Announcing the Final Examination of Jan Marsh for the degree of Master of Science

Time & Location: November 1, 2010 at 2:00 PM in Bldg. 44 Main Conference Room
Title: An Uncertainty Quantification of the Variation of Internal Heat Transfer Coefficients and the Effect on Airfoil Life

Uncertainty in accurately knowing applied internal heat transfer coefficients inside of a cooling passage can lead to uncertainty in predicting low cycle fatigue life of a turbine vane or blade. Under-predicting a life value for a turbine part can have disastrous effects on the engine as a whole, and can negate efforts in innovative design for advanced cooling techniques for turbine components. Quantification of this fatigue life uncertainty utilizing a computational framework is the primary objective of this thesis.

Through the use of probabilistic design methodologies a process is developed to simulate uncertainties of internal heat transfer coefficient, which are then applied to the aft section of a non-rotating turbine blade component, internally cooled through a multi-pass serpentine channel. While keeping all other parameters constant internal heat transfer coefficients are varied according to a prescribed uncertainty range throughout the passages. The effect on the low cycle fatigue life of the airfoil is then evaluated at three discrete locations: near the base of the airfoil, towards the tip, and at mid-span. A generic low cycle fatigue life prediction model is used for these evaluations.

Even though the probabilistic design process uses independent random numbers to simulate the variation, in reality heat transfer coefficients at points located closely together should be correlated. For this reason, an autocorrelation function is implemented. By changing the value of this function the strength of the correlation of neighboring internal heat transfer coefficients to each other over a certain distance can be controlled. In order to test the effect that this correlation strength has on the low cycle fatigue life calculation, low and high values are chosen and analyzed.

The magnitude of the prescribed uncertainty range of the internal heat transfer coefficient variation is varied to further study the effects on life. Investigated values include 5%, 10% and 20% for the straight ribbed passages and 10%, 20%, and 40% for both the tip and hub turns. As expected there is a significant dependence of low cycle fatigue life to the variation in internal heat transfer coefficients. For the 20/40% case, variations in life as high as 50-60% are recorded, furthermore a trend is observed showing that as the magnitude of the uncertainty range of internal heat transfer coefficients narrows so does the range of the low cycle fatigue life uncertainty.

Major: Aerospace Engineering

Educational Career:
Bachelor’s of Aerospace Engineering, BS, 2008, University of Central Florida

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Approved for distribution by Dr. Jayanta Kapat, Committee Chair, on October 15, 2010.

The public is welcome to attend.