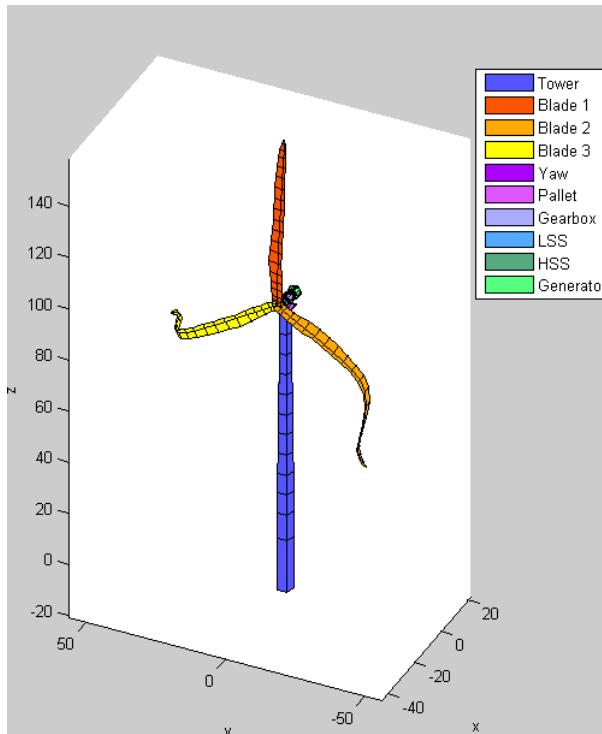


Design of Wind Energy Systems

Lecture 02

Introduction to aeroelastic simulation, quiz & outlook



Prof. Dr. M. Kühn
Bernd Kuhnle, Luis Vera-Tudela

ForWind – Wind Energy Systems

Topics

- I. Why are aeroelastic simulations important?
- II. Approach to simulations in this course
- III. Quiz about general wind turbine knowledge

No reproduction, publication or dissemination of this material
is authorized, except with written consent of the author.

Oldenburg, April 2015

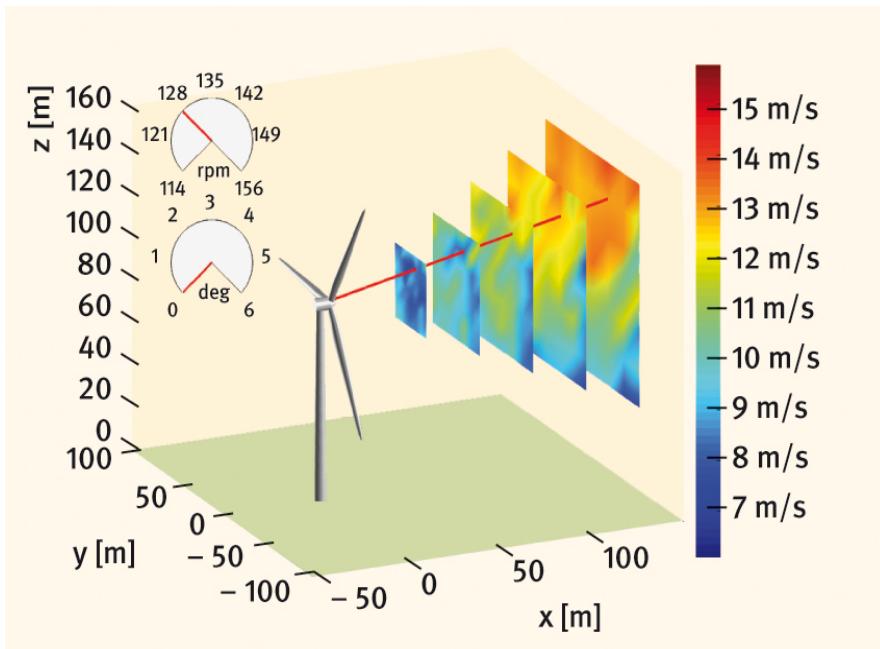
Prof. Dr. Martin Kühn



Section I: Why are aero-servo- hydro-elastic simulations important?

Why are aero-(hydro-servo)-elastic simulations important?

Wind conditions



Extreme wind (?)

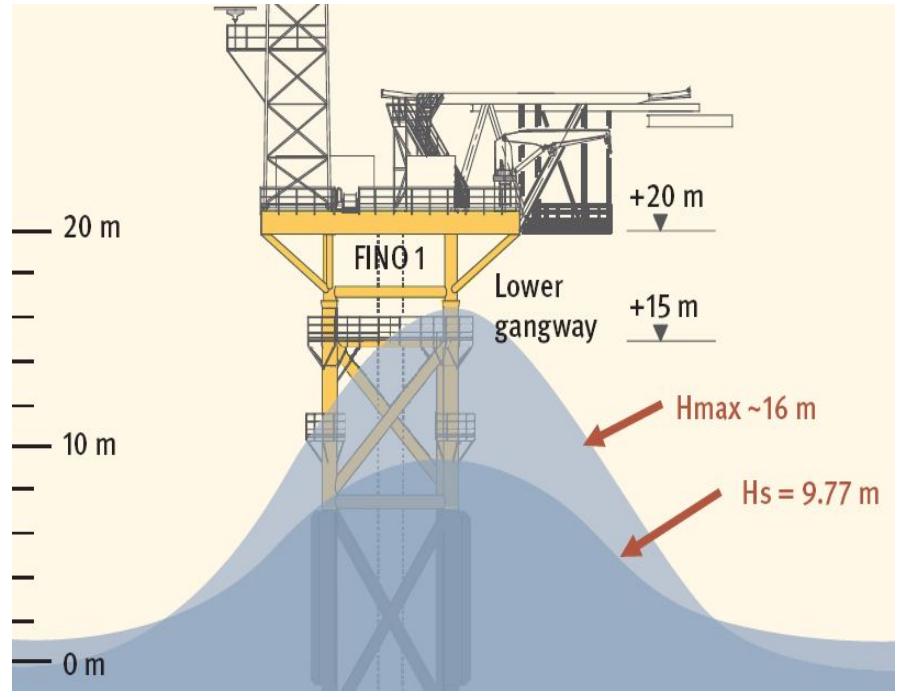


Why are aero-(hydro-servo)-elastic simulations important?

Good weather conditions



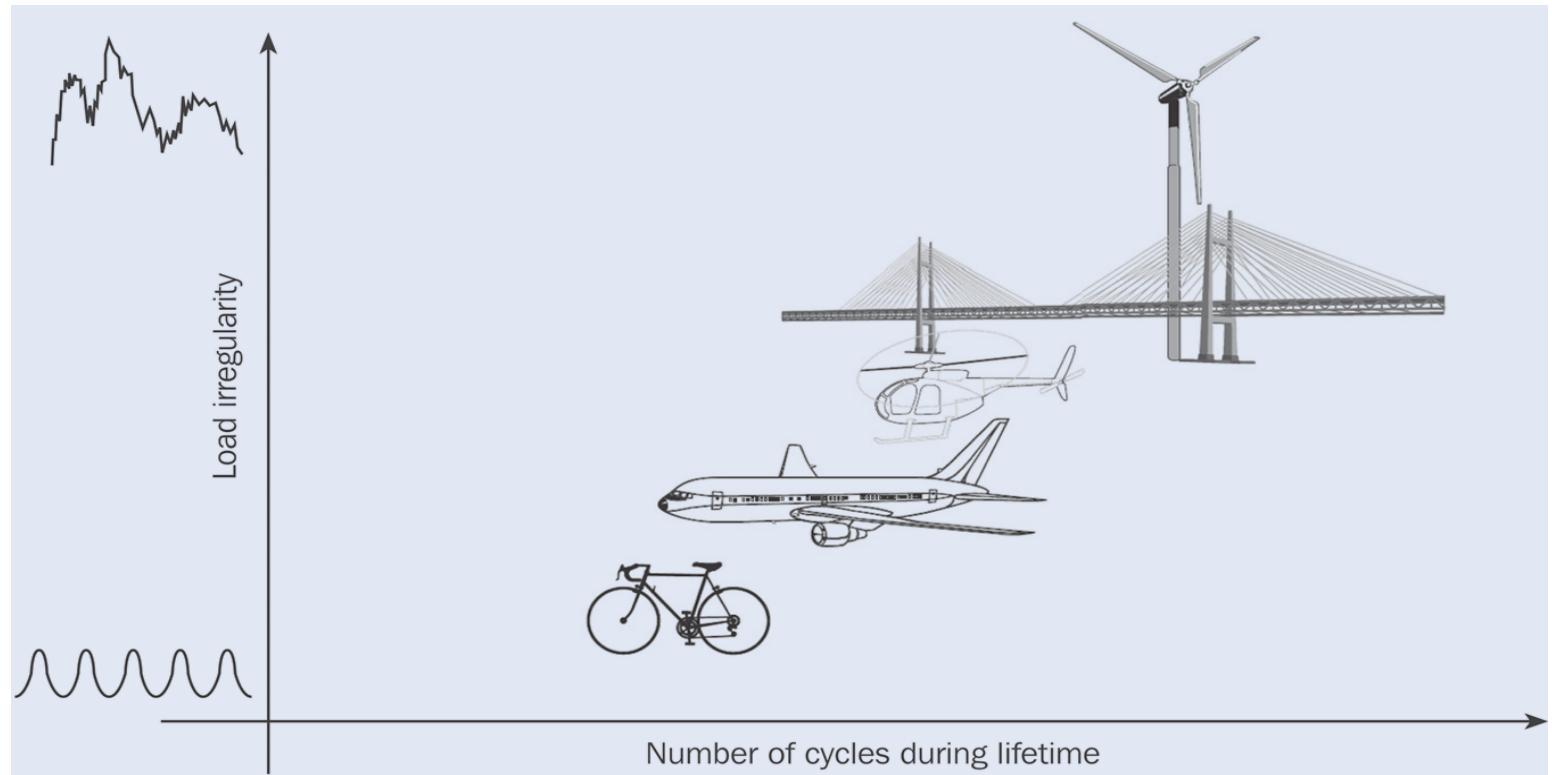
„Cyclone Britta“ 2006



(c) Garrad Hassan

Why are aero-(hydro-servo)-elastic simulations important?

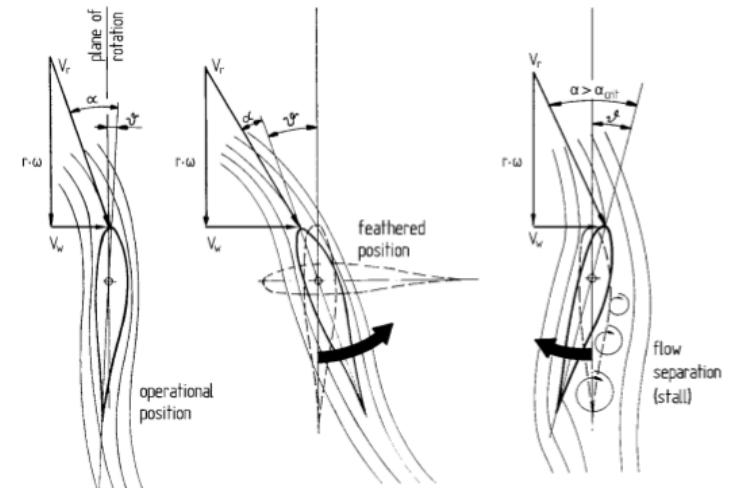
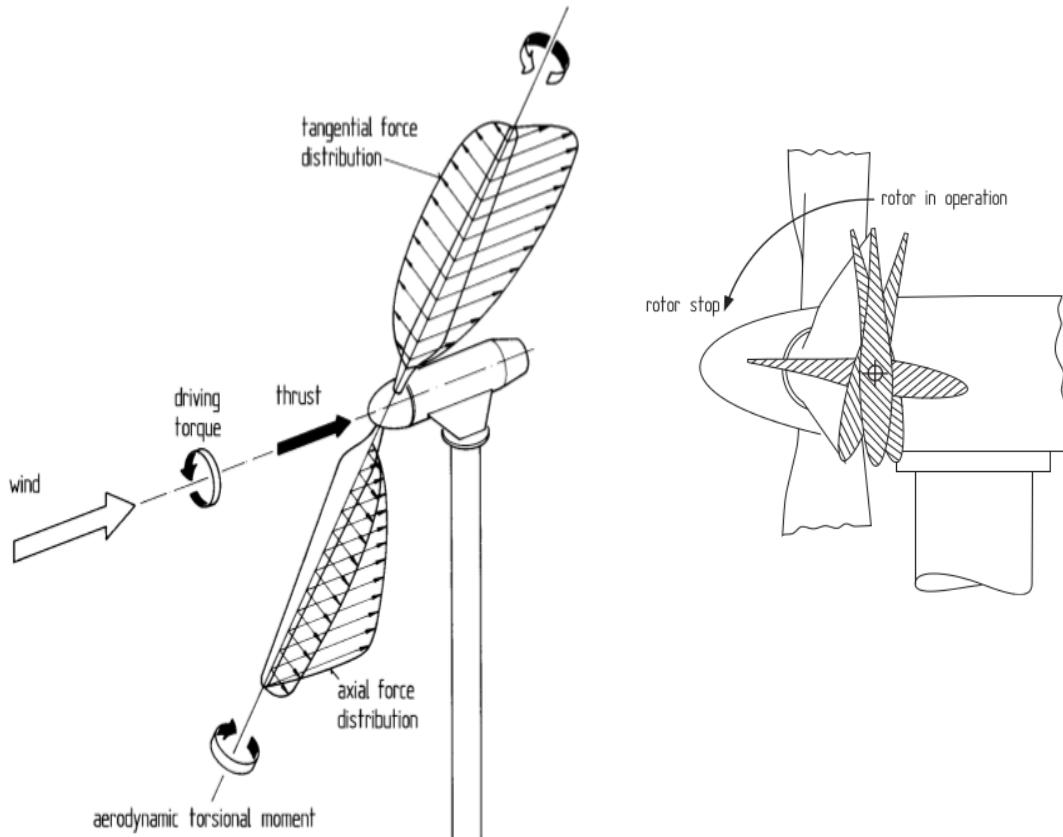
Fatigue loading



(c) TU Delft - ECN

Why are aero-(hydro-servo)-elastic simulations important?

Dynamic loading, regulation & aerodynamics



Hau, 2005



blogs.law.harvard.edu

Section II: Approach to simulations in this course

Focus on wind turbine modeling

Starting with turbine specification:

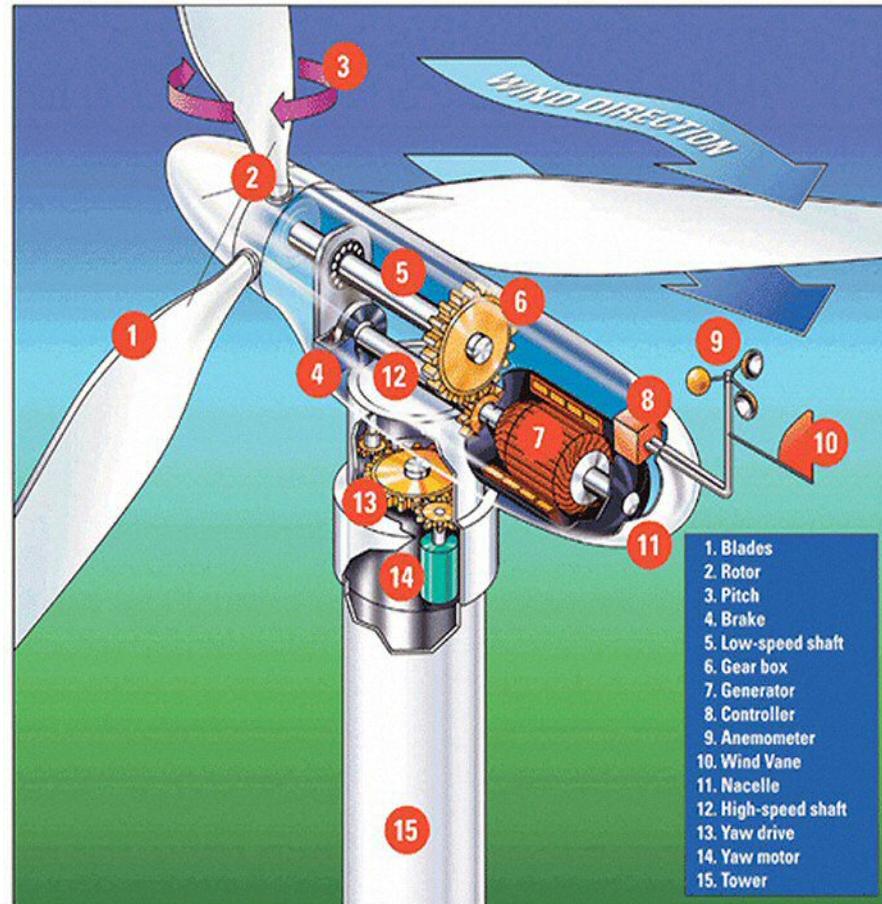
- Main parameters
- Blade & tower
- Performance

To calculate:

- Power output
- Mechanical loads

And to analyse in:

- Time & frequency domains

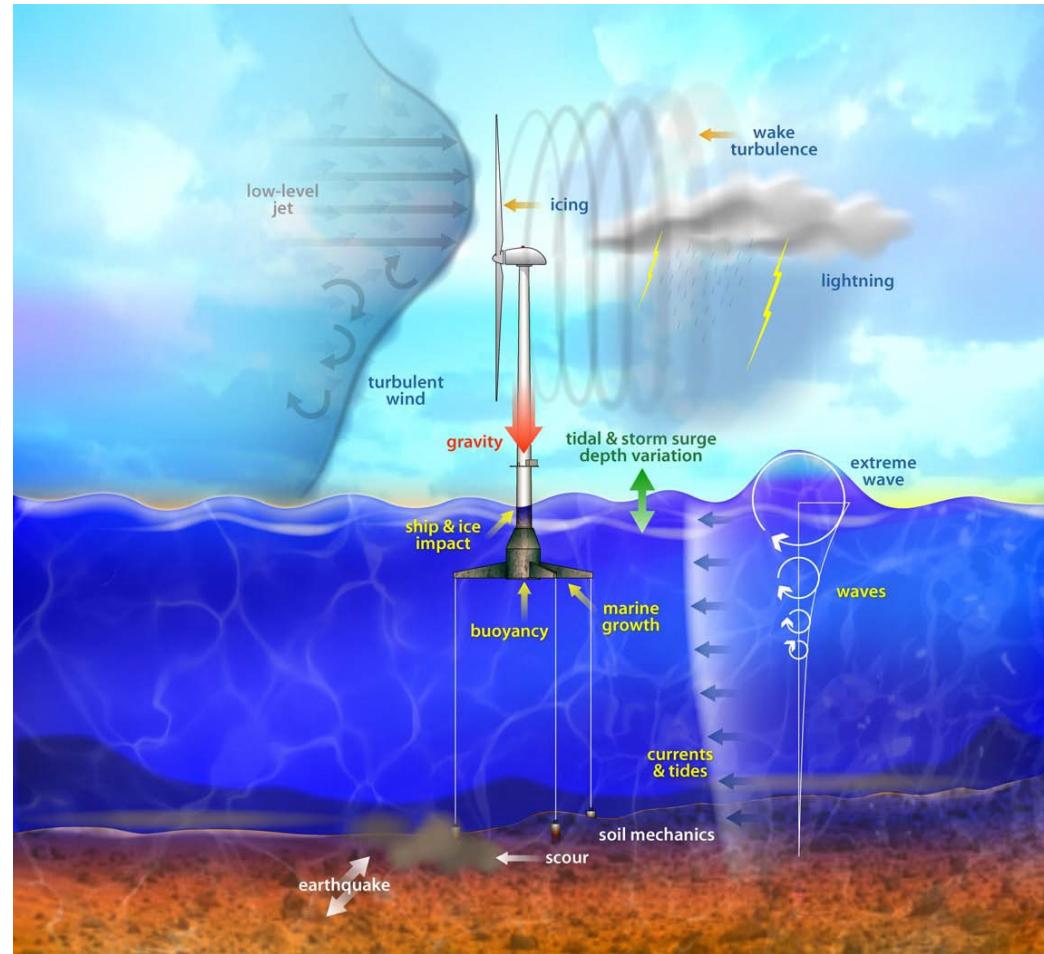


www.wwindea.org

Understanding aeroelastic phenomena

Focused on:

- Wind flow
- Aerodynamics
- Waves
- Hydrodynamics
- Soil dynamics
- Structural dynamics
- Controls
- Electrical grid

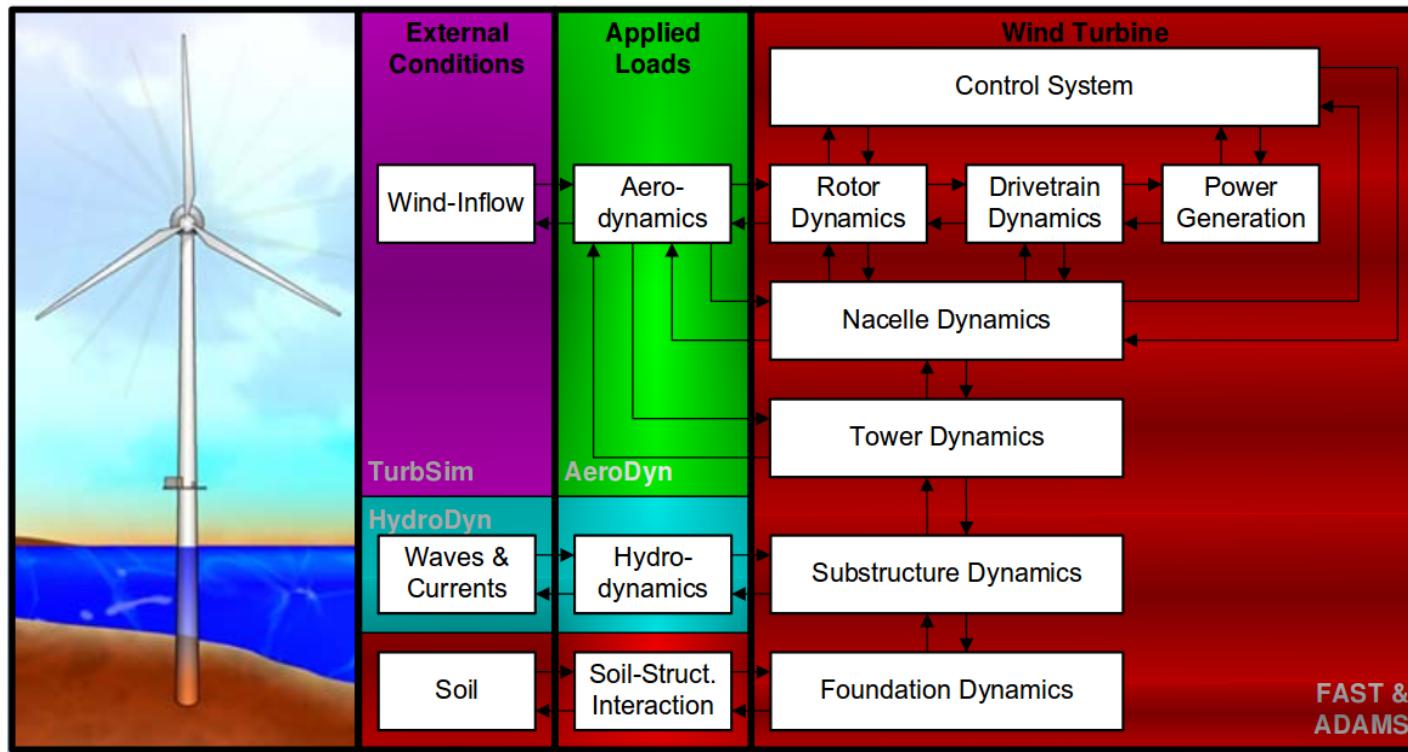


Jonkman, 2013

Using software

From two sources:

- NREL codes – <https://wind.nrel.gov/designcodes/>
- Matlab scripts – stud.IP
- (All what you need will be uploaded to stud.IP)



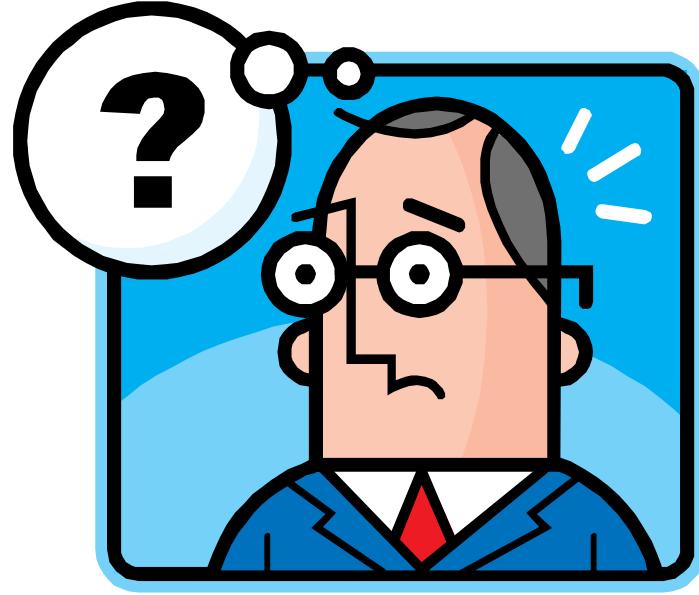
Solving problems in teams

- Of 2 to 3 students
- Named after colors:
 - (1) Red, (2) green, (3) blue, (4) yellow, (5) pink, (6) turquoise, (7) orange, (8) black, (9) violet, (10) grey
- Each team receives starting information
- And a set of questions to solve or discuss in/after each session

And reading, reading, reading

Here a list of some books on wind energy:

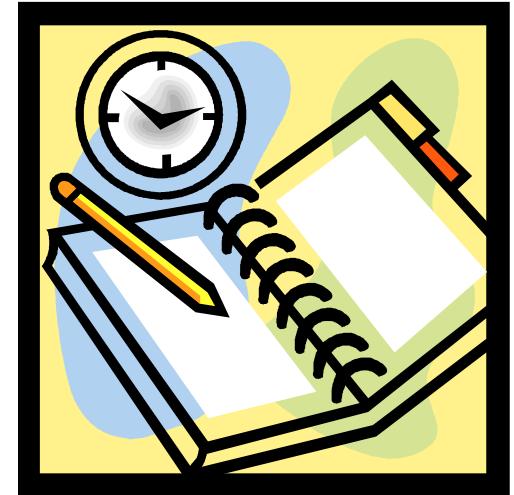
- # Burton, T. et al, Wind Energy Handbook, 2001
- # Hansen, M., Aerodynamics of Wind Turbines, 2008
- # Hau, E., Wind Turbines. Fundamentals, Technologies, Application, Economics, 2006
- # Manwell, J. et al., Wind Energy Explained. Theory, Design and Application, 2002



Section III: Quiz

About the quiz

- It is anonymous & individual (**15 min**)
- Its questions have different levels of difficulty
- Some should be answered by now
- Some will be answered during the semester
- Answers should help customize the lecture



Summary

- Section I: Why are aero-elastic simulations important?
- Section II: Introduction to simulations
- Section III: Quiz
 - # Aerodynamics on a blade profile
 - # Wind turbine system dynamics and loads
 - # Control regimes for wind turbines
 - # General information
 - # Influence of the environment on turbine loading

