

# Applied Dynamics Awarded Phase II US Air Force Research Lab SBIR Project on Real Time Multi-Physics Modeling of High Speed Vehicles

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**July 19, 2016. Ann Arbor, Michigan.**

Applied Dynamics today announced receipt of award notification from the Air Force Research Lab for a Phase II Small Business Innovative Research (SBIR) project for continued development of real time multi-physics modeling technology for high speed vehicles. The development of complex systems in aerospace and defense and other industries is making increased use of multi-physics modeling. Advanced materials, digital manufacturing methods, optimized power architectures, and high speed computer control are driving a wave of innovation for large complex systems such as aircraft, naval and commercial marine, power generation and distribution, and missile defense. Multi-physics modeling as part of the design process allows for better design decisions to be made. But in order to get the most of these innovations, multi-physics modeling dynamics must be extended into the system real time controls.

High speed vehicles including supersonic and hypersonic aircraft, missile systems, and missile defense systems exhibit complex, high energy dynamics. This high energy behavior increases the complexity of guidance, navigation, and control. Model based control that incorporates aero-thermal interactions, thermal-structural interactions, and structural-aero interactions as a combined modeling algorithm represents a promising approach to enable precision control of high speed vehicles with aeroelastic structural behavior. The challenge with incorporating this multi-interaction, multi-physics modeling into real time control is the very high computational demand associated with solving the various equations without need for very expensive, custom-designed computer architectures. Finite element based multi-physics model computation traditionally requires many minutes to calculate a single second of dynamic vehicle behavior.

“For our Phase I research we were very fortunate to start with aeroelastic, multi-physics technology developed by top minds in the academic research community through previous Air Force research projects that took some very innovative approaches for addressing high speed vehicle dynamics modeling.” said Scott James, Applied Dynamics president and CEO. “This code was not specifically designed for real time but rather designed for off-line design analysis. However, the architecture of the code was relatively light-weight and showed good potential for the task ahead. We started by de-constructing this non real time code, then performed detailed benchmarking and analysis, and began

reconstructing the code to be optimized for real time and maximize parallel computation on standard multi-core processors. Throughout this process we identified performance bottlenecks caused by single code modules or collections of modules and worked in cooperation with our university research partners to address and circumvent these bottlenecks through the use of novel computational methods. We eventually were able to achieve real time performance using off-the-shelf server class, Intel multi-core PC processors, exceeding our expectations for the phase one work.”

With the rise of a wide range of next generation technology including composite materials and digital manufacturing methods, such as 3D printing, a vision is presented for air vehicles of the future that are lighter, more energy efficient, and faster. Stronger vehicle materials allow for thinner, lighter parts and the reduction of structural members to save weight. However, these design changes often result in an air vehicle structure that is more flexible, i.e. exhibits higher aeroelastic dynamics. Supersonic and hypersonic air vehicles experience higher energy and heat and as a result of increased thrust and atmospheric interaction which compounds the problem of higher aeroelastic dynamics. This dynamic aeroelastic behavior reduces natural aerodynamic stability and makes guidance, navigation, and control more difficult. Real time modeling of the aeroelastic structural behavior and its interactions with thermal effects and aerodynamic effects allows for electronic control systems to be developed to augment stability and offer high performance closed-loop control of these complex systems of the future. This real time multi-physics model based control becomes a key enabler to this vision of future aircraft, weapon systems, and many other complex systems.

Applied Dynamics has completed extensive research and development in the area of real time model execution for highly parallel systems for more than a decade. The resulting technology and knowhow has Applied Dynamics ideally positioned to deliver a range of enabling technology and expertise to help the US military meet its development goals for hypersonic aircraft and weapons through the end of the decade.

About Applied Dynamics - Applied Dynamics helps companies make better use of modeling assets through all stages of product development, verification testing, demonstration, training, and maintenance. Applied Dynamics flagship product, the ADvantage Framework, is a real time, industrial Internet of Things (IoT) model based systems engineering software platform providing an agile, feature-rich environment for supporting product the development lifecycle through development, integration, verification, and certification. ADvantage embraces an open architecture and allows its users to leverage best-in-class COTS and open source technologies. The ADvantage user base includes more than 50% of the Fortune 500 aerospace and defense companies and extends into marine, power systems, oil & gas, and the automotive industry.

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