Sensoren T-Shore Sensors

Elective course 'Maintenance of wind turbines' K1312

3 lessons of 4 hours on sensors

Lesson 1: Acquire general knowledge about the function and operation of sensors

Lesson 2: Acquiring skills and learning in practice

Lesson 3: Carry out an integral assignment

Agenda lesson 2

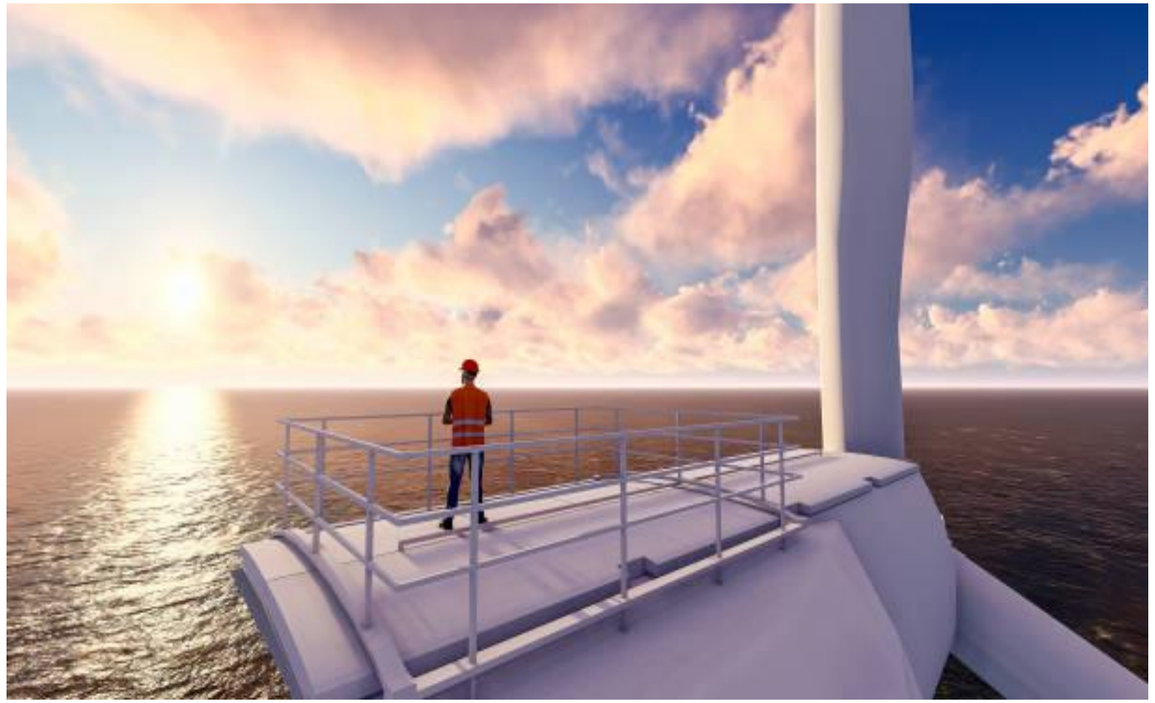
1. Agenda and lesson goal	5 min
2. Retrieve prior knowledge (mentimeter.com)	10 min
3. Working on 2 workstations	90 min
4. Pause	15 min
5. Working on 2 workstations	90 min
6. Completion and preview	30 min

T-shore

Lesson objectives

1. After the lesson you will know how to find out what is wrong with a sensor

2. After the lesson you can fix a malfunction and replace a sensor if necessary



T-shore

Retrieve prior knowledge (10 min)

Possible questions (mentimeter.com):

- What do we already know about the subject?
- What is a sensor?
- How does a sensor work?
- What sensors do we have at work and at home?
- Which sensors are in the wind turbine?
- Where are the sensors located?
- What could be wrong or broken?
- What is important in the context of safety?

T-shore

Theory 1/6

Sensor 1: Rotor sensor

The rotor contains a sensor to pitch the blades. This system ensures that the blades are optimal for energy production at any wind speed. This also means less wear and tear. The rotor makes a maximum of 16 revolutions per minute.

T-shore

Theory 2/6

Sensor 2: Windspeed sensor

Between the rotor and the main shaft is the speed sensor. If the blades go too fast, this sensor transmits a signal. The disc has openings. The sensor 'counts' the openings, as it were, while rotating. This is a binary sensor.

T-shore

Theory 3/6

Sensor 3: Rotor Lock

There is a Rotor Lock on the main shaft. This will block the rotor from working on it safely. This Lock can be operated manually and is driven by a hydraulic pump (on or off). In fact, this is a safety lock when working on the machine.

T-shore

Theory 4/6

Sensor 4: Windrichtingsensor

Each blade has its own sensor (pitch cylinders). The blades move continuously because the wind is constantly changing. They are hydraulically driven pitch cylinders.

The sensor has a controlling (where is the wind coming from) and a steering function (how should the blades change with the changing wind currents).

The sensor always indicates whether more oil pressure needs to come from the left or from the right to adjust the blades.

T-shore

Theory 5/6

Sensor 5: Gearbox sensor

There are two sensors in the Gear box (gearbox/gear room).

A sensor to measure the **temperature** of the oil in the Gear box. Too low is too viscous. Too high is too liquid.

Operating temperature is 85 degrees Celsius.

A second sensor detects the **metal particles** via a magnet. If too many or too large metal particles are released as a result of wear/friction of the gear system, accelerated wear occurs.

T-shore

Theory 6/6

Sensor 6: Brake sensor

Between the Gear box and the generator is the brake sensor. This sensor registers whether the brake is active

T-shore

Practical assignments (4x 45 min including switches)

Procedure

12 students: four groups of 3 students

4 workstations will be set up:

- **The Festo simulator**
- **The Nacelle**
- **The Lucas Nülle case with sensors and measuring equipment**
- **A table with separate sensors (from the wind turbine, a home or other machines)**

Each group works for an average of 45 minutes on a specific assignment per workstation. After rotating and working on all four workstations, the students return to the classroom and discuss/report their findings and experiences.

T-shore

The Festo simulator

Assignment workstation 1

1. The teacher briefly explains the assignment (5 min.)
2. The group starts by visualizing all the sensors as they are present in the simulator (Festo).
3. Show this in the attached sketch (longitudinal section of the wind turbine).
4. Describe name and function of the different sensors
5. Work out a malfunction.
    - For example, describe what happens if the temperature sensor in the Gear box is faulty and the outside temperature is - 4 degrees Celsius.
    - For example, describe what happens if the wind speed is too high
    - Or describe another situation of your choice

T-shore

The Festo simulator

Assignment workstation 1

Detecting a faulty sensor in a wind turbine/Festo simulator

During an inspection, the control system of the wind turbine reports that there is no longer a signal coming through from a temperature sensor in the nacelle.

Work in a team and share experience after analyzing the diagnosis.

Information:

The display indicates that there is a malfunction with the temperature sensor

1. What steps do I have to go through in order to make the correct diagnosis?
2. What equipment do I need?
3. What safety instructions do I need follow?

T-shore

The Festo simulator

Reflection questions

1. How can you tell from the measurement that a sensor is defective?
2. What could have been the cause if there was no power supply?
3. Why is it important to always check the wiring?

The Festo simulator

Answer information:

Background information/resources

What (measuring) equipment do I need?

- Digital Multimeters
- Technical diagram of the sensor circuit
- Safety equipment
- Backup temperature sensor (to replace)
- Tool case

T-shore

De Festo simulator step-by-step plan

1. **Preparation and safety** (switch off the turbine according to the safety procedure) Check whether the nacelle is safe to enter. Set the Multimeter to the correct measuring position.
2. **Voltage control** on the sensor. Locate the temperature sensor in the nacelle. Find excitement and move on to the next step.
3. **Check signal wire**. Locate the signal wire that runs from the sensor to the control. Measure the output signal from the sensor. Write down the value and compare it with the expected value according to the data sheet.
4. **Resistance measurement**. Compare the measured resistors with the factory values.
5. **Continuity** of wiring. Repair or replace
6. **Assessment**. If there is no signal but power is available and the wiring is correct. Sensor defective. If the wiring is interrupted, correct the cable break.
7. **Wrapping up**. Install a new sensor if necessary. Restore the installation and test the system again after powering off. Fill in the work report.

T-shore

The Nacelle

Assignment Workstation 2. The Nacelle

1. The group works on the Nacelle under supervision
2. The teacher gives short instruction (5 min)
3. Start by imaging all the sensors on the Nacelle. Please indicate this in the attached sketch/drawing of the Nacelle
4. There is a mechanical failure and an electronic failure
5. Investigate which sensor has which malfunction
6. Discuss this with the teacher
7. Fix the fault

T-shore

The Nacelle

Assignment workstation 2: the Nacelle

Troubleshooting the wind turbine wind speed sensor

Situation sketch

An error message has been received via the SCADA system for a wind turbine; "Incorrect values wind speed sensor data unreliable". The turbine has automatically gone into safe mode.

The WP4 instructor gives the order to investigate what the cause is.

T-shore

The Nacelle

1. **What steps should I take to find out what the cause is?**
2. **What do I need to do to make the correct diagnosis and make a possible repair?**

Think of:

- Preparation
- Safety aspects
- Diagnosis
- Repair/replacement
- Control
- Materials needed
- Assessment criteria

T-shore

The Nacelle: answer information

1. Preparation

- Secure the installation (everything is at a standstill, no voltage)
- Read the error message from the display/SCADA screen
- Check the documentation and electrical diagrams of the sensor installation
- Determine what type of sensor is used (e.g. analog or digital, etc.)

2. Diagnosis

- Inspect the physical condition of the wind sensor (cable breakage, contamination, damage)
- Measure the signal value with a multimeter or measuring system
- Check that the sensor's power supply is present
- Temporarily shut down the sensor and simulate an input signal to check, test

3. Repair/replacement

- If defective; Disassemble the sensor and replace it with a new one
- Check connections and grounding
- Repair any cable damage

4. Control

- Restart the system and check that the sensor is transmitting the correct values again
- Observe if the wind turbine starts up normally again
- Report your findings and fill in the malfunction report

T-shore

The Nacelle: answer information

Materials required:

- Multimeter
- Documentation of the system
- Replacement wind sensor (optional)
- Tool set for electronic work
- Safety equipment (parachute, helmet, gloves, etc.)

Assessment criteria:

- Working safely in accordance with regulations
- Correct use of measuring instruments
- Logical and structured management research
- Correct Repairs/Replacement
- Accurate reporting of work

T-shore

The Lucas Nülle sensor case

Assignment workstation 3

Lucas Nülle case with sensors and measuring equipment

1. The teacher gives brief instructions on which equipment with accompanying instruction is present in this case

2. Analyze the different sensors. Follow the Lucas Nülle software instructions

T-shore

Workstation 4: table with test sensors

Assignment workstation 4. Table with various sensors and **measuringequipment**

If a sensor is linked to certain parts of a wind turbine or a similar part of a wind turbine.

1. The teacher briefly explains the various sensors and peripherals
2. We start by analyzing some sensors

- What material is a sensor made of?
- Can I dissect the sensor or replace parts of it?
- How can I measure whether this sensor is still working?
- Work out the flow diagram of a sensor how it perceives, transmits and displays the signal (wind/light/pressure/temperature) in a binary or analog value. Look for this information on the internet or textbook.

T-shore

Workstation 4: table with test sensors

Assigment workstation 4

Working with the Multimeter

The Multimeter is an important measuring instrument to diagnose whether the various sensors are still functioning.

1. Perform a resistance measurement
2. Measure the voltage of a battery
3. What possibilities does the Multimeter have?

Share these experiences with each other

T-shore

Test yourself Kahoot

Link to questionnaire

Conclusion, evaluation and preview (30 min)

- How did the exercises go?
- Short repetition of important theory
- Has the lesson objective been achieved?
- How did the lesson go?
- Preview next lesson and exam

T-shore