1. **Research Title:** Aerothermoelastic Analysis Methodologies for Aircraft Design

2. **Individual Sponsor:**

   Dr. Philip S. Beran, AFRL/RQVC,
   2210 Eighth Street, Bldg 146
   WPAFB, OH 45433
   Philip.Beran@us.af.mil

3. **Academic Area/Field and Education Level:** Aerospace or Mechanical Engineering / Computational Physics and Numerical Analysis (BA/BS, MS or Ph.D. level).

4. **Objectives:** To develop, apply, and assess computational methods for analyzing the physical interactions that result from coupling aerodynamics, structural dynamics, and heat transfer. The methods should be sufficiently accurate to reliably capture nonlinear responses, while being sufficiently efficient to employ in a multidisciplinary design optimization procedure. The methods should be applied to benchmark problems (e.g., wing structure or engine aft deck structure) of reasonable topological complexity and with realistic constraints (e.g., flutter).

5. **Description:** The understanding of structural behavior under aerodynamic and thermal loading is relevant to many aerospace applications, including behaviors of structural components exposed to engine heating or heating generated by high aerodynamic speeds. Thermal expansion and material softening degrade the structure, elicit static and dynamic responses (including loss of dynamic stability), and can complicate the prediction of these structural responses. Structural heating is important to understand from several standpoints, including controllability (are control surfaces still effective?); engine integration (does vehicle shape-change impact propulsion?); stability (will heated wings flutter?), and sub-systems (do vital sub-systems get too hot over time?). This topic offers several different avenues of fundamental research, including:
   a. forming a first-principles understanding of aerothermoelastic interactions and applying this understanding to describe the behavior of canonical and built-up structures;
   b. developing computational methodologies to capture the relevant multidisciplinary physics, including interface techniques needed to accurately couple the disciplines;
   c. establishing a multi-fidelity framework to model disciplines at the fidelity level appropriate for design (e.g., only use more expensive models when critical to the design).
   d. quantify risks and uncertainties caused by use of lower fidelity models;
   e. developing sensitivity analysis methods to evaluate how design parameters influence static and/or dynamic structural behavior;
   f. developing higher order methods (e.g., Discontinuous Galerkin) to reduce the number of degrees of freedom needed to model the relevant multidisciplinary physics;
   g. establishing a model reduction framework for enabling aerothermoelastic physics to be captured during design.

6. **Research Classification/Restrictions:** Unclassified

7. **Eligible Research Institutions:** All DAGSI Universities.

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