DEPARTMENT OF MECHANICAL ENGINEERING
WILLIAM MAXWELL REED SEMINAR SERIES

"Exploring High-speed Flows with Large-Scale Computing"

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Abstract: Since the dot-com boom of the late 1990's, computing architecture and capability have grown and evolved at an exponential rate. These advancements have allowed computational engineers and scientists to model and even predict increasing larger and more complex systems. For example, in 2000 Adams, et al. published results from one of the largest Computational Fluid Dynamics (CFD) simulations at the time. The team used 8 vector processors for 6 weeks to solve the 20 million grid points system. Fast forward a decade and members of Stanford's Center for Turbulence Research were able to use the DoE's IBM BlueGene/Q Sequoia supercomputer to carry out CFD for a grid with over 2 trillion points (while using more than 1 million processors simultaneously)! Advancements like these have not only allowed researchers to look at finer features over a wider range of parameters, but also to use high-fidelity approaches that remove many of the limiting assumptions inherent to lower-fidelity numerical modeling. At the same time, these more capable systems allow higher-fidelity CFD to be applied to entire geometries rather than just individual components or sub-systems.

This presentation will review some recent high-fidelity CFD research being performed in the Hypersonic Sciences branch of the High-Speed Division of the Air Force Research Laboratory's Aerospace Systems Directorate. Specifically, the talk will revolve around the first DoD High Performance Computer Modernization Program (HPCMP) Frontier Project, the largest single computational award ever given within the DoD HPCMP. The overall goal of the project was to apply wall-resolved implicit large eddy simulations (ILES) to a full-scale hypersonic geometry at flight conditions. The talk will cover the steps required to achieve this feat, including: performing simulations with grids in excess of a 2^31 points; challenges of months-long simulations to resolve the full range of time-scales present in the system; and finally (and probably most importantly) managing, compressing, and extracting information from the ExaBytes of instantaneous data being generated within each simulation. The talk will also include ongoing efforts extending this methodology to transition to turbulence, and how large-scale computing is being used to improve thermal non-equilibrium modeling.

Bio: Nicholas Bisek received his PhD from the University of Michigan investigating the effects of plasma-based flow control devices for hypersonic concepts. A post-doctoral research appointment at AFRL allowed him to extend the research to include surface ablation. In 2010 he accepted a civilian appointment in AFRL's Computational Sciences Center where he expanded his research interests to explore unsteady supersonic/hypersonic turbulent shock boundary-layer interaction via near-wall resolved large eddy simulations.

Nick has been a Principle Investigator on several ongoing DoD HPCMP research projects, including the first Frontier Project which provided over 1 billion core-hours of computational resources to apply high-fidelity numerical methods to complex configurations. He has authored over 10 journal articles and 30 conference papers in the areas of computational fluid dynamics, magnetohydrodynamics, and large-scale computing. He is an active member of the APS, AMSE, and an associate fellow of the AIAA, where he's served as a past chair of the LES Discuss Group, and an alumni of the PlasmaDyanmics and Lasers (PDL) and Fluid Dynamics (FD) Technical Committees. Some of Nick's recent awards include the 2017 DoD HPCMP Hero Award for Technical Excellence, the 2018 AFRL Dr. R. Rivir Scientific and Technical Achievement Award, and the 2019 AIAA Dayton-Cincinnati Section award for Outstanding Technical Contribution.

Date: Friday, Aug. 28th
Place: CB Rm. TBA

Time: 3PM
Contact: Dr. Alexandre Martin 257-4462

Meet the speaker and have refreshments
Attendance open to all interested persons

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