ALPES

Aircraft Loads Prediction using Enhanced Simulation

Project Overview

ALPES ("Aircraft Loads Prediction using Enhanced Simulation") is an EC FP7 Marie Curie European Industrial Doctorate Training Network which runs from 1st October 2013 to 30th Sept 2017. The aim of the network is to improve the prediction accuracy and efficiency of the loads experienced by an aircraft in-flight and on the ground. Such computations are a key element of the aircraft design process.

The **ALPES** network will consist of five Early Stage Researchers (ESRs), all registered for a PhD at the University of Bristol, working on interrelated aircraft loads projects. A novel research programme will be combined with a highly industrially focused training schedule, including placements at Airbus in the UK and France. The programme will contribute towards two key aspects of the ACARE2020 and FLIGHTPATH2050 initiatives:

- Environmentally friendly aircraft designs
- Faster design and certification process

Full Partners	Sector	Country
University of Bristol (UoB) coordinator:	Academia	UK
LMS International (LMS)	Industry	Belgium
Associate Partner		
Airbus Operations Ltd UK	Industry	UK

Key Participants

- University of Bristol
  - Prof Jonathan Cooper
  - Dr Ann Gaitonde
  - Dr Dorian Jones
  - Dr Mark Lowenberg
- LMS
  - Dr Yves Lemmens
  - Dr Jens de Boer
- Airbus
  - Tom Wilson

UoB has one of the top European aerospace engineering departments, with a wide experience in the provision of PhD programmes and participation in national and international research programmes. There is particular expertise in aerodynamics, composites, dynamics, loads and aeroelasticity.

LMS is a world leader in research and application of structural simulation and testing. It has participated in many EC and regional funded collaborative aerospace projects. Many of these projects have resulted in commercialization of technologies into software products that are used worldwide by the aeronautical and surface transportation industries to assist in virtual design engineering and product analysis.

Airbus Operations Ltd is the UK based part of Airbus which has approximately 50% of the annual global airliner sales market, and is primarily responsible for the design, development, and manufacture of high technology wings for all Airbus aircraft. The company is also responsible for design & supply of the landing gear. Airbus maintains a very active research capability so that it can maintain its leadership in the civil aircraft market.

Project Background - The loads experienced by an aircraft in-flight (due to manoeuvres and gusts) and on the ground (e.g. landing, turning, braking) are the key elements in determining the aircraft structural sizing. Aircraft designers aim to achieve minimum structural weight, whilst ensuring that failure cannot occur at any point of an aircraft's operation and in-service life due to excessive stresses or deflections. An important part of this requirement is to be able to predict accurately the loads at all points in the flight envelope.

The **ALPES** network has a number of aims and objectives focussed on the development of improved loads prediction methods, and also producing a focused and relevant training experience. It is expected that on completion of their studies the ESRs will move directly into the aerospace industry with highly relevant knowledge, skills and expertise.

Aims - The main aims of the ALPES network are:

To develop novel methods and procedures to improve the accuracy and efficiency of aircraft loads predictions

To provide an industrially focused training regime for the researchers so that they can move directly into the European Aerospace Industry

To assess the methodologies developed in ALPES on industrial scale models, working with engineers in industry

To transfer the technical developments made in ALPES into industry

Objectives

- To improve the modelling of landing, manoeuvre and gust loads for combined high load events
- To develop reduced order aeroelastic modelling approaches for landing, manoeuvres and gust loads
- To development efficient and accurate gust loads modelling techniques combining high and low fidelity methods
- To develop improved approaches to determine worst case predictions of gust, manoeuvre and landing loads
- To develop methods for uncertainty quantification of landing, gust and manoeuvre loads
- To implement the developed technologies into the aerospace industry
- To provide a focused and relevant training experience so that the ESRs can move directly into the aerospace industry with a highly relevant knowledge and skills.
- To provide the ESRs with the necessary technical and computational skills to perform industrial standard loads calculations
- To provide the ESRs with technical and research skills to be able to make a contribution to research in the area of aircraft loads.

Location - The ESRs employed on the ALPES network will be registered for PhDs at the University of Bristol, but will be based primarily for half of the time in Bristol, UK, and the other half at LMS in Leuven, Belgium.

However, shorter periods of time will also be spent on placement at Airbus in Filton, UK and/or Toulouse, France, depending upon the candidate R&D programme.
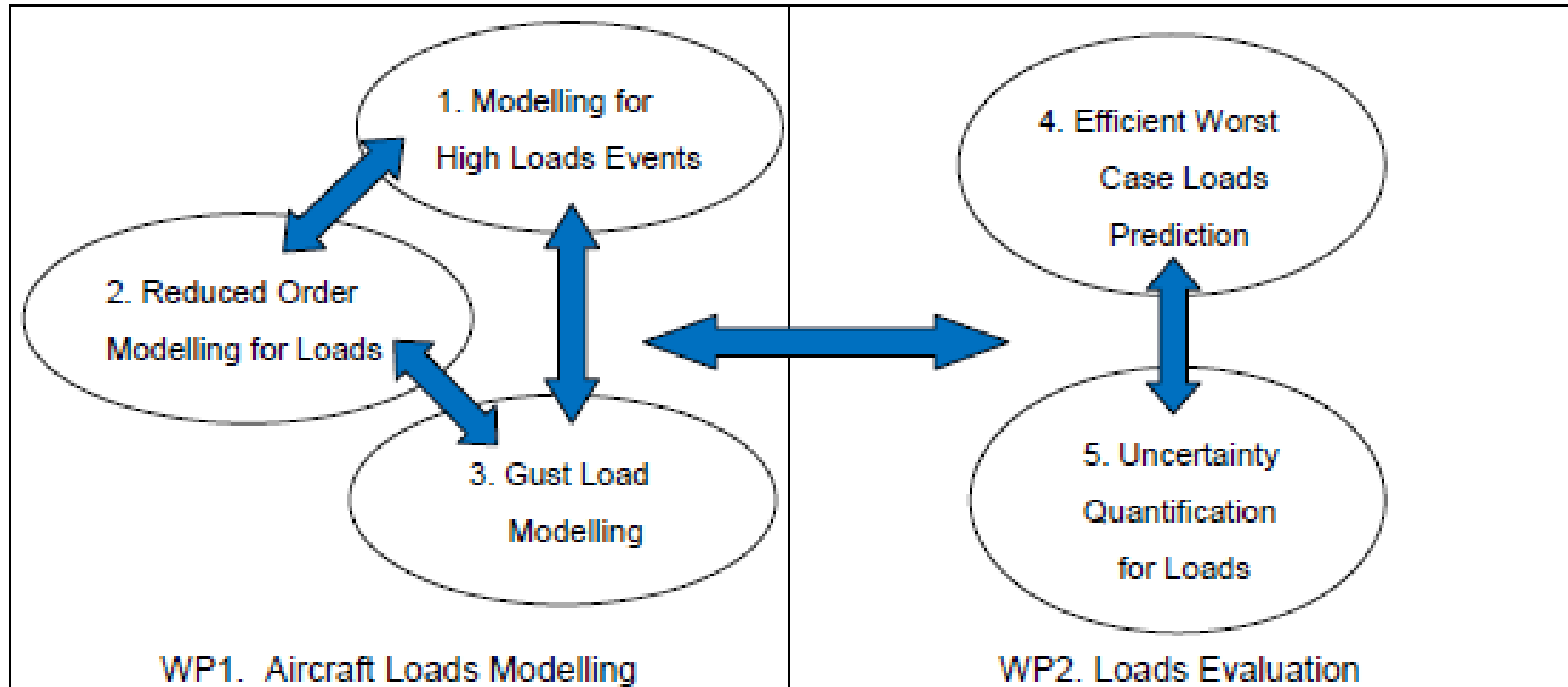
PhD Programmes - Each ESR in the ALPES network will follow one of the following PhD topics, supervised jointly by university based academics and engineers working in industry:

1. Improved modelling of landing, manoeuvre and gust loads for combined high load events
2. Reduced order modelling approaches for landing, manoeuvres and gust loads
3. Development of efficient and accurate gust loads modelling techniques combining high and low fidelity methods
4. Development of improved approaches to determine worst case predictions of gust, manoeuvre and landing loads
5. Development of methods for uncertainty quantification of landing, gust and manoeuvre loads

Further details of each project can be found elsewhere

PhD Interaction

Training

There will be a strong industrial focus to the training, with short courses and placements being undertaken to provide relevant technical knowledge and transferrable skills.

Technical Skills Training

No	Main Training Events & Conferences	WP	Lead Institution	Project Year
	Compulsory Scientific Courses			
S1	Applied Aerodynamics	1 & 2	UoB	1
S2	Practical Modal Analysis	1 & 2	UoB	1
S3	Computational Aerodynamics	1&2	UoB	1
S4	Optimisation Theory and Applications	2	UoB	1
S5	Numerical simulation of multi-body systems	1 & 2	LMS	1
S6	Landing Gear Master Class	1 & 2	LMS	1
S7	Introduction to Aircraft Aeroelasticity and Loads	1 & 2	Airbus	1
	Optional Scientific Courses			
S8	Aerodynamics 3	1	UoB	2
S9	Nonlinear Dynamics and Chaos	1 & 2	UoB	2
S10	Vibrations 3	1 & 2	UoB	2
S11	Aircraft Dynamics 4	1 & 2	UoB	2
S12	Aircraft systems modelling and simulation	1 & 2	LMS	2
S13	Test-based Correlation and Updating of Finite Element Models	1 & 2	LMS	2
S14	Ground Vibration Testing (GVT) Master Class	1 & 2	LMS	2
S15	Industrial applications of optimisation and uncertainty analysis	2	LMS	2

Transferable Skills Training

Compulsory Transferable skills training				
T1	Managing your PhD	1 & 2	UoB	1
T2	Time and task management	1 & 2	LMS	1
T3	Presenting your research at meetings, seminars and conferences in internationally diverse contexts (levels 1&2)	1 & 2	UoB	2
T4	Industrial R&D: IPR aspects & entrepreneurship	1 & 2	LMS	2
T5	Completing your PhD in an internationally diverse context	1 & 2	UoB	3
T6	The Viva in an internationally diverse context	1 & 2	UoB	3
Optional Transferable Skills Training				
T7	Presentation skills	1 & 2	LMS	1
T8	Effective communication	1 & 2	LMS	1
T9	Guidelines to (and the importance of) keeping a laboratory notebook	1 & 2	UoB	1
T10	Coaching & negotiation skills	1 & 2	LMS	3
T11	Leadership training	1 & 2	LMS	3
T12	Patents, IP, Inventorship vs Authorship	1 & 2	UoB	3
Conferences & Workshops				
C1	SDM (April 2014, 2015, 2016)	1 & 2	UoB	1,2,3
C2	IFASD (June 2015)	1 & 2	UoB	2
C3	DiPART (Dec 2013, 2014, 2015, 2016)	1 & 2	UoB	1,2,3,4
C4	ALPES Scientific Workshops	1 & 2	LMS	1,2,3
C5	Final ALPES workshop	1 & 2	All	4