

# Workshop on Nonlinear Aeroelasticity and Flight Dynamics of Very Flexible Aircraft

13<sup>th</sup> – 14<sup>th</sup> November 2014



*At Engineers' House, The Promenade, Clifton Down, Bristol BS8 3NB*  
<http://www.eefvenues.co.uk/conference-venues/bristol/default.aspx>



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X-HALE / University of Michigan



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A very successful and well attended Workshop was given as part of the ALPES Project by Professor Carlos Cesnik of Michigan University on 13/14 November 2014. The group consisted of delegates

from Industry (Siemens PLM, Airbus, DLR, Facebook, BAE Systems) as well as many universities – (including Bristol, Brunel, Swansea, Delft, Berlin, Milan, Cranfield, Imperial College and Liverpool).

For highly efficient long duration flight, optimum configurations present longer wingspan than typically seen in traditional aircraft. Examples of such are found on high-altitude, long-endurance (HALE) aircraft and future “green” commercial transport aircraft designs. The requirements lead to geometrically nonlinear wing deformations, making aeroelastic-coupled-flight-dynamic considerations even more critical in the design cycle due to the inherent nonlinear nature of the problem.

This two-day workshop, led by Carlos E. S. Cesnik, discussed a range of techniques for geometrically-nonlinear modelling and simulation in this new flight regime, along with the needs and challenges involved in experimental characterization. A mix of lectures and group discussions was used to better explore the issues in this important new direction for aircraft development.

**Outline:**

**Day 1 – Thursday 13<sup>th</sup> November**

**10.00** Registration  
Opening Remarks  
Introduction / Motivation  
Review of Linear Aeroelastic Analysis (of Traditional Aircraft)  
**12:30** Lunch  
Geometrically-nonlinear Structural Dynamics  
**15:00** Coffee break  
Unsteady Aerodynamics  
**17.30** Close of Day 1

**Day 2 – Friday 14<sup>th</sup> November**

**09.00** Complete Equations of Motion  
Nonlinear Aeroelastic Simulation Toolbox (NAST)  
**10:30** Coffee break  
Numerical Studies  
Aeroelastic Scaling for Very Flexible Aircraft  
**12:30** Lunch  
Experimental Studies  
Final Thoughts/Discussion  
**15.00** Close of Workshop

**Carlos Cesnik** is a Professor of Aerospace Engineering and the Director of the Active Aeroelasticity and Structures Research Laboratory (<http://gust.engin.umich.edu>) at the University of Michigan, USA, and is currently the Benjamin Meaker Visiting Professor at the University of Bristol. His research interests have focused on computational and experimental aeroelasticity of highly flexible wings, coupled nonlinear aeroelasticity and flight dynamic response in high-altitude long-endurance (HALE) aircraft and hypersonic vehicles, bio-inspired micro air vehicle (MAV) aeroelasticity, and active vibration and noise reductions in helicopters. Before his appointment at the University of Michigan, Prof. Cesnik was the Boeing Assistant/Associate Professor of Aeronautics and Astronautics at MIT, USA, after working as a research engineer at EMBRAER (Brazil). Professor Cesnik is a Fellow of the American Institute of Aeronautics and Astronautics (AIAA) and the Royal Aeronautical Society (RAeS).

This workshop is part of the Marie-Curie ALPES (Aircraft Loads Prediction using Enhanced Simulation) Initial Training Network, a four-year project to develop improved aircraft loads modelling and prediction. There are currently five researchers based at the University of Bristol and Siemens who are part of the project.

