**A DESIGN METHODOLOGY FOR VENUSIAN WIND TURBINES.** L. Ghabuzyan[1], C. Chhun[2], J. Vega[2], Z. Bravo[2], J. Kuo[2], and J. Sauder[3], [1]lghabuz@calstatela.edu, California State University, Los Angeles, Los Angeles, CA; [2]California State University, Los Angeles, Los Angeles, CA; [3]Jet Propulsion Laboratory, Pasadena, CA.

**Introduction:** Venus is known as Earth's sister planet, due to their similar size and proximity. Yet, Venus remains relatively unexplored compare to Earth's more distant neighbors. This is because, unlike Earth, the Venusian atmosphere is made up of 96% carbon dioxide, a greenhouse gas. As a result of greenhouse effect, its atmospheric temperature has been recorded to be as high as 464°C. In addition, the pressure at the planet's surface is approximately 90 atm. This harsh environment makes it difficult for conventional rovers with electrical components to survive for long duration. Therefore, any future rover missions on Venus will need to rely on mechanical means to power the rover, e.g. wind turbine. Wind turbines have been extensively studied under Earth conditions [1], which existing design tools and principles can be applied to design a wind turbine to operate on Venus. The aim of this work is to develop a fast and lower cost design methodology to develop and optimize various turbine designs.

**Proposed Design Methodology:** The proposed design methodology utilizes Blade Element Momentum (BEM) theorem [2], a well-established accurate and low cost approach to predict the performance of a turbine. In this work, a BEM model was implemented in conjunction with computational fluid dynamics (CFD) simulations and wind tunnel experiments, and they are used to study and optimize performance of wind turbines.

The geometry of the blade will tremendously influence the turbine’s coefficient of power. To reduce cost and improve design speed, a design process was established, shown in Figure 1. Once an initial blade shape (such as optimum blade [3]) has been developed, and its performance can be predicted using the BEM model. If the performance of the blade meets the design requirements, CFD simulations are performed to validate BEM results. Then, a scaled wind turbine model is manufactured and tested in the wind tunnel for validation. From simulation and experimental results, any necessary modifications can be made to the blade design and the process is repeated until the turbine performance is optimized. An overview of the design methodology, highlights of simulation and experimental results, as well as lessons learned will be presented.

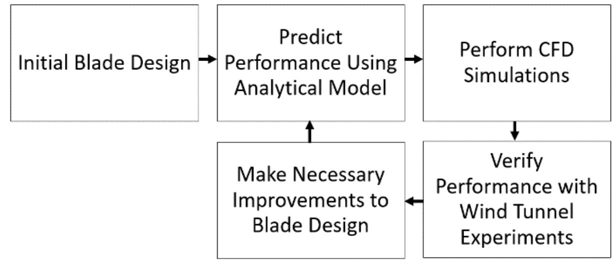


Figure 1: Turbine Design Methodology

**References:**

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