

Department of Mathematics and Statistics Colloquium

Acoustic Modeling of the Rocket Flame Trench at Wallops Island Flight Facility

Abby Maltese

James Madison University

Abstract: When a launch vehicle lifts off, its exhaust is guided away from the launch vehicle by a flame trench. It has been found that certain flame trench geometries can add to the acoustic stress on the rocket which can damage the launch vehicle and payload (Ranow, 2021). This study aims to add to the understanding of how flame trench geometry affects the sound emitted by the rocket exhaust as it flows through the flame trench at launch. These discoveries can help guide future flame trench design.

This study focuses on the MARS Pad 0A flame trench at the Wallops Island Flight Facility. Key assumptions are that all the flame trench materials have the same properties and will remain intact during launch. Additionally, it is assumed that the rocket exhaust flow is steady and does not change over time. These assumptions are made due to the scope of this project and the emphasis on analyzing the geometry of the flame trench and its relationship to acoustic pressure opposed to the materials or change of flow over time.

The flame trenches were modeled in Fusion360 and then analyzed and visualized in COMSOL. Five different models were modeled and tested. After the first set of simulations were completed, the boundary conditions were altered, and the simulations were run again resulting in a more realistic scenario. This study examines how frequency and amplitude affect the resulting acoustic pressure throughout the flame trench and how the change in geometry alters the flow of the soundwaves. The importance of three-dimensional acoustic simulations are discussed.

Visually Representing Propositional Logic

Andre Mas

James Madison University

Abstract: Propositional & predicate logic provides a standard for the formal reasoning we use in Mathematics- an argument is valid if we can formally prove that the conditions we impose imply the conclusion. Proofs are traditionally done symbolically, but is this the **only** way? We examine the idea of expressive completeness in logic, which raises a visual representation of propositional logic and proofs in this system.

Incidence Matrices of Subsets and the Representation Theory of the Symmetric Group

Colby Sherwood

James Madison University

Abstract: Incidence matrices describing the intersection of subsets of a set have been studied by mathematicians since the 1960s. They arise naturally in many combinatorial investigations, and the ranks of these matrices over finite fields have applications to design theory, coding theory and algebraic combinatorics. While the ranks of the inclusion matrices have been calculated, very little is known about the other obvious incidence relations such as having intersection of a fixed size. In this talk we show how the situation can be understood in terms of the representation theory of the symmetric group, and we solve the rank problem for 2-subsets vs. n -subsets intersecting in a set of size 1.

Monday, May 2nd at 3:10 pm via Zoom