2025 Spring MD-DC-VA Section Meeting
Student Poster Session

Shock Associated Noise in Rocketry

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Rocketry within itself is a practice known for creating excessive levels of noise, and yet the effects of these extreme acoustics is a notably understudied topic. Thus, as researchers have begun to investigate the propagation of acoustic waves from a launch, they have been stunned by the number of problems caused by these acoustic occurrences. These include the reflection of sound waves back to the rocket, causing damage to the vessel and its payload. Also, as recently discovered, the sound waves appear to be causing disruptions of Earth's Ionosphere. The research team is focusing here upon better understanding the role of curved turbulent acoustic pressure flows in creating these Shock Associated Noise (SAN) occurrences. To accomplish this, past iterations of the project have formulated code that implements the Euler Predictor-Corrector Method to predict shock wave strengths and locations within a turbulent Coanda jet flow. However, numerical issues have arisen in the implementation of this method, leading to the search for a better numerical solution method.

Rocket Flame Trench Analysis with COMSOL Multi-physics Software

Adam Short, Val Paz-Soldan
James Madison University

60% of payload first-day rocket launch failures are caused by issues related to acoustic loads at launch. In order to prevent many of these failures, we must be able to analyze, predict, and account for acoustic loads on the rocket. When a rocket launches, exhaust from the rocket produces noise that often causes structural damage to the rocket or its payload (Figures 1 & 2).. A flame trench can be used to offset or reduce the overall structural damage. Flame trenches are a acoustical mitigation technique used during rocket launches that provide a place for rocket exhaust to escape. The absence of a place for the exhaust to escape causes the noise to bounce back up into the rocket exhaust, potentially causing damage to the rocket or its payload. The goal of this work is to see if there is any significance in modifying the dimensions, or angle of the flame trench in order to find/optimize the best design to mitigate the potential damage. To accomplish this, we will use 2 pieces of software: SolidWorks, and COMSOL.

2028 Olympic Results Prediction Model

David Cho, Joshua Moylan, Courtney Smith
Virginia Military Institute

The summer Olympics, occurring once every four years, allows athletes to represent their country and compete against the best. This spectacle is viewed by billions worldwide as they cheer for their country's success. Medal tables, which track the standings of each country are a point of conversation to determine which country "won" the Olympics. The MCM has tasked our group with creating a model that is capable of predicting the number of gold and total number of medals won by a country at the 2028 Los Angeles Olympics, as well as identifying different aspects that

impact a country's standings. For our models, we only considered the Olympics that occurred in the last 25 years (2000-2024), as earlier Olympics have many countries that do not exist as well as sports that are no longer competed in that could skew our regression model. Our group utilized multi-linear regression models to determine the standings of the upcoming 2028 Olympics. Our variables for these models were the percent of events the country participated in, the number of athletes the country sends, and the historical results of past Olympics. Further models could look at the correlation between Olympic success and monetary investment the country puts into different sports. Similarly, suggestions are made for smaller countries that wish to improve their Olympic standings. Our model uses a linear regression to predict medal results and MATLAB's Classification Learner and a Principal Component Analysis to better visualize the data and identify which event is most important for a country. Finally, we discussed the "great coach effect" and other non performance factors that could impact a country's standing in future Olympics.

Modeling the Summer Olympics

Kevin Dougherty, Hai-Hsin Huang, James Wynn
Virginia Military Institute

The conclusion of the 2024 Summer Olympics ended with the United States claiming victory along with four countries earning their first medals. While attempts have been made to predict the number of medals based on specific athletes, most tend favor the participation of particular athletes while disregarding historical medal counts. Data files provided by the International Olympic Committee include data for the number of programs provided for each sport, the host country, medal counts for participating countries, and a complete list of participating athletes. Random forests decision trees were used to predict the medal counts of the 2028 Summer Olympics using prior gold medal counts across sports programs paired and provide strategic insights for countries seeking their first medal using a separate model total previous medals, number of athletes per event, and home country advantage as predictors.

Five-Ring Forecast

Philip Crouch, Andres Hall, Chun-Hao Liu
Virginia Military Institute

Different countries compete for medals at the Olympic Games. Rankings are frequently based on the performance during the games. We use statistical models and historical data to predict the medal outcome for the next year. This study predicts the number of Olympic medals for participating countries using the MATLAB Regression Learner application. The model uses a Logarithmic Regression technique, and we combine the factors like total medals, medal classification, Olympic year, and host nation data. Principal Component Analysis (PCA) has also been used. The goal of this method is to offer an organized, data- driven way for predicting Olympic results.

Data Driven Application Development

Alexandra Veremeychik
Montgomery College

In this poster we explore the development of data-driven web applications designed to address potential systemic inequities in trespass towing within Montgomery County, Maryland. By analyzing towing data from July 2021 to June 2024 and integrating geographic, economic, and demographic

datasets, we explored measures with the potential to track disparities. This included the development of a mathematical model to rank towing companies based on carefully chosen parameters and a GIS towing activity tracker incorporating over 100,000 data points.

Bridging the gap: Preparing High School Students for Real-World Applications Beyond Algebra 2 and Equipping Them for Success in the Workforce and College

Isabel, Deters
St. Mary's College of Maryland

The aim of this senior project is to develop a real-life applications of mathematics curriculum specifically designed for high school juniors and seniors who do not intend to pursue STEM majors in college or plan to enter the workforce directly after graduation. This initiative stems from the recognition of a significant gap in the early math education of college freshmen, many of whom struggle with basic college-level mathematics. This struggle is often due to the lack of math coursework required after Algebra 2 in high school, leading to a deficiency in essential mathematical skills and practical applications. The proposed curriculum will focus on teaching foundational mathematical concepts that are directly applicable to real-world scenarios such as personal finance, basic statistics, business mathematics, and critical thinking, with the goal of preparing students for the demands they will face in both higher education and the workforce. By bridging the gap between high school mathematics and practical applications, this project aims to equip students with the necessary skills to succeed in a variety of non-STEM fields and foster a more mathematically literate society.

Testing the Boundaries of a Coanda Jet

Josiah Walker, Gregory Granahan
James Madison University

Rocket launches create immense amounts of noise that impact people and the environment for miles around. Rocket launch noise can harm people's hearing and vibrate the launch vehicle so much that sensitive payloads can be damaged due to building resonances during launch. Rocket noise during flight has also been found to disrupt Earth's atmosphere significantly. Shock Associated Noise (SAN) has been identified as one of the primary sources of noise in rocket launches, particularly SAN from Supersonic Turbulent Coanda wall jets [1]. These air jets follow curved surfaces due to the Coanda effect, and the shock structure directly determines the noise emissions of a Coanda Wall Jet when turbulent eddies interact with a shock wave. Still, this shock cell structure is poorly understood. This work explores a specific Coanda Jet called a Coanda Flare, a tulip-shaped nozzle that burns excess gas during petroleum processing. Methods developed on the Coanda Flare can then be applied to other cases, such as noise emission from curved rocket flame trenches that produce most of the damage to the rocket itself. This work seeks to experimentally improve the Jet Boundary model of the Coanda flare, which currently has 2-8error from manually digitizing those images. To improve, the current work aims to capture more precise images of the Coanda Flare Jet boundary at various operating conditions and automate the digitization process to develop a new Jet Boundary equation. This paper outlines methods for achieving these improvements: the redesign of a Z-type Schlieren system, the development of a 2D Coanda Flare, and the implementation of Canny Edge detection to digitize the jet boundary.

Impact of March Madness on University Metrics

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Mount St. Mary's University

The NCAA basketball tournament participation has long been speculated to influence various university metrics. This study examines whether participation in the tournament influences key university metrics such as tuition prices, enrollment, and standardized test scores. Our study found when basketball teams made it to the tournament their schools saw a statistically significant increase in student enrollment and ACT scores in the lower percentile, meaning the overall academic quality of students increased. Additionally, tuition prices increased when a school made the tournament. Basketball success, for teams in the NCAA tournament, may have a measurable impact on important key university metrics such as tuition prices, enrollment, and standardized test scores.