# NASA SBIR 2014 Phase I Solicitation

## A3.05 Physics-Based Conceptual Design Tools

**Lead Center: LaRC**

**Participating Center(s): GRC**

NASA continues to investigate the potential of advanced, innovative propulsion and aircraft concepts to improve fuel efficiency and reduce the environmental footprint of future generations of commercial transports across the subsonic and supersonic flight regimes. Conceptual design and analysis of unconventional vehicle concepts and technologies is used for technology portfolio investment planning, development of advanced concepts to provide technology pull, and independent technical assessment of new concepts. The agency's systems analysts need to have the best conceptual design/analysis tools possible to support these efforts. Substantial progress has been recently made in incorporating more physics-based analysis tools in the conceptual design process and NASA has developed a capability that integrates several analysis tools and models in engineering frameworks, such as ModelCenter and OpenMDAO. The current focus is instead on filling remaining capability gaps in specific design disciplines. As such, the purpose of this subtopic is to solicit proposals for innovative solutions which address the problem of rapidly obtaining reasonably accurate airframe weight and center of gravity estimates during the conceptual design of unconventional configurations.

Historically, empirical and semi-empirical weight estimation methods have been utilized during the conceptual design phase. These methods work well for the conceptual design of conventional vehicles with parameters that reside within the historical databases used to develop the methodologies. These methods are not well suited, however, for unconventional vehicle concepts, or even conventional concepts which reside outside of the database (for example, very high aspect ratio swept wings). Developing higher order, more accurate tools suitable for conceptual design is a difficult challenge. The first issue is analysis turnaround time. To perform the configuration trades and optimization typical of conceptual design, runtimes measured in seconds or minutes, instead of hours or days, are required. However, rapid analysis turnaround time alone is insufficient. To be suitable for conceptual design, tools and methods are needed which accurately predict the "as-built" characteristics. Because it is not possible to model every detail of the design and account for all the underlying physics in the problem formulation, it is difficult to predict the "as-built" characteristics with physics-based methods alone. What is usually required is a combination of these methods with some semi-empirical corrections. A final challenge in conceptual design is a lack of detailed design information. Lower order, empirical-based methods often require only gross design parameters as inputs. High-order, physics-based methods currently require detailed design knowledge to be useful. For example, whereas semi-empirical weight prediction tools provide estimates for wing weight without needing a structural layout, such detail is necessary to successfully utilize finite-element analysis tools. This gap between the analysis capability and the maturity of the design being analyzed currently limits the usefulness of high order analysis in conceptual design. Physics-based tools for conceptual design are needed which are consistent with the amount of design knowledge that is available at the conceptual design stage.

Specifically for FY 2014, desired capabilities include the following:

- New weight estimation relationships valid for wing and/or fuselage geometries outside of current historical databases.

- Increased fidelity loads generation.
- Engineering based weight estimation techniques for systems, equipment, and operational items.