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Introduction to Morphing Aircraft Research

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THE concept of a variable geometry aircraft has excited aircraft designers since the inception of manned flight, and aviation history is rich with examples of these vehicles. There are numerous operational aircraft that demonstrate shape changes; these range from variable-sweep wings on the F-14, B-1B, and Tornado, to name a few, to the variable geometry of the propulsion system such as that found on the V-22 Osprey and the Harrier. These are stunning examples of nontraditional thinking in air vehicle design, and demonstrations of how dramatic departures from existing design principles had to be pursued to meet demanding performance specifications.

Recently, the term "morphing" has been used to describe vehicle adaptability of this type, but on a much broader scale. The term is loosely used to describe any nontraditional method of moving vehicle components. In this form, the focus is typically on conformal control surfaces, camber variations, or other changes to the wing cross-sectional shape. Another more radical definition is a change of vehicle *state* to achieve a performance metric, whether it is shape, color, etc. In terms of shape change, this means geometry variations that go beyond sweeping wings or thrust vectoring; it means large changes in span, wing area, chord, etc. To achieve significant variations in performance, it has been shown that these parameters need to change on the order of 100%. This clearly goes beyond simple geometric changes that have been previously implemented.

No matter how one chooses to define morphing aircraft, there are several common engineering challenges that need to be addressed. Some of the more notable are distributed high-power density actuation concepts, structural mechanization concepts, flexible skins, and control law development. In addition to the basic technology development, it is paramount to simultaneously pursue an understanding of the system level performance benefit made available with this technology. The surge of performance in smart material based actuation concepts has ignited several initiatives in shape control concepts for aircraft. The papers in this special section represent a cross section of some of the most recent efforts in this area.

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