NSF CAREER AWARD: An Experimental Investigation of the Flow Fields over Bio-Inspired and Finite Span Wings Undergoing Dynamic Stall

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Airfoils are central components of many important technologies, including wind turbines, turbomachinery and aircraft, and better understanding of flows over airfoils is critical to their continued development. When the angle of attack of an airfoil is changed rapidly it the developed lift and the stall angle are considerably higher than for an airfoil at fixed angles of attack. Under dynamics conditions the loss of lift can be abrupt causing rapid changes in the aerodynamic and loading characteristics. This phenomenon is known as dynamic stall (DS). Dynamic stall plays a key role in the development of two transformational technologies: wind power generation and the development of high-performance aircraft. It is widely anticipated that the Joint Strike Fighter will be the last manned fighter developed for the US Department of Defense. Removing the pilot increases the performance potential by increasing the allowable forces experienced during extreme maneuvers for which dynamic stall is central. Dynamic stall also results in high unsteady loads on wind turbine blades which, if controlled, can increase their performance and durability. The goals of this experimental study are to: 1. Develop a bio-inspired strategy, based on the flippers of humpback whales, to control or delay DS and 2. Quantify the velocity and vorticity fields in the critical region near the airfoil leading edge for finite aspect ratio airfoils for which data does not currently exist.

Dr. Bohl’s educational objectives include the development of new curricula for college and high school courses. Graduate students will gain experience by acting as mentors to the undergraduates who will enhance their educational experience through focused research. Students will be recruited from primarily under-represented groups using Clarkson University's pipeline programs such as the NSF sponsored S-STEM program. A senior-level problem-based undergraduate course in bio-fluid mechanics will be developed addressing the concept of biomimicry using the PI's research as a case example. A similar collaborative effort will be undertaken with a local high school. Once developed, these materials will be disseminated to other area teachers through the Clarkson University Office of Educational Partnerships.