​**NARC Seminar, 8 March, 2017**

​Titles and Abstracts

**​David Seal, Mathematics Department​**

**Title:** **When Calculus meets discontinuities in the real world: How do we numerically solve such a problem?**

**Abstract:** Care need be taken when definitions and methods from calculus are applied to the "real" world.  That is to say, in a first year calculus course one is often taught that many functions do not have formal derivatives, according to the standard definition of the derivative.  These pathological issues are often described as discontinuities, cusps, unbounded behavior, or that the problem has too much "wigglie-ness."  (For any mathematicians in the audience, think { y = x sin(1/x) }.)  However, in many physical applications such as traffic flow, blast wave (or supersonic) problems in gas dynamics, pings from a radar system, tsunami and storm surge modeling, or in solar plume radiation from the sun, the exact solution does indeed contain the simplest of the aforementioned issues: discontinuities.  In the theory for these mathematical problems (many of which can be cast as hyperbolic equations), physical constraints such as conservation of mass, momentum and energy need to be satisfied in order for the model to capture the correct physically relevant solution.  What is more nefarious, is that when these equations are discretized as part of the process required to solve these equations on a computer, it becomes even more cumbersome to maintain these important and physically significant characteristics.  In this work, we will outline a large class of so-called high-order methods that have been in development for the past several decades, and we will point to issues involving artificial oscillations that arise when an out of the box solver is applied to such a hyperbolic problem.  In addition, we will point to recently funded Naval Academy Research Council (NARC) funding that lead to the development of a so-called limiter for the discontinuous Galerkin (DG) spatial discretization.

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**Guilnard Moufarrej, Languages and Cultures Department**

​ **Title:** **Music, Social Media, and the Exploitation of the Children of Syria**

**Abstract**: Since the beginning of the conflict in Syria in 2011, songs and social media have served as an important propaganda tool for both government and anti-government militants. In what a journalist describes as “a war of songs,” both sides have competed to hook more listeners emotionally, and have even resorted to using children to disseminate political ideas and ideologies and rally support and sympathy. The co-optation of children in time of war is not a recent phenomenon: during World War II, the Nazi party and other global forces depended on the indoctrination of their youth. However, the groups in Syria are benefiting from technological advancements, not only to militarize local children, but also to recruit adults and children from around the world. Videos posted on YouTube—which have garnered millions of viewers—feature children expressing ideologies and ideas through songs. Some scenes show children bearing arms and expressing their readiness to fight and become martyrs.

 My presentation deals with the use of children and music in war propaganda in the Syrian conflict. Drawing from studies that discuss the importance of music in propaganda and the role of the latter in recruiting children to war throughout history, I argue that teaching children songs based on extremist ideologies beyond their understanding is a form of child exploitation. I contend that exploitation through songs and graphic videos will have long-term damaging psychological effects. These songs are disfiguring the image of innocent children and could be rallying more youths to join in the war.

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​**Ron Warzoha, Mechanical Engineering Department**

**Title: Development of a Miniaturized, Infrared Microscopy-based Steady-State Instrument for Measurements of Heat Flow Across High-Performance Thermal Interfaces**

**Abstract:** Miniaturization has been a staple of the wider electronics industry for several decades. From transistors to large data centers, the desire to decrease the footprint and simultaneously improve the performance of electronic systems has long burdened thermal engineers. Of increasing concern is the transfer of heat across an interface between two contacting materials; as device length scales are reduced, the temperature difference across an interface (i.e. the resistance to heat flow) increases. This is directly governed by a reduction in the thermal impedance across the device(s) and attached substrate(s), rendering the existing interface a greater contributor to the overall thermal resistance across the entire electronic stack. To mitigate these impacts, interstitial materials called thermal interface materials (TIMs) are inserted at the junction. Recently, the Defense Advanced Research Projects Agency (DARPA) supported a program (NanoThermal Interface Materials, NTI) to develop TIMs that could achieve an interfacial thermal resistance as low as 0.01 mm2∙K/W, which is more than two orders of magnitude lower than what can currently be achieved. However, a direct measurement of interfacial thermal resistance below 5 mm2∙K/W has not been made with sufficient accuracy in support of this program. Instead, research scientists have turned to less direct characterization techniques that are not capable of replicating the conditions under which TIMs must perform. Consequently, materials physicists require a more suitable steady-state instrument to measure interfacial thermal resistance across high-performance interfaces.

The work described in this presentation supports a continuing multi-year effort to design, characterize and test an instrument that can measure the interfacial thermal resistance across materials like those developed for the DARPA NTI Program. To that end, I first detail a preliminary effort to characterize the minimum measurable thermal resistance that can be achieved using standard steady-state measurement equipment. The results of this study support and explain the difficulties encountered in measuring the high-performance TIMs that were developed for the NTI program. A numerical parametric study conducted in COMSOL Multiphysics Simulation software indicates that the thermal probes used within standard devices limit the minimum measurement of interfacial thermal resistance to 3 mm2∙K/W. An analytical framework is then developed to help minimize uncertainty in standard steady-state measurement instruments such that measurement resolution can be further improved. A simple parametric analysis reveals that both a maximization in the number of temperature measurements that can be made within the instrument *and* a reduction in the length scale of the instrument is required to achieve the magnitude resolution required by the NTI program. The remainder of the presentation will focus on two subsequent studies conducted to improve instrument measurement capabilities with the use of: (1) infrared thermography and infrared microscopy (to increase the number of temperature measurements that can be made within the instrument) and (2) a reduction in the length scale of the measurement instrument to decrease the measurement uncertainty of the temperature difference across the interface of interest. Time permitting, discussions of ongoing research activities in other areas, including directed energy weapons and nanoscale thermal transport, will be included. This work was funded in part by a Junior NARC and in part by the Office of Naval Research and Dr. Mark Spector.