

Use of an Industrial Strength Aeroelastic Software Tool for Educating Wind Turbine Engineers

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AESW in Education

The use of aeroelastic analysis software (AESW) for wind turbines is today a well-established practice in the industry. In addition to wind turbine manufacturers, suppliers, consultancy companies as well as research institution are among the users of aeroelastic software.

Still, aeroelastic software apparently has seen little use in university level wind turbine technology classes. This is particularly so at an introductory level – at an advanced level AESW has seen some use, but mostly in a project context and typically not as a teaching or learning tool.

Use of AESW in an educational context at university level potentially has many benefits:

- Students get to know an important kind of tool for the industry
- Students get an improved knowledge of the work flow in the industry
- AESW has the potential of being an effective teaching tool for lecturers as well as an effective learning tool for students

The goal of introducing AESW in education has recently received focused attention from at least two groups. In addition to Ashes developed by Simis Fraunhofer IWES is developing *OneWind for Students*

Ashes @ NTNU

Ashes has been used in the class *TEP 4175 Energy from Environmental Flows* taught by Prof. Ole G. Dahlhaug during fall semester 2013. The class had app. 150 students.

The main portion of the class was a group project where the students were asked to design and test the rotor and the generator of a model scale wind turbine.

Ashes was successfully used in the design of the rotor and subsequently to export the designed blade to the CAD program AutoDesk Inventor. The wooden rotor was finally manufactured in a milling machine.

The project was largely considered a success and will be continued in 2014. The following improvements are among those planned for the use of Ashes in the project:

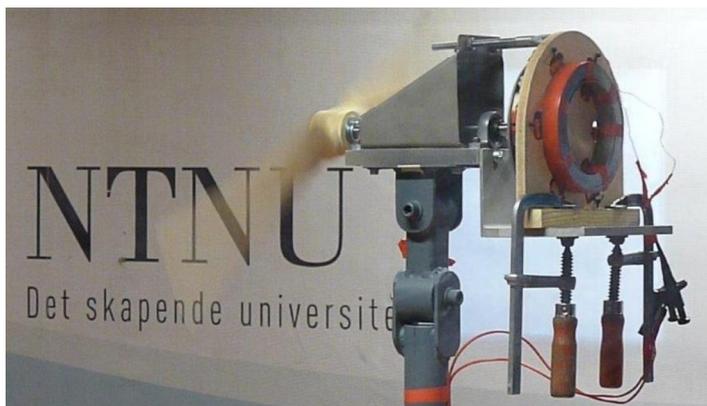
- A relatively elastic plastic material will be used instead of wood. Ashes will be extended to allow for accurate analysis of the large deflections of a solid blade in a soft material.
- As Mac computers have become very popular among students Ashes will also be delivered as a Mac version..

Ashes @ HiST

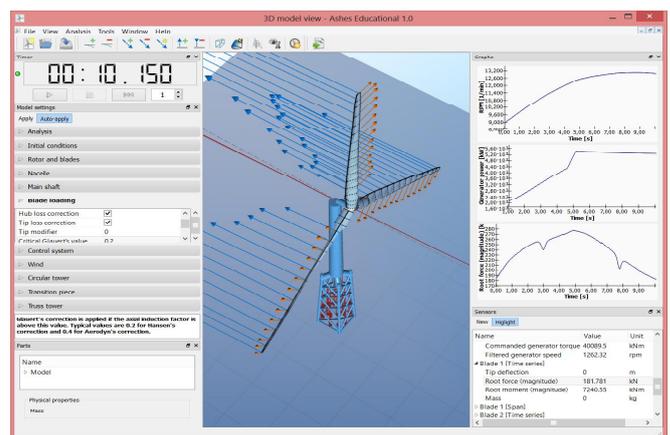
In 2012 the University College in Sør-Trøndelag (HiST) established a BSc degree in renewable energy focusing on hydro power and wind power. HiST and Simis have established a cooperation to leverage the use of Ashes in teaching wind turbine technology. In particular, Ashes will be used in the class *TFNE2003 Wind power and hydro power* taught by Håvard Karoliussen. Ashes has already been introduced in the elective class *AIM306V Wind power – An introduction* taught by Terje Meisler.

As a part of the cooperation with HiST a set of exercises is being developed where learning wind turbine technology is integrated with learning to use an aeroelastic tool in general and Ashes in particular.

Ashes will be offered for use in project and thesis work for the students of renewable energy at a later stage. Of particular interest is using Ashes in a context with the small scale wind turbines available at the HiST campus.



Model scale wind turbine tested in the NTNU wind tunnel. Photo: B. Brandåstrø



Graphical user interface for Ashes Educational 1.0

Conclusions

The aeroelastic software Ashes has been successfully introduced as a tool for teaching wind turbine technology for 150 students at NTNU. Ashes is particularly well suited for use by students because of the emphasis on a rich graphical user interface, visualization, as well as real-time analysis.

The development of Ashes will continue in cooperation with academic partners to optimize the benefit for both students and teachers. Software tools introduced for students will typically be compared to modern software used in other contexts rather than traditional engineering software. To be seen as a learning tool rather than a chore by the students this is likely to require an excellent user experience.