DNV·GL

Introduction to Bladed
Wind Turbine Design Software

Cardiff University / DNV GL
November 2016


BLADED
Wind turbine design
Bladed version 4.6.
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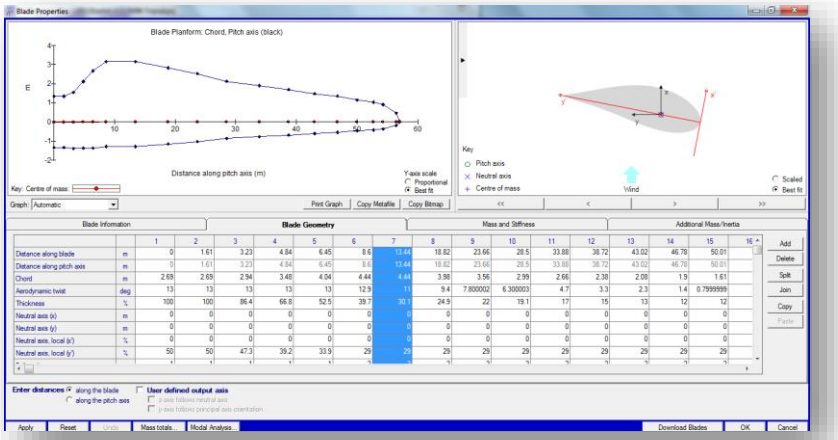
Bladed: Wind turbine design software

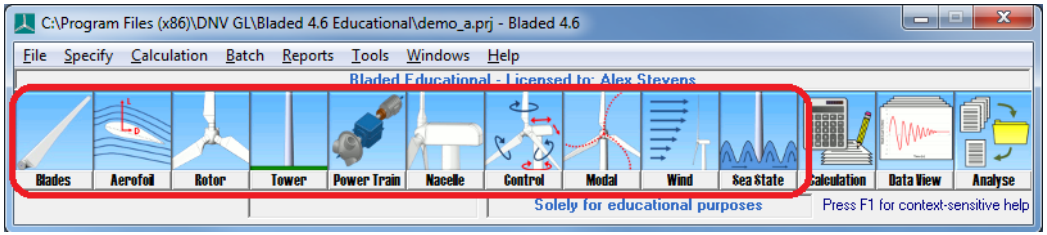
- Bladed is the industry standard integrated software package for the design of onshore and offshore wind turbines.
- Based on self-consistent and rigorous multibody formulation of structural dynamics
- Maintained and developed by engineers with over 3 decades experience in the wind industry
- 500 licenses worldwide, 300 organisations
- Full technical support and training courses

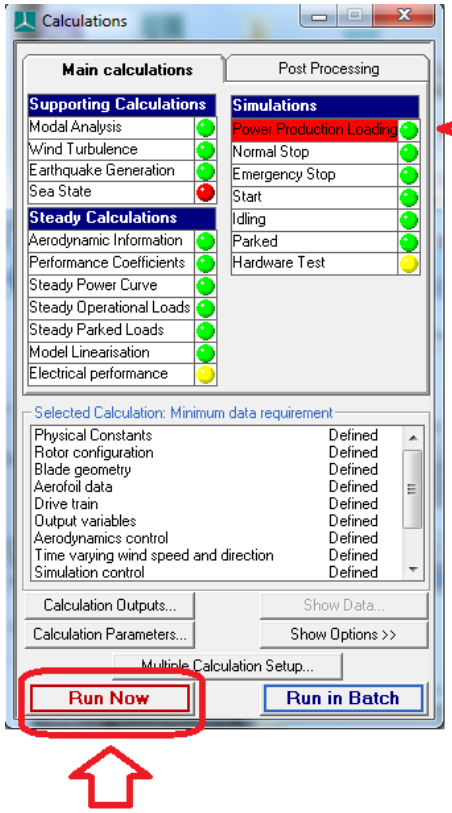


Bladed: A Virtual Wind Turbine

1) INPUT

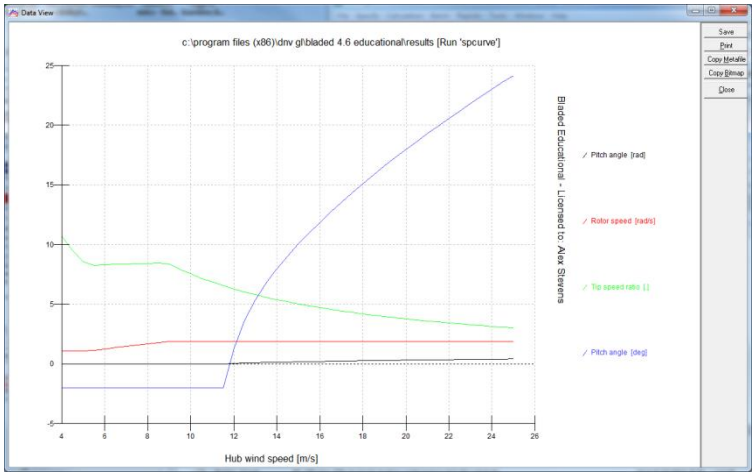
- Turbine definition
- Environmental Conditions (Wind + Wave)





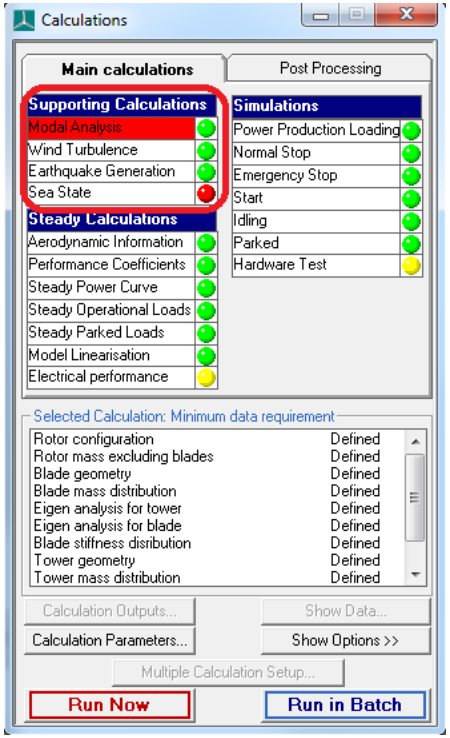
2) Choose a Calculation type and RUN

3) OUTPUT: loads and performance data and graphs



Four main categories of calculations

- 1) Preliminary Calculations



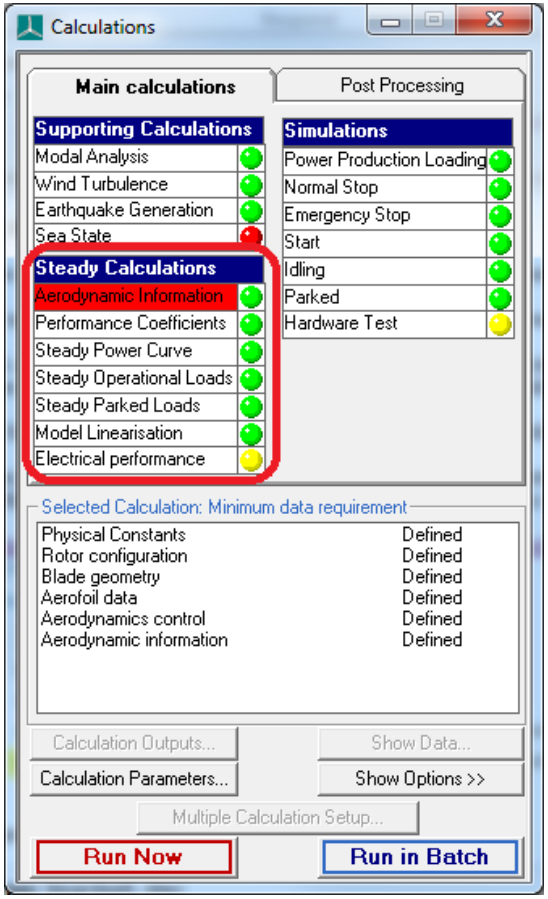
e.g. Modal Analysis, Turbulent wind file generation

These are stand-alone calculations that often need to be performed before full simulations.

For example 'Wind Turbulence' generates input turbulent wind conditions for time-domain simulations.

Four main categories of calculations

- 2) ‘Steady’ Calculations



These calculations generate a wide range of turbine outputs under ‘steady state’ conditions.

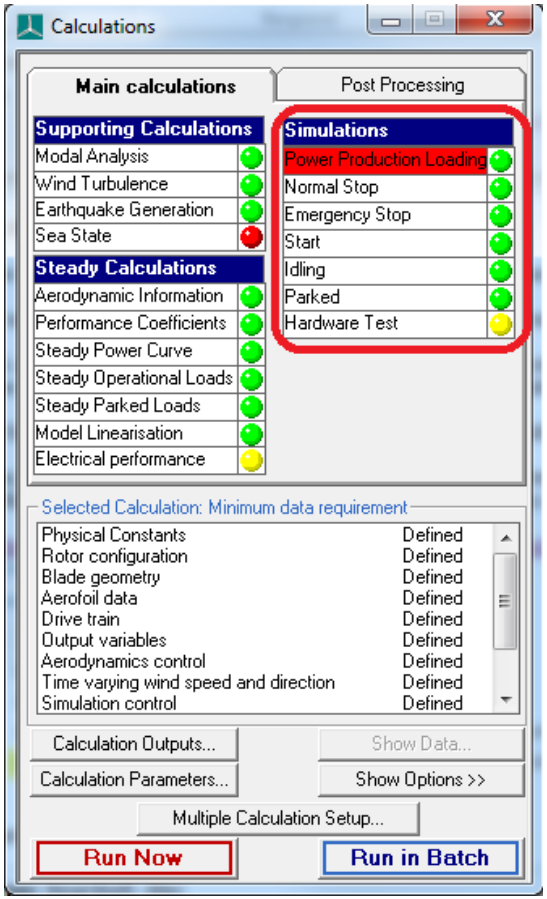
They are NOT time-domain dynamic calculations

They are quick to run but the price of speed is that they include many approximations.

Think of them as providing good ‘snap shot’ approximations of turbine conditions.

Four main categories of calculations

- 3) ‘Simulations’



These are time-domain simulations.

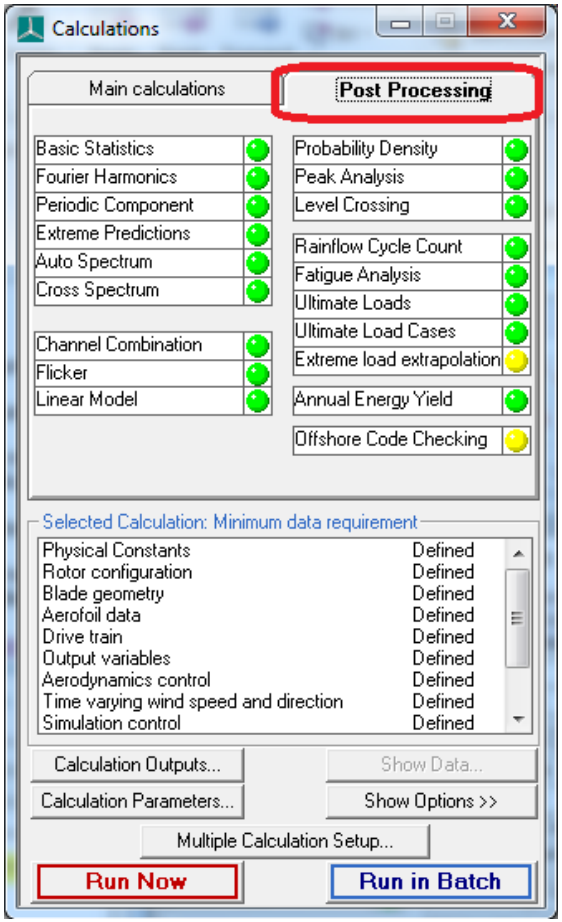
They are slow to run and provide very detailed, dynamic time series output.

Choice of wind input: constant, transient or turbulent.

Turbulent simulations require a pre-calculated turbulence file.

Four main categories of calculations

- 4) Post Processing Calculations

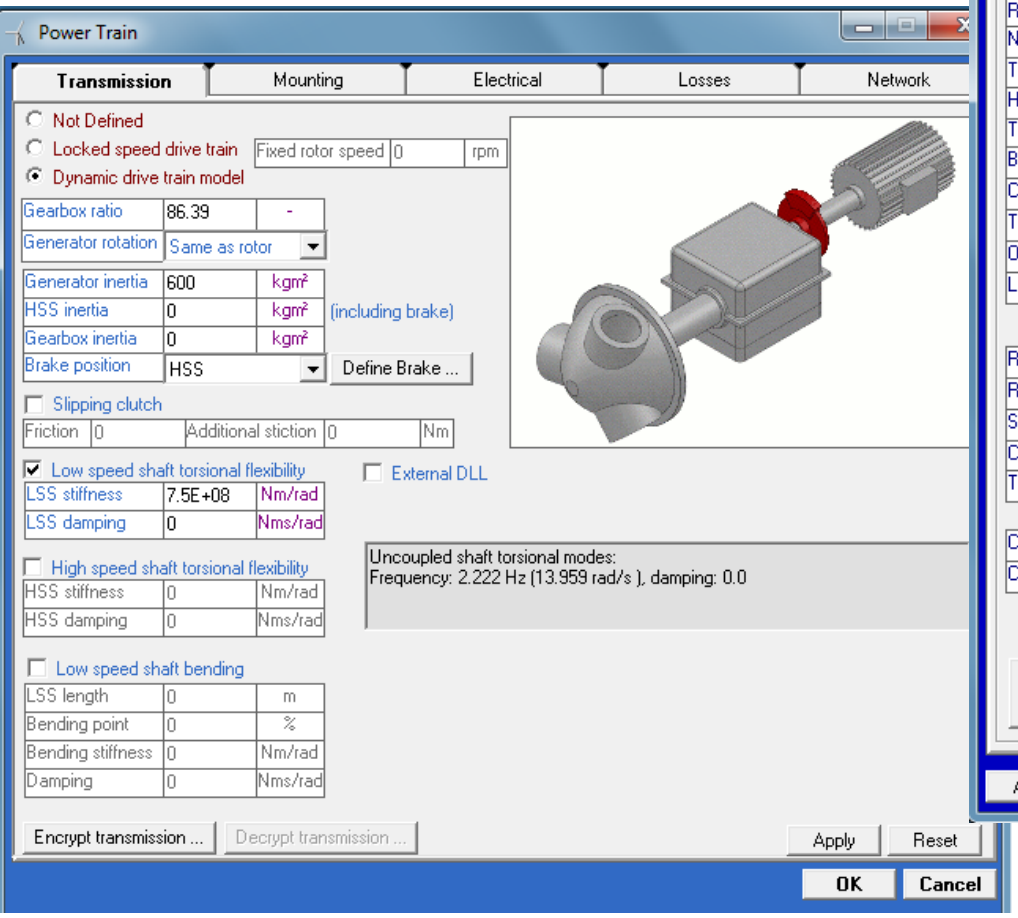


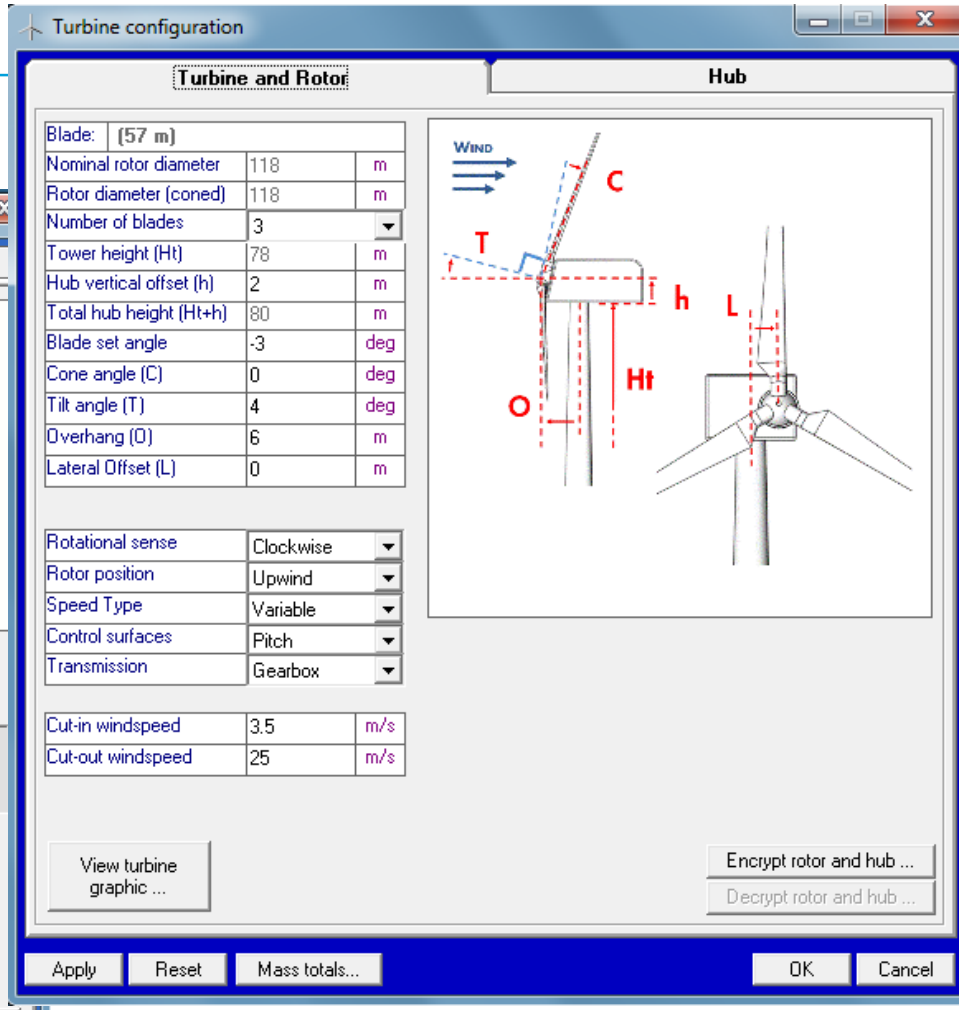
The input for these calculations is the output from simulations that have already been run.

They allow simulation output data to be analysed in a wide variety of ways.

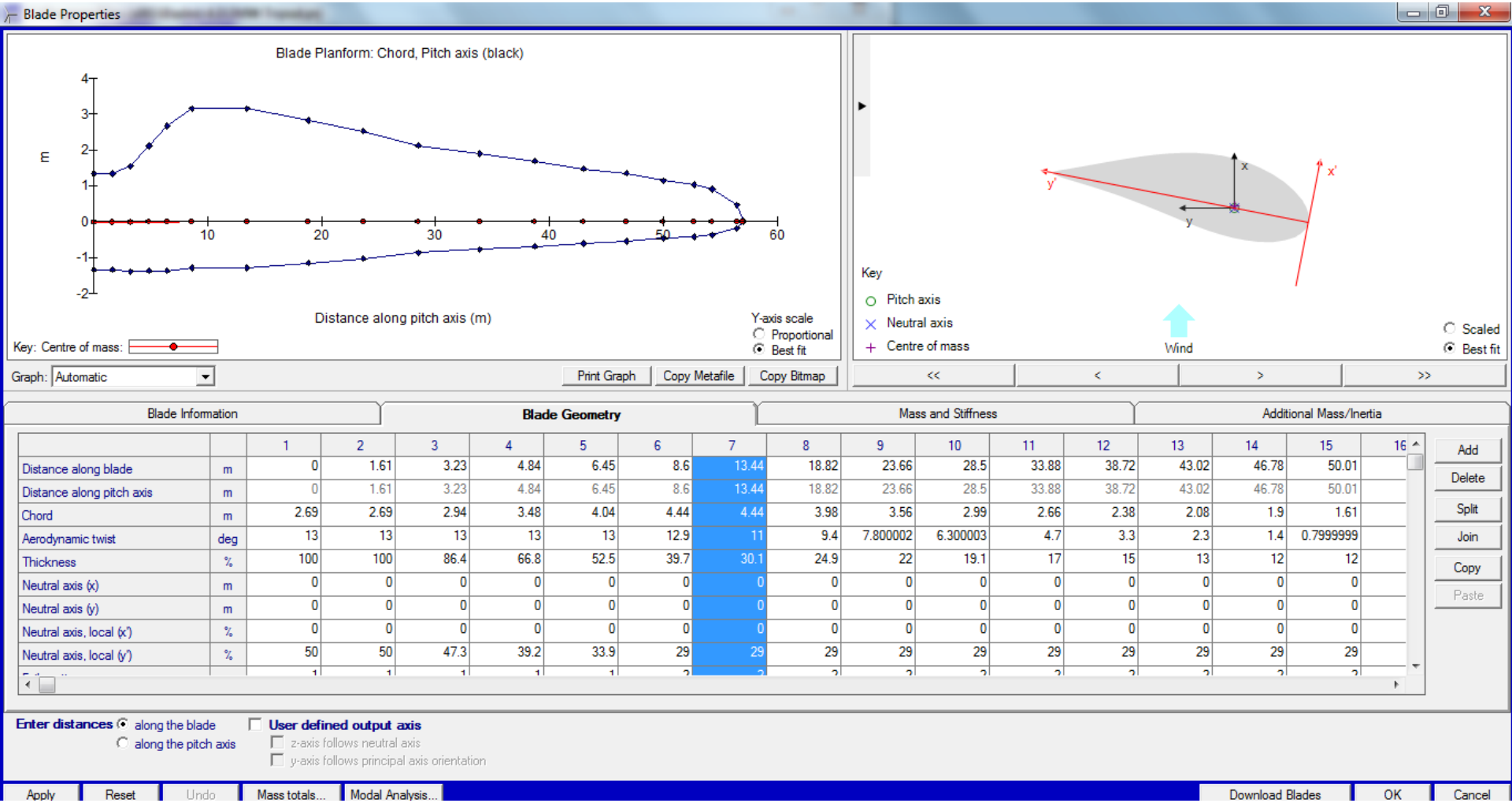
Examples of Bladed input screens

Drivetrain and hub definitions



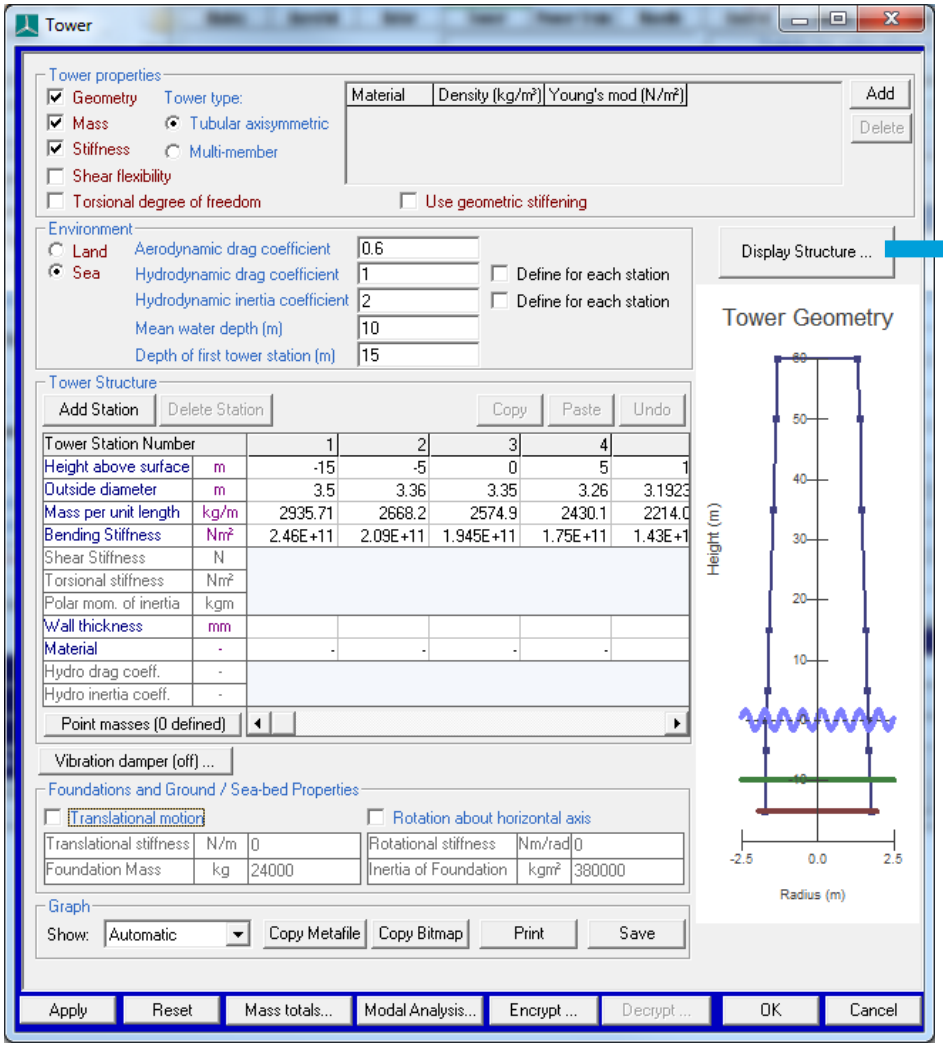


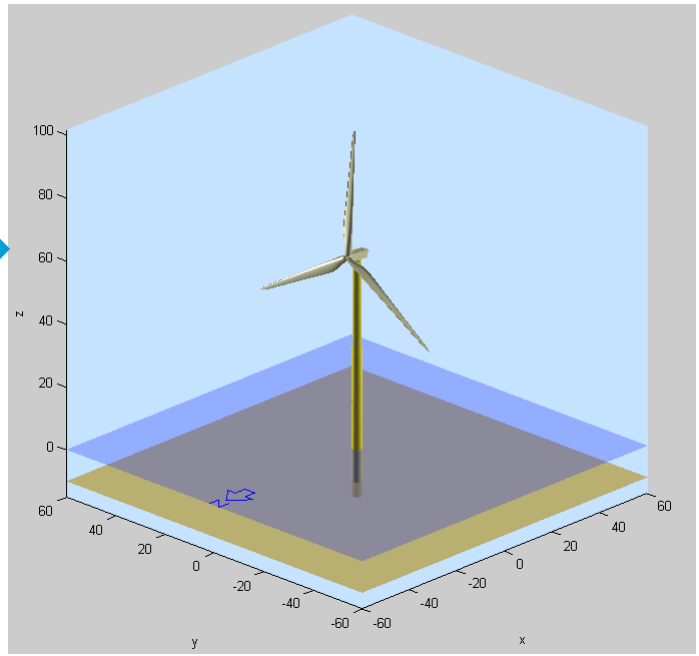
Blade definition



		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Distance along blade	m	0	1.61	3.23	4.84	6.45	8.6	13.44	18.82	23.66	28.5	33.88	38.72	43.02	46.78	50.01	
Distance along pitch axis	m	0	1.61	3.23	4.84	6.45	8.6	13.44	18.82	23.66	28.5	33.88	38.72	43.02	46.78	50.01	
Chord	m	2.69	2.69	2.94	3.48	4.04	4.44	4.44	3.98	3.56	2.99	2.66	2.38	2.08	1.9	1.61	
Aerodynamic twist	deg	13	13	13	13	13	12.9	11	9.4	7.800002	6.300003	4.7	3.3	2.3	1.4	0.7999999	
Thickness	%	100	100	86.4	66.8	52.5	39.7	30.1	24.9	22	19.1	17	15	13	12	12	
Neutral axis (x)	m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Neutral axis (y)	m	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Neutral axis, local (x')	%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Neutral axis, local (y')	%	50	50	47.3	39.2	33.9	29	29	29	29	29	29	29	29	29	29	

Tower module





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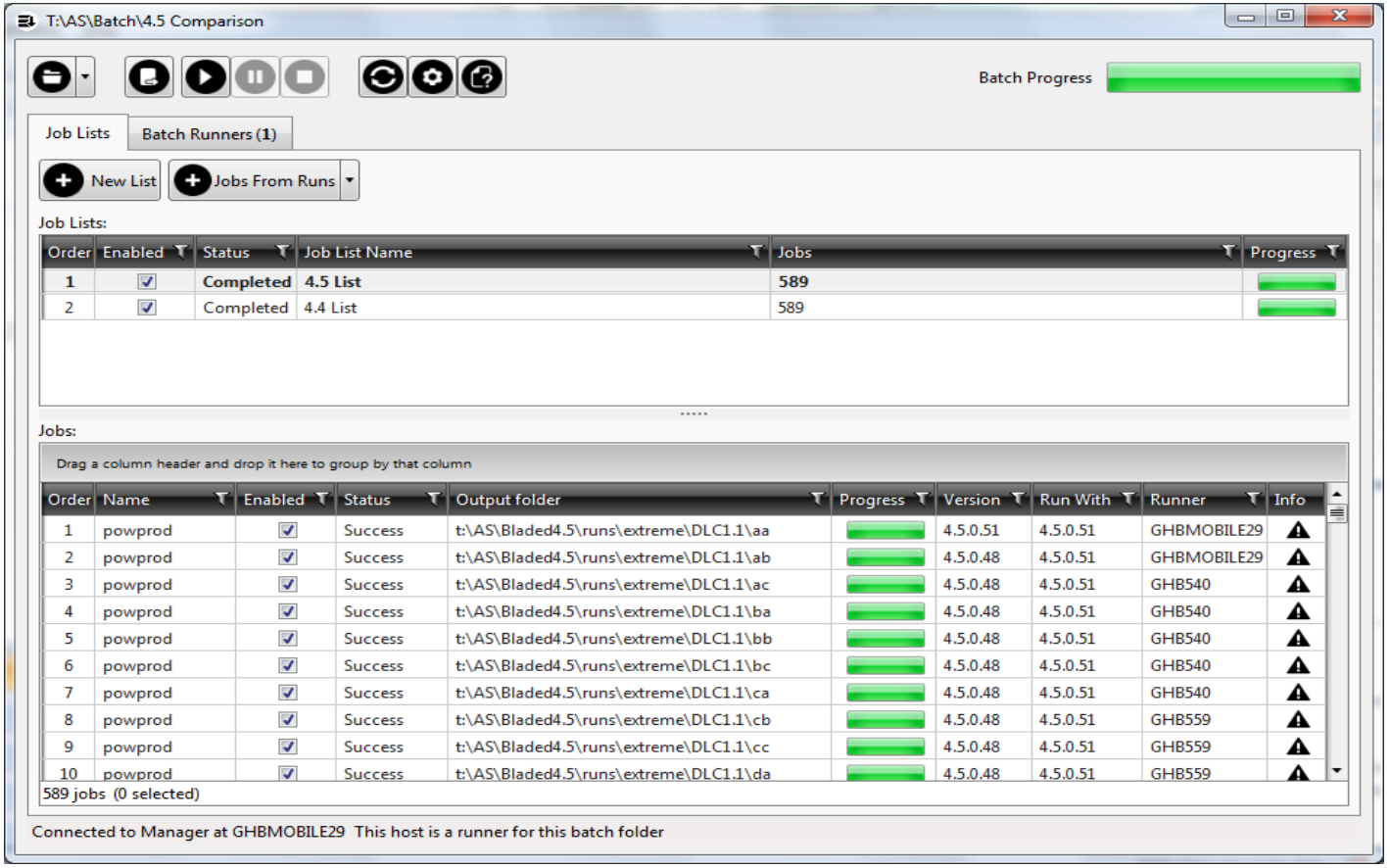
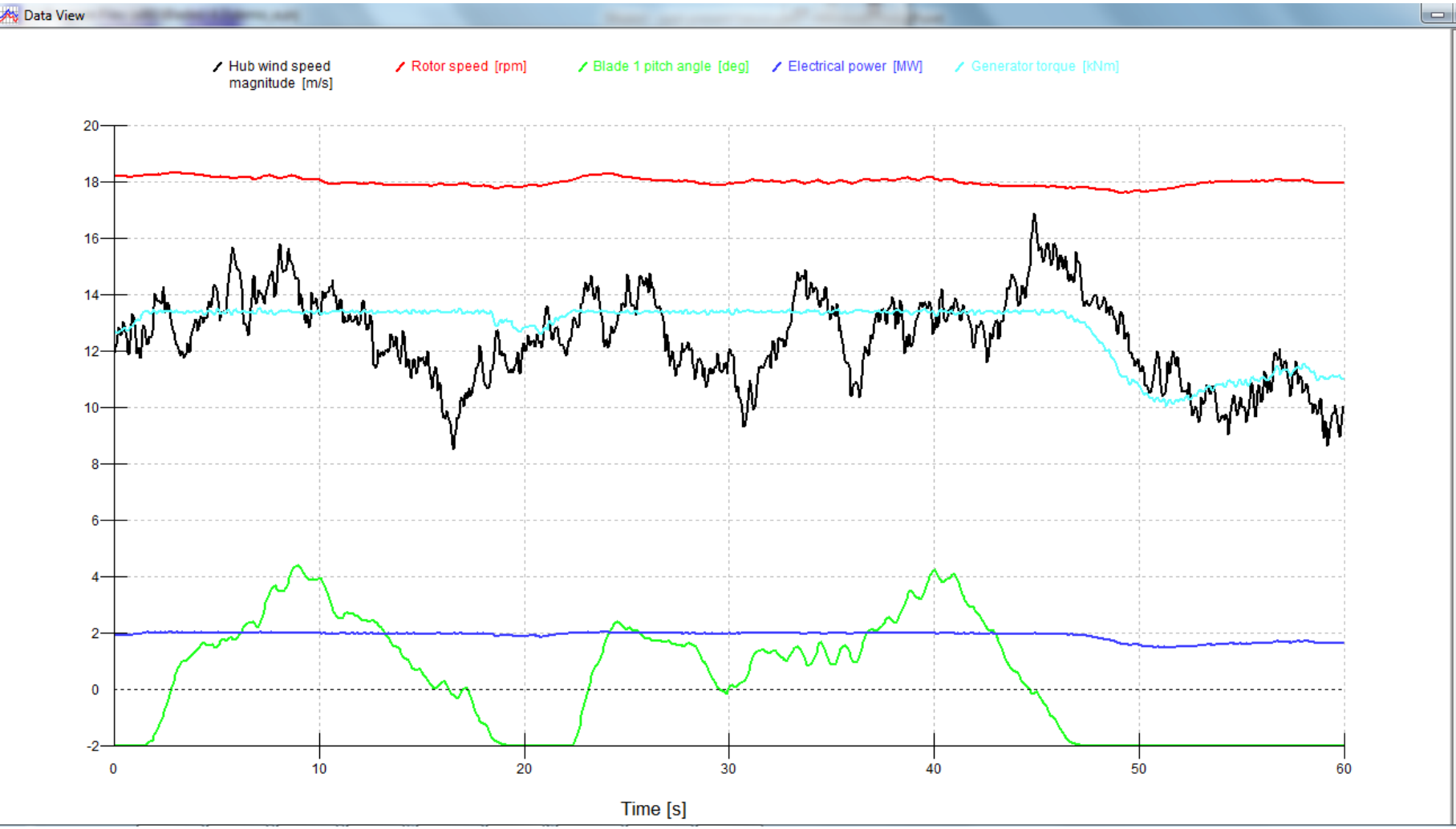
Batch Capability

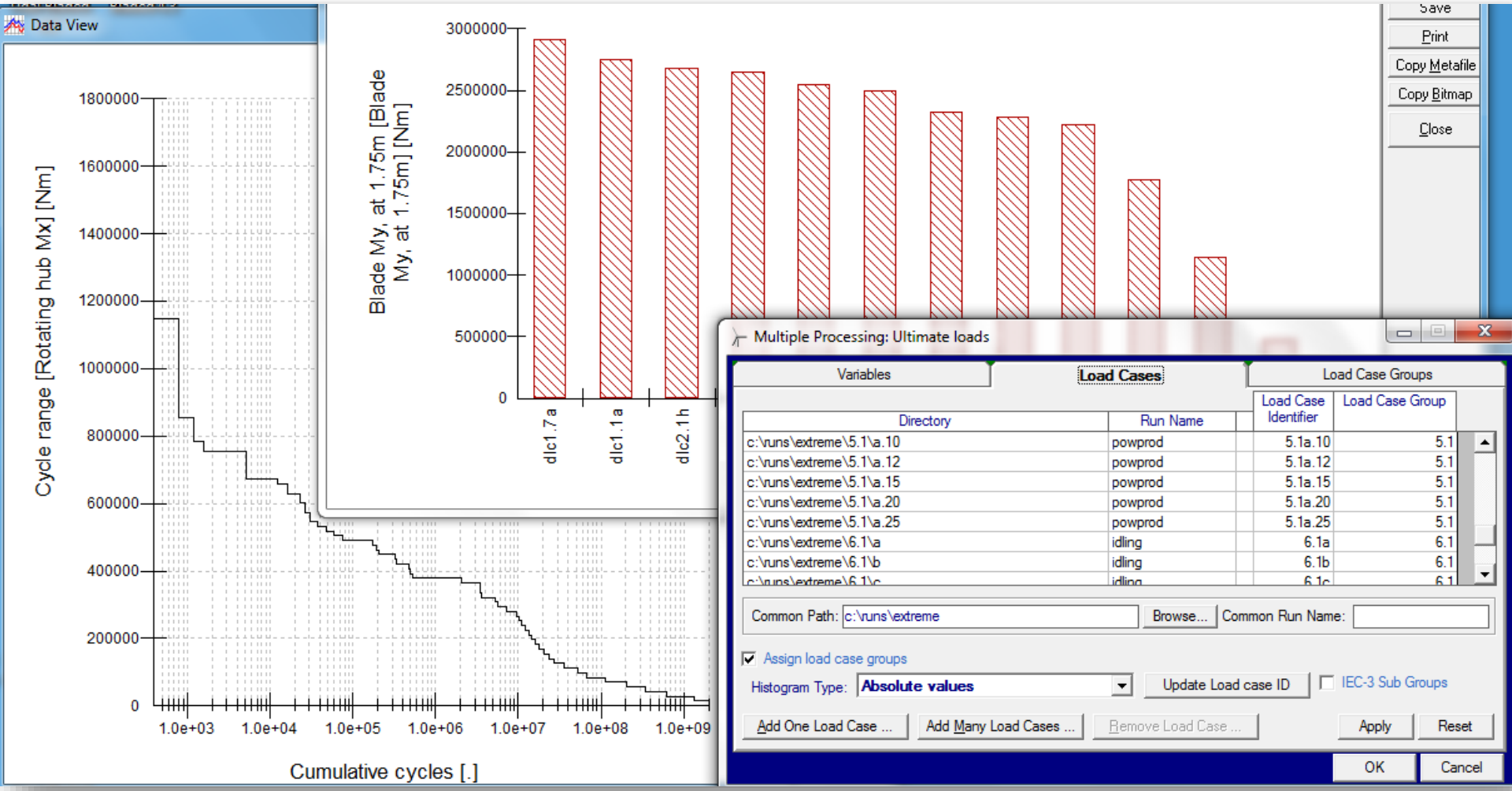
- The full version of Bladed includes a Batch function that allows large numbers of simulations to be run, using multiple cores
- This feature is disabled for Bladed Educational



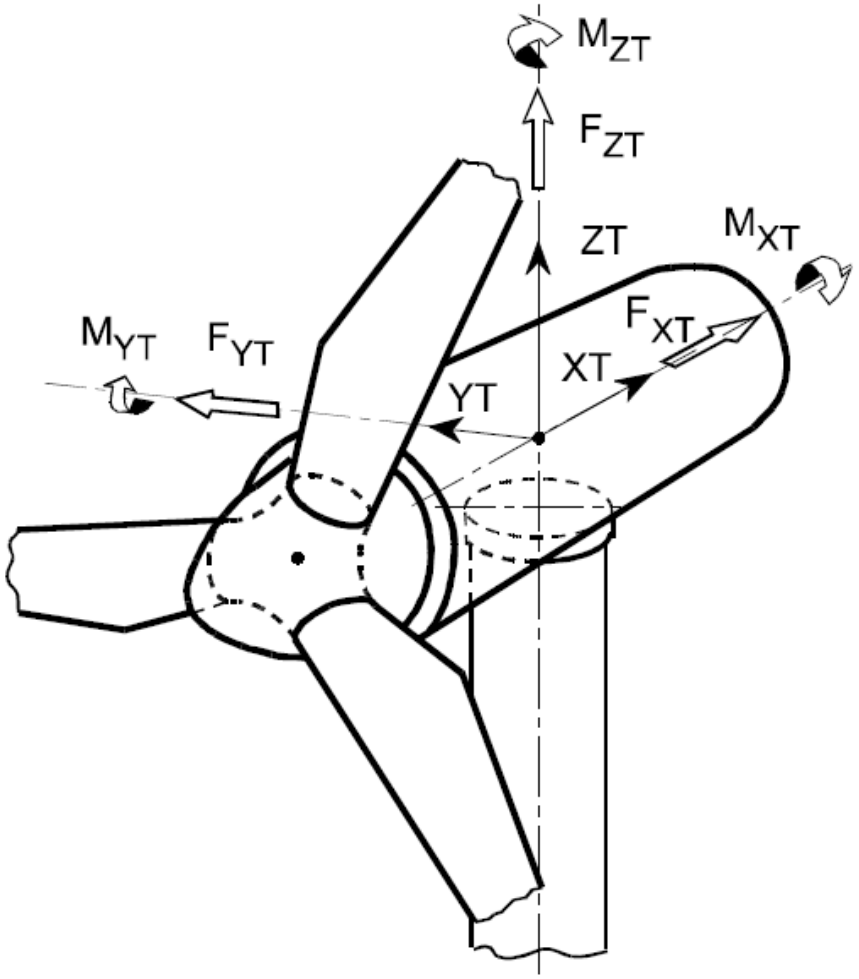
Example graphical output of time-domain simulation



Post processing output examples



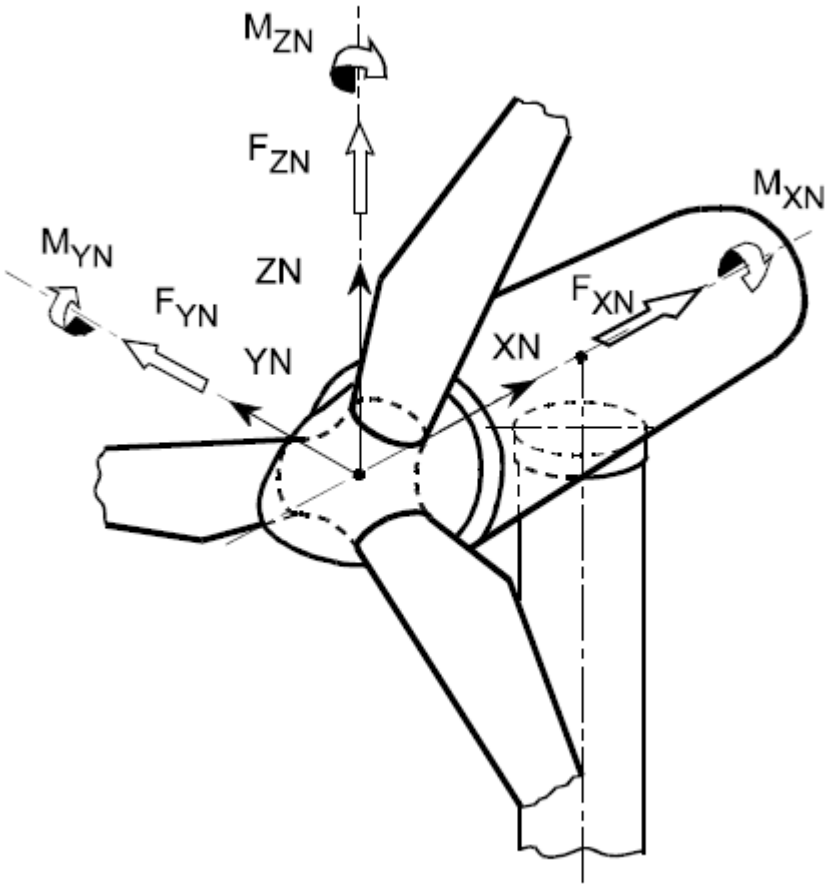
Coordinate Systems in Bladed (1)



Tower Loads

('Global' coordinate system)

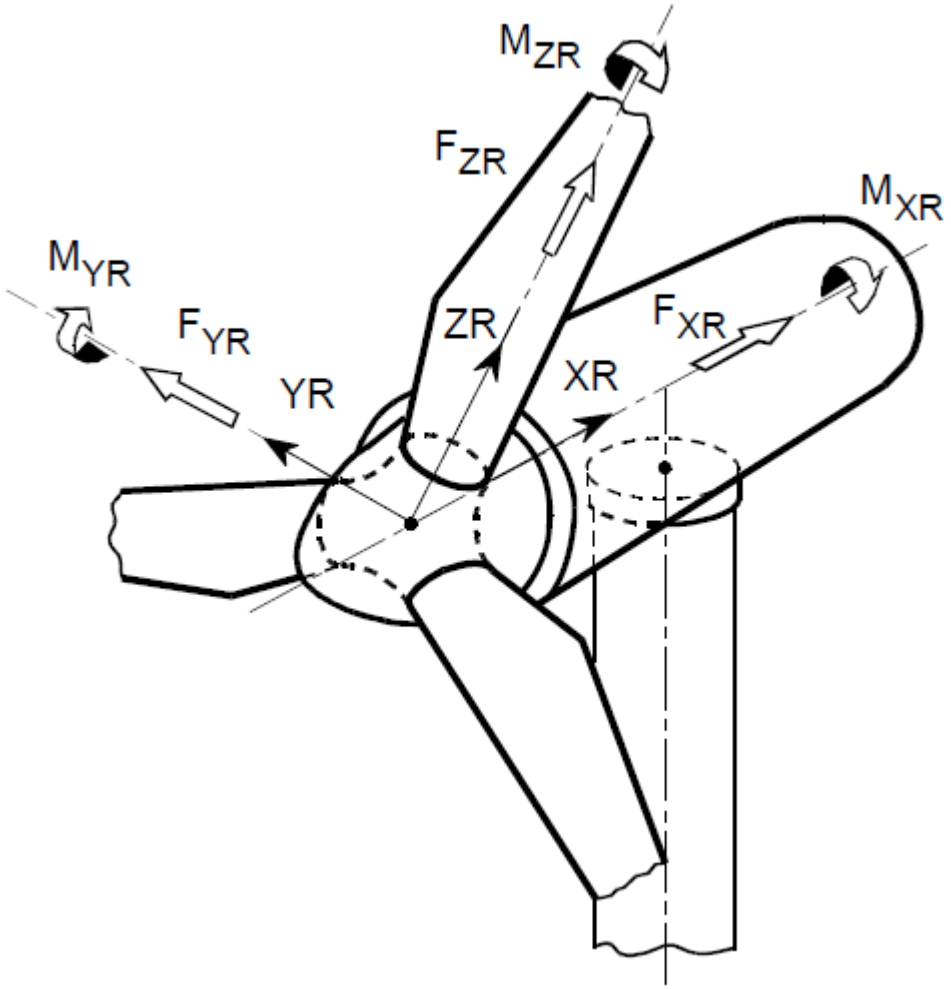
Coordinate Systems in Bladed (2)



Hub Loads

(Stationary system)

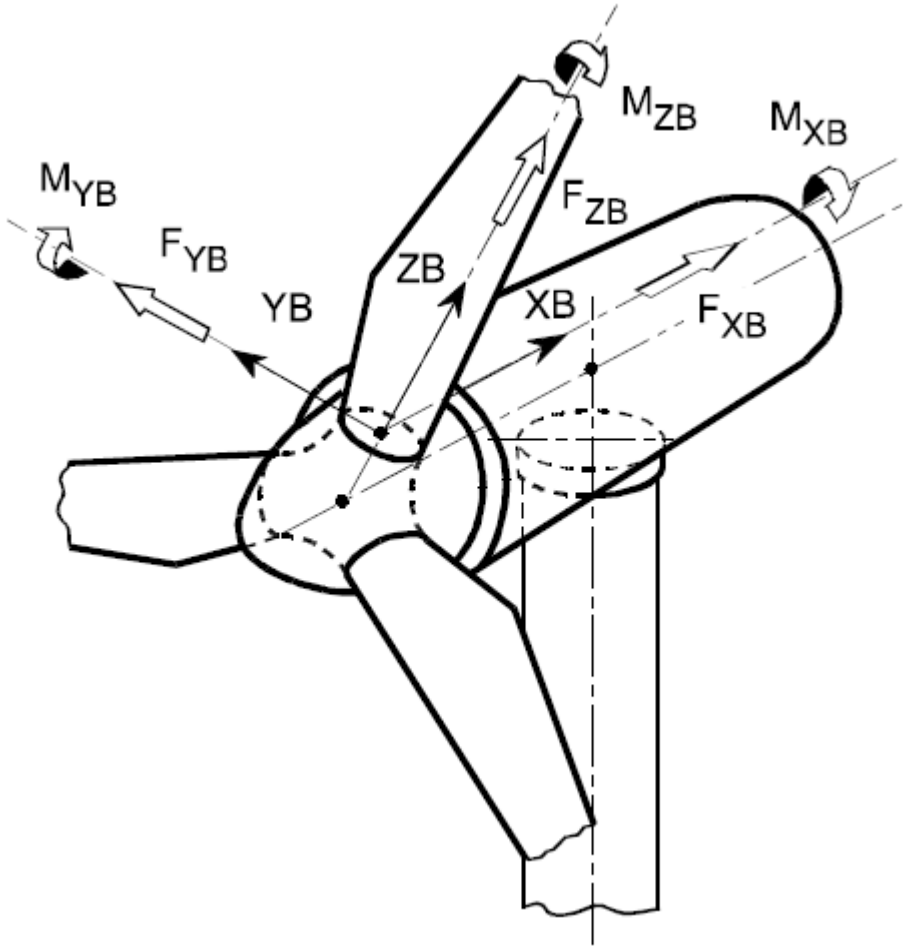
Coordinate Systems in Bladed (3)



Hub Loads

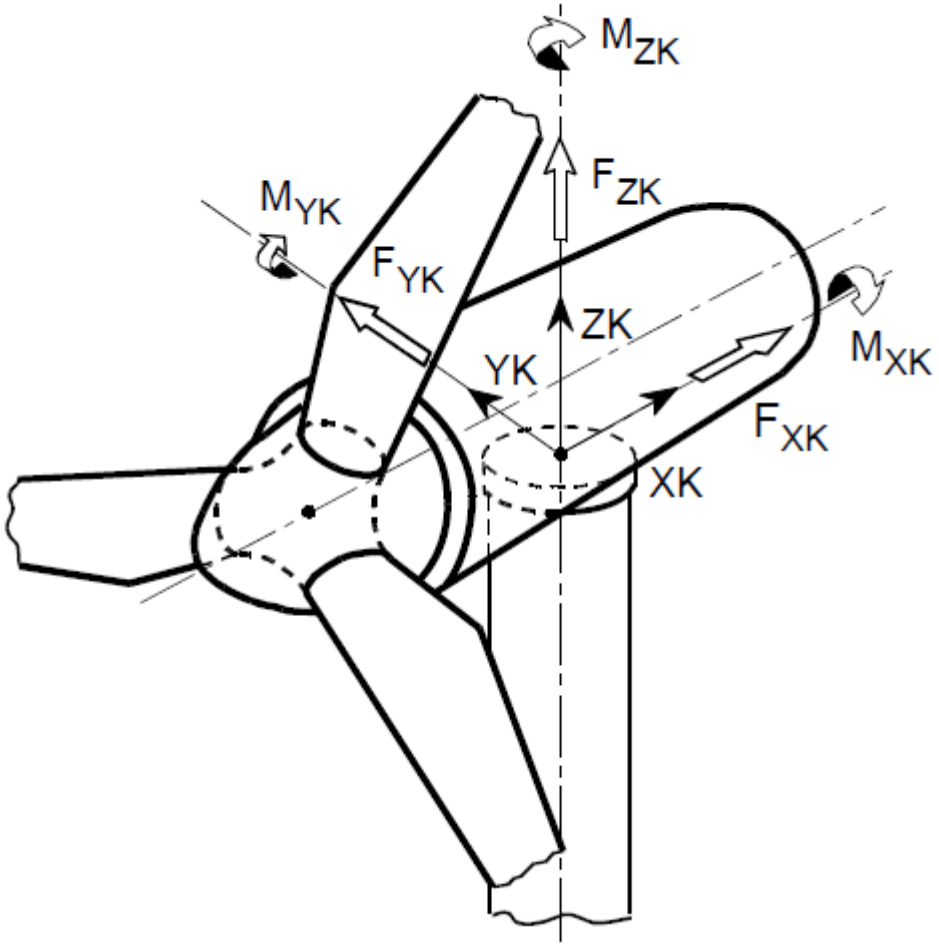
(Rotating system)

Coordinate Systems in Bladed (4)



Blade Root Loads

Coordinate Systems in Bladed (5)



Yaw Bearing Loads

Coordinate Systems in Bladed (6) – Blade Loads

Principal axes

Z axis parallel to deformed neutral axis. Y axis parallel to principal axis. Rotates about z axis with pitch.

Root axes

Z axis parallel to pitch axis.
Y axis perpendicular to rotor axis when blade
is at zero pitch. Does not rotate with twist or deflection, does rotate about z axis with pitch

Aerodynamic axes

Origin at 25% chord. Z axis parallel
to deformed neutral axis. Y axis parallel to chord. Rotates about z axis with pitch.

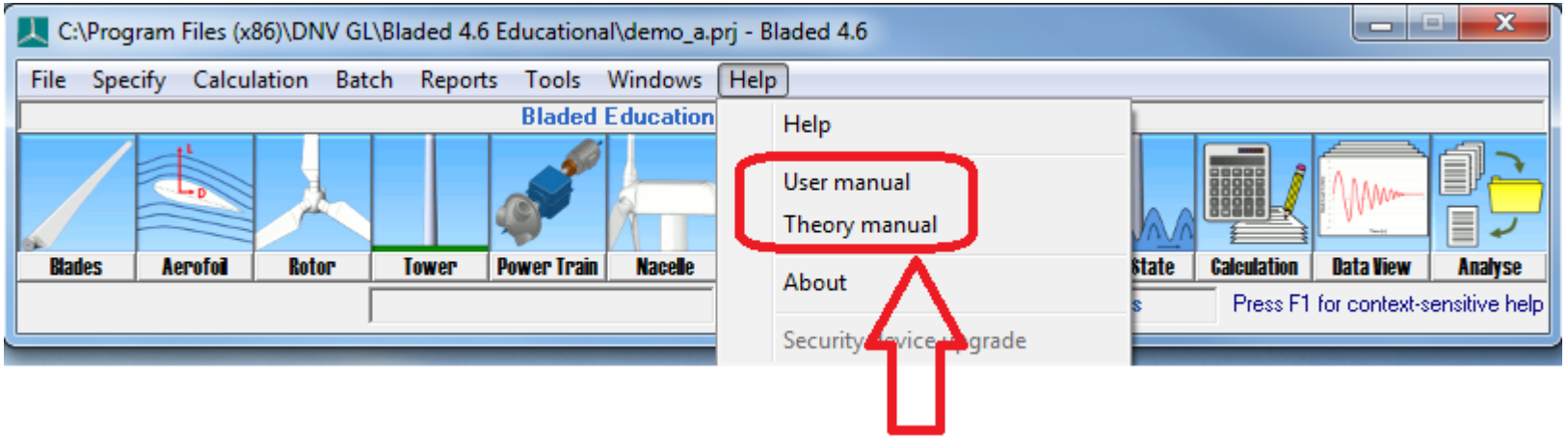
Help and Support

- Bladed Educational Introductory Guide

- Google : ‘Bladed Educational Youtube Videos’

https://www.youtube.com/playlist?list=PLmQHHinSMOEopu_2I6KhQFflflz4VkD7l

- Bladed User Manual and Theory Manual



- Or simply press ’F1’ for instant access to User Manual!

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