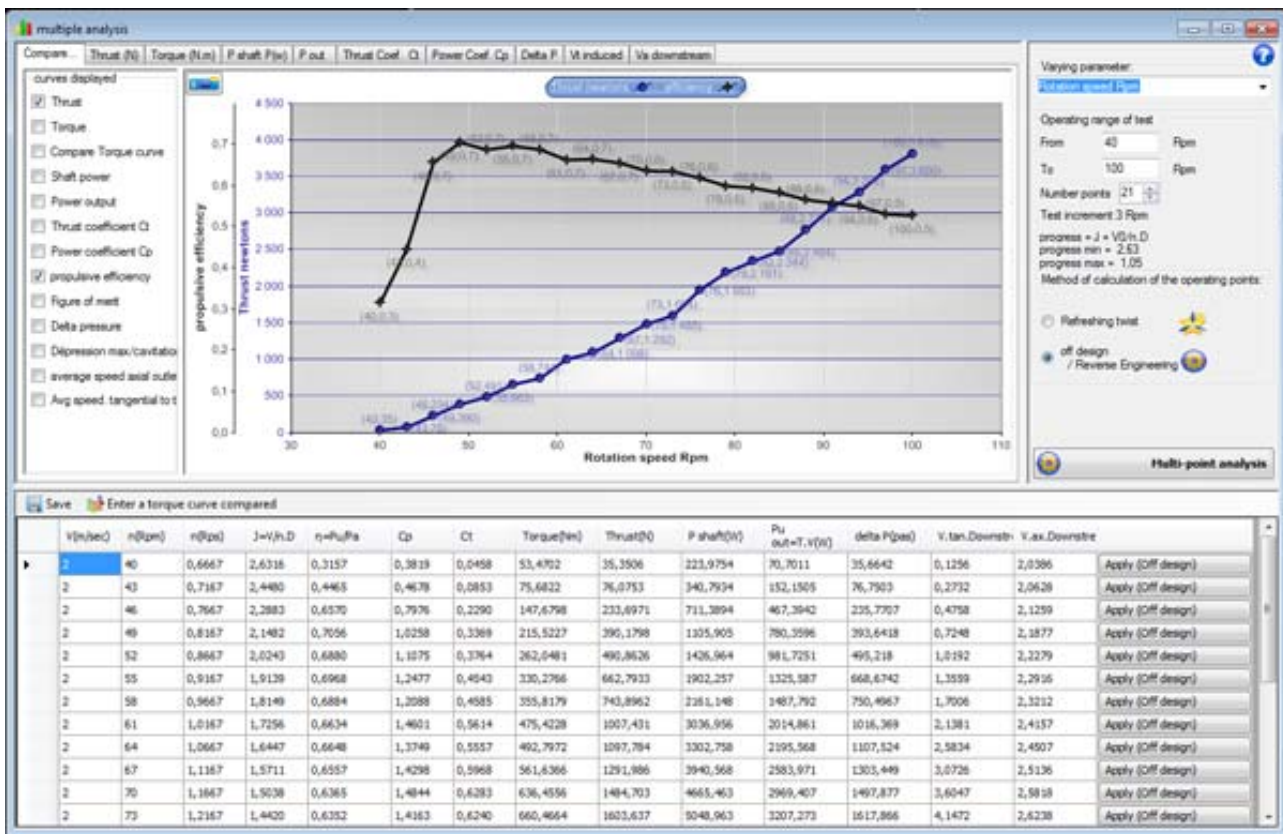


- **You can select two types of analysis :**

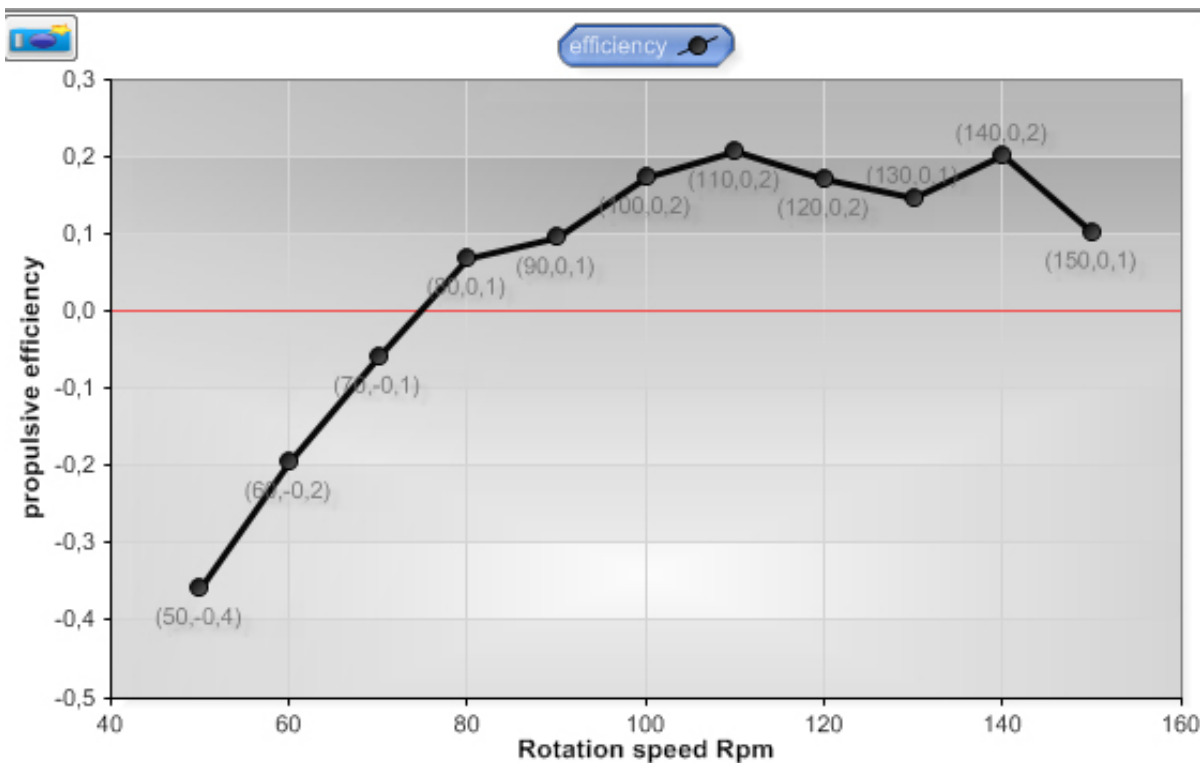


1. **"Refreshing twist":** If you want the optimum twist is rebuilt at each operating point tested, héliciel **updates twisting**, and calculates the performance of the propeller **at each test point**. You can then test the optimum performance that offers your propeller blades with the given dimensions.
2. **"Off design/Reverse Engineering":** Twisting and rigging of the propeller will be constant and the propeller will be analyzed in "offdesign" way. So you see the evolution of performance of a given propeller outside of its design point.

It remains only to start the analysis. Graphs can be saved, a "compare" graphic used to display the selected curves, data calculations can be recorded as text or spreadsheet ...



Ranges selected test can give results that completely out of the mode of operation of the propeller and give such negative returns: below for example, the rotation speed range tested for this thrust propeller, tells us that in the fluid velocity of operating point of design (2 m / s) ,our propeller has a propulsive efficiency of 0.2 at 140 rpm, But at 60 rpm performance is negative, our propeller operates in energy harvesting ...



Research of the actual rotational speed (point of operation) for electric motors and generators coupled to the propellers:

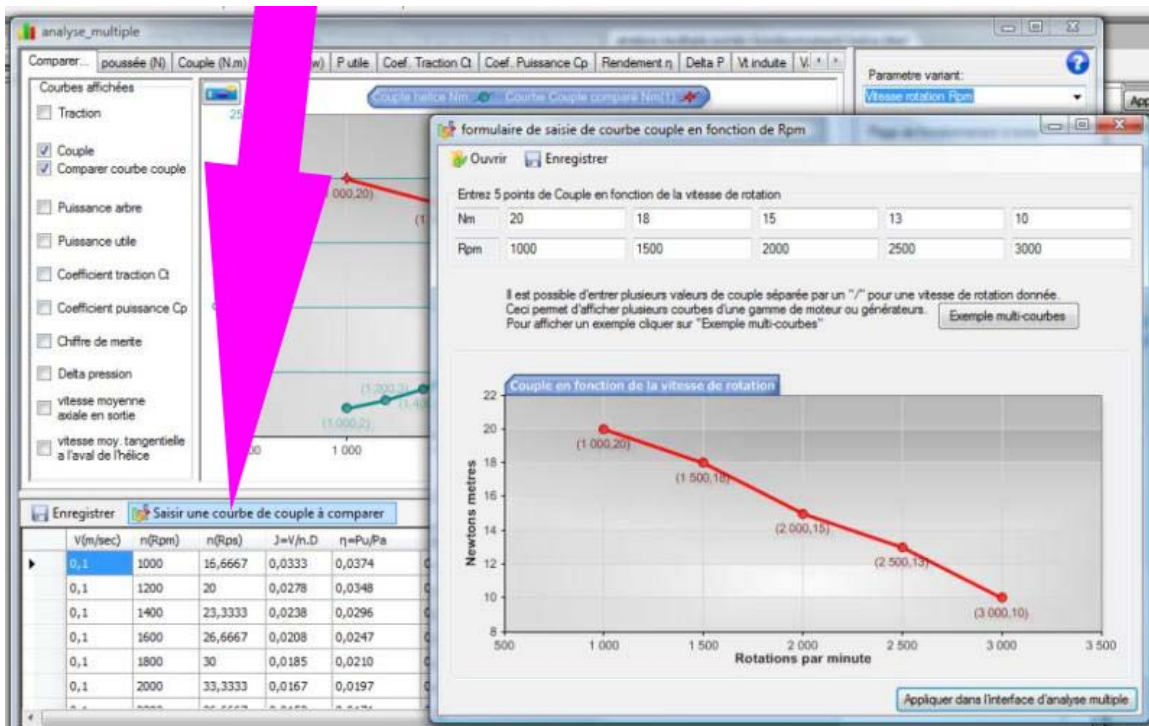
- Electric motors have a rotational speed changed by the resisting torque applied to them. The actual operating speed of an engine of this type, corresponding to the speed given by the intersection between the torque curve and the curve of load torque of the propeller.

- For a wind generator or tidal turbine type powered by a propeller energy recovery, the problem is the same, operating speed is the point of intersection between the curve of the generator load torque and the torque curve of the propeller.

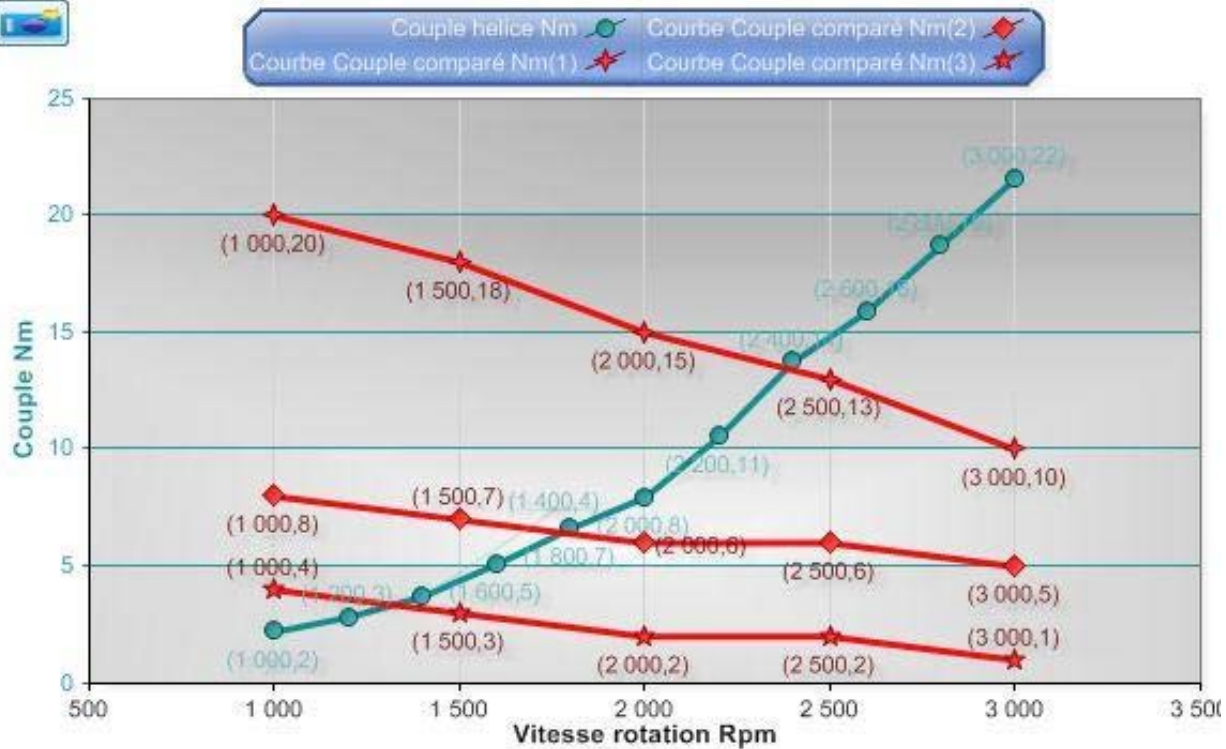
In 2 cases, the actual rotational speed of the system is determined by the balance of the resistive torques and torque motors.

To quickly see what will be the operating speed of your system: generator / turbine or motor / propeller, Simply place on a same graph, the torque curve of the propeller, and the torque curve given for the motor or generator. To facilitate graphics resolution, of the actual operating point of the system, it is possible to insert your torque curve (provided by the manufacturer of the generator or motor) and make it appear superimposed:

input torque curve:



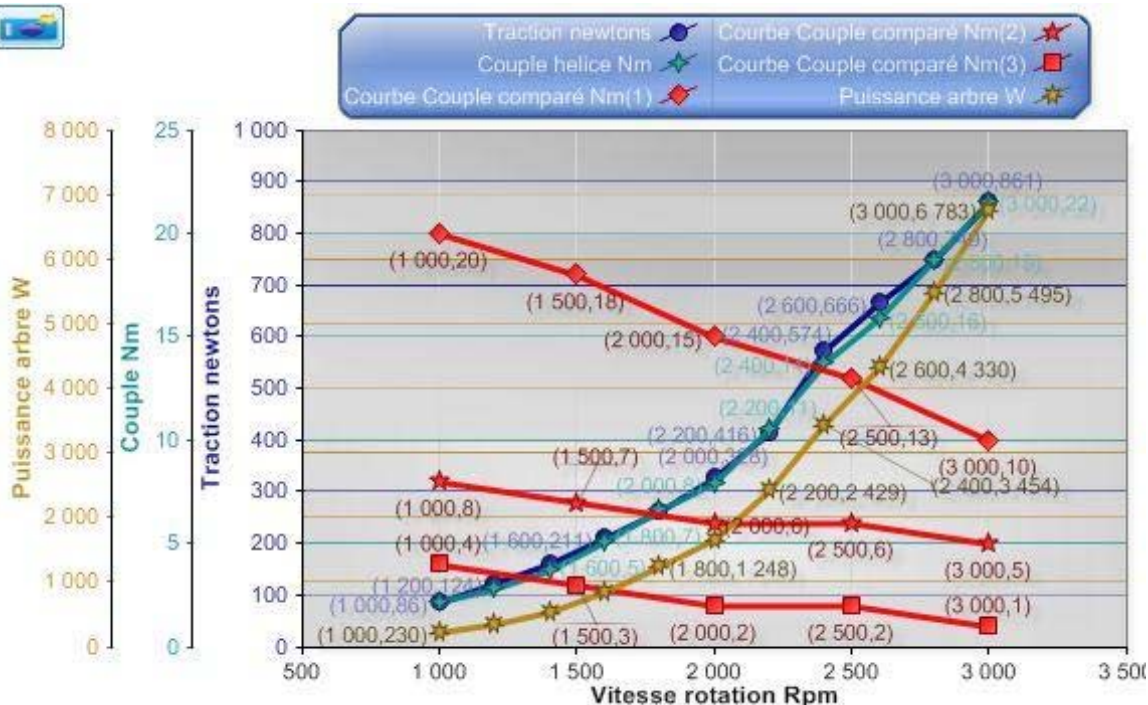
It is possible to enter multiple torque curves representing several motors or generators (3 motors curves in the example below) and editing performance curves, depending on the rotational speed, to view directly the speed of rotation and the performance of the same propeller mounted on a variety of motors or generators of different powers:



So here we find that:

- the propeller mounted on the engine whose torque is described by curve 1 operate at 1300 rpm
- the propeller mounted on the engine whose torque is described by curve 1 operate at 1750 rpm
- the propeller mounted on the engine whose torque is described by curve 1 operate at 2400 rpm

We can also overlay performance data and thrust to know the performance of the system in all three cases:



So here we find that:

- the propeller mounted on the engine, whose torque is described by the curve 1, will provide a thrust of 150 newton at 1300 rpm and a shaft power of about 300 watts
- the propeller mounted on the engine, whose torque is described by the curve 2, will provide a thrust

of 250 newton at 1750 rpm and a shaft power of about 1200 watts

- the propeller mounted on the engine, whose torque is described by the curve 3, will provide a thrust of 550 newton at 2400 rpm and a shaft power of about 3400 watts

Of course these values are valid only if the propeller has a strength appropriate to the calculated thrust, and that cavitation does not spray fluid. We must therefore control these parameters, at speeds of rotations found!