Special Topical Issue on Morphing Aircraft

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The definitions of a morphing aircraft are many and varied. The NATO RTO Technical Team on Morphing Vehicles suggested 'real-time adaptation to enable multi-point optimized performance' (McGowan et al., 2009). Weisshaar (2006) suggested 'a set of technologies that increase a vehicle's performance by manipulating certain characteristics to better match the vehicle state to the environment and task at hand.' Based on these definitions, established technologies such as flaps or retractable landing gear would be considered morphing technologies. However, morphing is often considered to require radical shape change(s) based on structural compliance. Geometrical wing parameters that can be affected by morphing include the planform (span, sweep, and chord), twist, dihedral, and camber. The magnitude of the deformation varies from large-scale planform changes for performance enhancement to small-scale changes for flight control.

The idea of changing the wing shape or geometry is far from new. The Wright Flyer used wing warping for roll control (Wright and Wright, 1906), and this morphing technology was critical to the success of their 'flying-machine.' Variable wing sweep has often been used to obtain improved performance at both low and high speed. The deployment of conventional flaps or slats on a commercial airplane changes the geometry of its wings. These examples have limited geometry change, with narrow benefits compared to those potentially available from a deformable and adaptable wing. Historically, morphing solutions always led to penalties in terms of cost, complexity, or weight, although in certain circumstances these have been overcome by system level benefits. The current trend for highly efficient and green aircraft makes such compromises less acceptable, calling for innovative morphing designs able to provide more benefits and fewer drawbacks.

Recent developments in smart materials may overcome the limitations and enhance the benefits from existing design solutions. Since the early 1990s, there has been a huge interest in morphing aircraft and also significant funding, particularly in the United States, from organizations such as DARPA, NASA, and the Air Force (Pendleton et al., 2000, Kudva, 2004). As this research topic has matured, investigations have become more diverse, and research is now widely distributed in universities, research organizations, and industry worldwide. The morphing aircraft challenge is to design a structure that is capable of withstanding the aerodynamic loads but is also able to change its shape. The blending of morphing and smart structures in an integrated approach requires multi-disciplinary thinking from the early development, which significantly

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increases the overall complexity, even at the preliminary design stage. Many developed concepts have a technology readiness level that is still very low.

This special issue of the *Journal of Intelligent Material Systems and Structures* brings together articles from a wide range of morphing technologies and morphing applications. The first article is an extensive review by Barbarino et al. (2011) that highlights the diverse range of morphing technologies presented in scientific and engineering literature. The remaining 16 articles reinforce the wide scope of morphing aircraft technology and research and are disparate in terms of the performance objective, the morphing concept, and the technological implementation. The research presented in this topical special issue is at the forefront of morphing technology and is sure to provide some provocative reading to scientists and engineers interested in applying results from the studies presented in this issue or carrying out research of their own on morphing aircraft.

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