11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

NOVEL AIR VEHICLE CONFIGURATIONS: FROM FLUTTERING WINGS TO MORPHING FLIGHT

Afzal Suleman[1]*, Jose L. Vale[1], Frederico Afonso[1], Fernando P. Lau[1], Sergio Ricci[2], Alessandro De Gaspari[2], Luca Riccobene[2], Luca Cavagna[2], Jonathan Cooper[3], Luke Lambert[3], Chris Wales[3], Ron Cheung[3], Raj Nangia[3], Arthur Rizzi[4], Mengmeng Zhang[4], Hans-Peter Monner[5], Bram V. de Kamp[5], Srinivas Vasista[5], Mauro Morelli[6], Jose Parizi[7], Felipe Odaguil[7], Grace R. de Lima[7] and Alexandre Antunes[7]

[1] Instituto Superior Tecnico, Av. Rovisco Pais, 1049-001, Lisbon, Portugal,
[2] Politecnico di Milano, Via La Masa 34, 20156 Milano, ITALY,
[3] Bristol University, Queens Building, Bristol BS8 1TR, UK
[4] KTH, Royal Institute of Technology, Teknikringen 8, Stockholm, Sweden
[5] Institut für Faserverbundleichtbau und Adaptronik, 38108 Braunschweig, Germany
[6] Council for Scientific and Industrial Research, Pretoria 0001, South Africa
[7] EMBRAER S.A., Av. Brigadeiro F. Lima, 12227-901, S. J. dos Campos, Brazil.

Key Words: *Morphing Aircraft, Joined-Wing Configuration, Transport Aircraft, Multidisciplinary Design Optimization, Experimental Validation and Evaluation.*

The aim of the FP7-NOVEMOR (**NO**vel Air **VE**hicle Configurations: From Fluttering Wings to **MOR**phing Flight) research project is to **investigate novel air vehicle configurations** with new lifting concepts and **morphing wing** solutions to enable cost-effective air transportation. A multidisciplinary analysis and design optimization environment has been developed to include analysis of novel configurations, such as the joined-wing concept for improved lift, and morphing wing solutions to tailor the wing for optimum lift and maneuvering capabilities. The design and development of the proposed solutions have been performed as an integral part of the aircraft conceptual design, rather than just as an add-on later in the design cycle, thus enabling innovative aircraft designs to be made through the use of morphing structures technologies. Such concepts have enabled improved aircraft efficiency, aerodynamic performance, reduced structural loads and lighter weight structures. The NOVEMOR project has focused on the following primary objectives:

1. Development of analytical and numerical tools capable of modelling adaptive/morphing aircraft and to take advantage of these concepts right from the conceptual and preliminary design phases by means of multidisciplinary design optimization techniques;

2. Morphing wing solutions (span and camber strategies and wing-tip devices) have been proposed to enhance lift capabilities and manoeuvring. These have been considered early in the design process, right from the beginning of aircraft design cycle, included in the conceptual design;

3. Developed small-scale proof-of-concepts prototypes, and subsonic and transonic wind tunnel models, different adaptive/morphing aircraft solutions to improve performance in terms of drag reduction, weight reduction, and flight stability; and

* Corresponding author: Suleman@ist.utl.pt

4. Performed benefits evaluation in terms of the impact on improved lift and manoeuvering and weight reduction of aircraft by comparing to a reference civil transport aircraft.

The project has reached the 30-month mark and several morphing concepts have been studied and are currently being implemented, validated and evaluated at the wind tunnel test facilities at CSIR, U. Bristol and Politecnico di Milano. The drawing of the transonic wind tunnel models are shown in Figure 1. Additionally, flight test models of the joined wing aircraft are also being performed at the Instituto Superior Tecnico. The results will be included in the final paper and also presented at the conference.

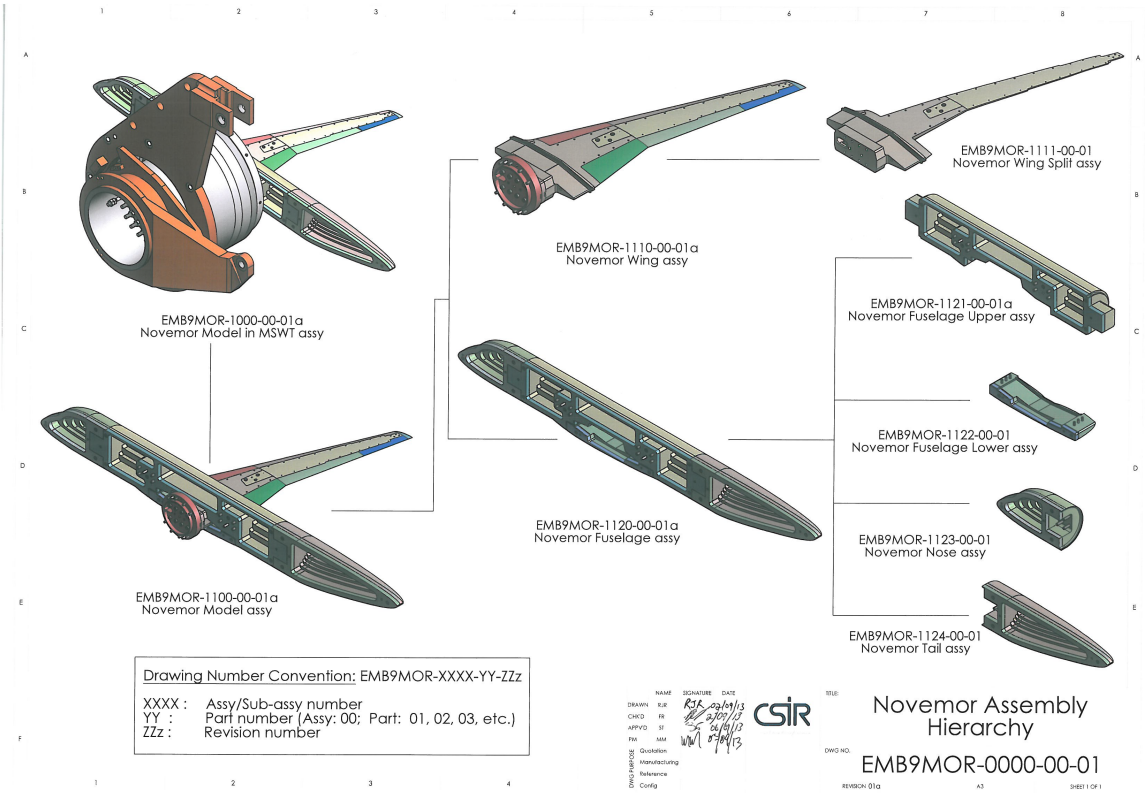

Figure 1: The transonic wind tunnel models of the morphing wing