Morphing structures

Paweł Skalski
The Łukasiewicz Research Network – Institute of Aviation
Aleja Krakowska 110/114, 02-256 Warsaw, Poland

Abstract:

Aviation is an industrial branch where the newest and most modern materials and technologies are used. Increased passenger and crew comfort by reduction of vibration and noise, increasing amount of structural systems and elements of life, improvements of precise indication and uncovering of infrared and electro-optical sensors on airplanes, are the benefits of using intelligent materials are expected to monitor the state of the construction, detect any kind of damage, and be self-repairing.

Composite materials presently have a wide range of applications. They offer much better benefits comparable to metal alloys, such as reduced weight, increased strength and improved corrosion resistance. However, composite materials react differently to stress and vibrations. Cracking of a metal component is gradual and predictable, while composite materials suffer significant impairment, as a result of accidental damage of an unforeseen and accidental nature. Flexible nature of material and controlled properties are desirable in applications in modern aerospace structures.

There is no clear definition of „morphing" structure in the scientist community, but „morphing" structure is or can be identified as structure in which form and surface can be controlled continuously (without any discrete point). As one of the most useful aviation research fields, „morphing" structure had been developed in the earliest times of aviation. Morphing structures enable the change of aerodynamic properties of the lift and steering surfaces during the flight, increasing the efficiency of the flight. The morphing structure can be identified as structure in which form and surface can be controlled continuously.

Nowadays, two morphing technology types are considered: discrete morphing, like flaps or retractable landing gears, which are mature technologies, and "continuous morphing", which is a single system that can provide multiple functions in a continuous motion.

For continuous and discrete morphing, technologies have been increasingly evolving during the last decades. Numerous projects are ongoing research. The three main current morphing technologies are shape memory material, actuators and skin morphing. Thanks to flexible materials, rolling motion was controlled with temporary deformations, which was the easiest way of controlling the flight's trajectory. Due to the relative effectiveness of this method, engineers have developed aileron, and later, flaps and slats, which are basically some removable wings parts, to keep control over the plane in a wider speed range.