A Detailed Investigation of the Fluid Dynamics and Heat Transfer Related to Injection From a Compound Angled Shaped Film Cooling Hole
Shane Haydt
Ph.D. Candidate, Experimental and Computational Convection Lab
Department of Mechanical and Nuclear Engineering
The Pennsylvania State University
Thursday, February 1, 2018
Time: 9:00 – 10:00 AM
Location: 362 Willard Building
Coffee and donuts will be provided

Abstract: Gas turbines are used around the world to provide thrust for airplanes and to generate electricity. Designers and operators are constantly chasing higher thermal efficiency, and even an incremental increase is considered an achievement. Higher thermal efficiency begets higher turbine inlet temperatures, and the parts that are exposed to these temperatures require sophisticated cooling technologies. One such cooling method is shaped film cooling, which ejects low momentum coolant with the goal of it staying attached to the wall, spreading laterally, and reducing the heat flux into the part primarily by providing a lower driving temperature for convection. The presence of film cooling can also increase the heat transfer coefficient, but this parameter is often not measured, since it is assumed to be negligible or in regions of high coolant concentration.

In an axially-oriented hole, the mainstream flows over the top of a cooling jet and around the sides, in equal measure, creating a symmetric flowfield. In a compound angled shaped hole, the mainstream flows primarily around the leeward side, creating a strong shear layer and an asymmetric streamwise vortex. The present study, the first of its kind, measures the flowfield, adiabatic effectiveness, and heat transfer coefficient augmentation for a range of compound angles. It is shown that asymmetry and vorticity magnitude increase with increasing compound angle and blowing ratio. This asymmetry results in increased heat transfer coefficient in regions adjacent to the cooling jet, where very little coolant coverage exists. For this reason, compound angled shaped holes can cause local regions of increased heat flux relative to an uncooled surface, which may be an issue for some designs if not properly accounted for.

Biography: Shane Haydt is a graduate student in the Experimental and Computational Convection Lab (ExCCL) at Penn State studying advanced film cooling geometries. Shane received his B.S. in Mechanical Engineering in 2009, M.S. in 2016, and will graduate with his Ph.D. in 2018, all from Penn State. In March 2018, Shane will start his new position as a Senior
Durability Engineer at Pratt & Whitney, designing cooling systems for gas turbine hot section components.