TEXAS TECH UNIVERSITY
Department *of* Mechanical Engineering™

Graduate Seminar (2021 Spring)

#1 Title: Up-Scaling of Offshore Wind Turbine using Environmental-based Design (EBD) Methodology

Abstract: Up-scaling of offshore wind turbines (OWTs) is the preferred method, particularly in offshore devices, to reduce the cost of wind power since they improve space management, increase availability and reduce number of turbines at wind farm level. However, it was observed that after certain level, upscaling costs outweigh the aforementioned benefits. That may be explained by the shortcomings associated to the current upscaling designs approaches, i.e. lack of sustainability, and limited exploration of the design space. As a result, this study aims to contribute to further reduce the cost of the electricity of offshore wind power by reliably and sustainably up-scaling OWTs at the conceptual level. To achieve that, the next research question was formulated for this work: can a 5 MW OWT be upscaled to 10 MW OWT using a design methodology that considers the circular economy principles (CE)? To answer this research question, two specific aims were developed: (1) to apply a reproducible design methodology, and (2) to achieve a more sustainable upscaled OWT design by applying the CE principles. To investigate these specific aims, the environmental-based design approach (EBD) along the CE principles was adapted and applied systematically to sustainably scale a 5-MW turbine to a 10-MW turbine. The results shows that the EBD and CE allows designers to explore the full design space, support all the phases of the design, and analyze circularity during the design process; hence more realistic, reliable, and sustainable designs for the next generation of large OWTs can be achieved, and thereby continuing to push the cost of electricity of wind power down.

Bio: Mr Abraham Nispel studied mechanical engineering at the Pontifical University Catholic of Valparaiso (PUCV) in which he graduated with honours after defending his Thesis on a “Preventive Maintenance Plan for a Fishmeal factory”. Thereafter, he started working as a project engineer in the Research Department of the PUCV, in which he was in charge of developing projects primarily related to renewable energies with university professors to obtain funding from state and non-state agencies to conduct the R&D projects. During his spell in the department, he helped academics to get significant funds from the government to develop innovative energy projects in solar energy and wave energy. During the same time, He also works as a research assistant for the Laboratory of materials of the school of Mechanical Engineering of the same university. After a spell in Australia and Mexico, Mr. Nispel was awarded a scholarship from the college of engineering of Texas Tech University (TTU) to pursue his Doctorate in the Department of Mechanical Engineering of the same institution. While as a full-time research assistant in Texas Tech, Mr Nispel was selected to have an international internship in Research cluster for dynamics and logistics, University of Bremen, Bremen, Germany. During his spell in Bremen, he investigated and applied more accurate techniques to model long term loads on offshore wind turbines structures, cooperated in offshore wind projects regarding installation and transport of offshore wind turbines, and also coordinated meetings to establish research collaborations across universities. Currently, Mr Nispel is working as a research assistant in the Laboratory of Product & Design and Development, wherein he has participated as author and co-author in several papers related to uncertainty quantification (UQ), probabilistic design and data-driven and physics-based prognostics in gearboxes and renewable energy devices, as well as engineering design.

#2 Title: Experiments and Simulations of a Propulsive Rotor with Synthetic Jets for Aerodynamic Performance Enhancement

Abstract: Understanding the effects of synthetic jets in a highly three-dimensional crossflow is critical for the improvement of active flow control techniques to enhance the aerodynamic performance of propulsive rotors. In this presentation, a laser Doppler velocimetry (LDV) measurements and three-dimensional computational fluid dynamics (CFD) simulation of a rotor is used to gain more insight into the behavior of the flow when flow control parameters are changed, including the position and momentum coefficient of the synthetic jet actuators mounted inside three rotor blades. To this end, a complete rotor assembly with a NACA 0012 airfoil was studied at 250, 500, 750 and 1000 revolutions per minute (RPM) with blade pitch angles of 2, 5, and 8 degrees. The rotor thrust, torque, and were measured experimentally using a high-capacity load cell, while laser Doppler velocimetry (LDV) measurements were obtained near the root, middle, and tip regions of the blade. The commercial software ANSYS FLUENT was used to compute the velocity components and aerodynamic forces around the blades. The results of both methods were compared to increase the reliability of the analysis.

Bio: Nicolas Peralta is a Ph.D. candidate in the Flow Control and Aerodynamics lab, directed by Dr. Victor H. Maldonado. His research interest includes the experimental and computational study of active flow control for 3D flows in rotorcrafts aiming to bring new solutions for aerodynamic enhancement.