FFAST

Future Fast Aeroelastic Simulation Technologies

State of the Art - Background

Unsteady load calculations play an important role in the design and development of an aircraft, and have an impact upon the concept and detailed structural design, aerodynamic characteristics, weight, flight control system, performance, etc. They determine the most extreme stress levels and estimate fatigue damage and damage tolerance for a particular design. For this purpose, loads cases due to gusts and manoeuvres are applied to detailed structural models during the design phase.

The flight conditions and manoeuvres, which provide the largest aircraft loads, are not known a priori. Therefore, the aerodynamic and inertial forces are calculated at a large number of conditions to estimate the maximum loads that the aircraft will experience.

Wing configurations at different flight conditions

These analyses have to be repeated for every update of the aircraft structure. For modern civil aircraft, each of these loads calculation cycles requires more than 6 weeks. This, together with the multiple times this calculation procedure needs to take place, has a detrimental effect on cost and time to market. The number of critical loads cases raises two main points.

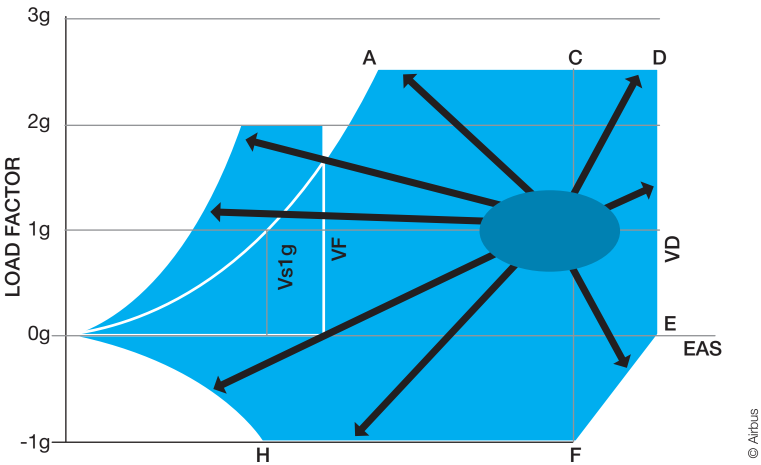
First, the replacement of the current low fidelity models with more accurate simulations is attractive because of the reduced tunnel testing costs and the decreased risk of design modification in the later phases, however the overall cost of the loads process must not increase.

Secondly, the new aircraft that will be vital to meet 2020 performance targets is likely to possess critical loads cases very different from those found on conventional aircraft. Engineering experience, that is currently used to reduce the number of critical loads cases without compromising air safety, cannot be extended to novel configurations.

Objectives

To solve the requirements of faster turnaround time and increased accuracy in the loads process, FFAST will develop, implement and assess a range of numerical simulation technologies to accelerate the aircraft loads process.

FFAST will focus on three areas of research that have been identified as offering major reductions in the total analysis cost/time:
- Faster identification of critical loads cases: the minimization of the number of requested aeroelastic analyses to some key-points by formalising the process and reducing dependency on engineering judgement; this will allow non-conventional configurations to be evaluated at lower risk;



Expanding high fidelity modelling from cruise to critical loads cases

- The extraction of aerodynamic and aeroelastic reduced order models (ROMs), suitable for loads analysis, from complex full order models. Such models reproduce the dominant characteristics of higher fidelity models, but at a much reduced cost;

- Reduced order model acceleration of full-order models: full order simulations are currently too expensive for routine use, but reduced order models offer cost savings through convergence acceleration.

Success in each research theme may make a considerable individual contribution to the reduction of loads analysis cost. Improvements are multiplicative and the step change in analysis costs will only come about if there are simultaneous improvements in each of the three identified areas.

Description of Work

The work naturally splits into critical load identification, aerodynamic reduced order modelling, aeroelastic reduced order modelling and validation & assessment. The full benefit of improvements in each of these areas, to deliver a significant impact on future aircraft design, will only be achieved if they are fully integrated. The main subdivisions of the work are the development and assessment of the following:

- Methods for reducing the number of analyses needed to identify the critical loads cases for conventional aircraft;
- Methods for making critical load identification applicable to non-conventional aircraft;
- Aerodynamic reduced order modelling techniques at a single flight point;
- Hybrid aerodynamic reduced order modelling/full order modelling techniques;
- Strategies for global reduced order models for across-the-envelope simulation;
- Hybrid aeroelastic reduced order modelling/full order modelling techniques;
- Construction of reduced order models from a unified non-linear aeroelastic system;
- Global aeroelastic reduced order models for use in early design phase.

The final stage of the project will involve the validation and assessment of candidate technologies.

Expected Results

FFAST is an upstream university led project, and, as a result, the main outputs will be:

- new knowledge in the form of novel numerical simulation technologies and innovative approaches to the loads process;
- early release software;
- a solution database for unsteady loads cases, and

- recommendations in the form of written reports on a range of candidate technologies, that will guide future research investment.

The FFAST project will contribute to improving European industrial competitiveness by developing capabilities to design an aircraft concept that will have significantly lower fuel burn levels than today's best standards. Lowering aircraft fuel burn will result in reductions in CO_2 emissions that will go a significant way to meeting the ACARE 2020 vision targets. In order to meet these targets the aircraft design process must evolve rapidly to allow a number of concepts to be retained and assessed from top level definition through to high levels of maturity whilst also reducing lead times. New tools and technologies are required to enable this. In this context, FFAST will provide the foundation for a new approach in the key area of rapid critical load analysis, across a range of granularity and fidelity.

Acronym:	FFAST
Name of proposal:	Future Fast Aeroelastic Simulation Technologies
Grant Agreement:	233665
Instrument:	CP – FP
Total cost:	3 711 290 €
EU contribution:	2 735 511 €
Call:	FP7–AAT–2008–RTD–1
Starting date:	01.01.2010
Ending date:	31.12.2012
Duration:	36 months
Technical domain:	Design Tools and Production

Coordinator: Dr. Ann Louise Gaitonde
University of Bristol, UK.
Senate House Tyndall Avenue
UK -BS8 1TH Bristol
E-mail: ann.gaitonde@bristol.ac.uk
Tel: +44 (0)117 331 547 5
Fax: +44 (0)117 927 277 1

EC Officer:

Partners:

Institut National de Recherche en Informatique et en Automatique (INRIA)	FR
Council for Scientific and Industrial Research (CSIR)	ZA
Delft University of Technology (TUDelft)	NL
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)	DE
International Research Institute for Advanced Systems (IRIAS)	RU
The University of Liverpool (ULIV)	UK
Politecnico di Milano (POLIMI)	IT
Numeca International S.A	BE
Optimad engineering Srl	IT
Airbus UK Limited	UK
EADS Deutschland GmbH, Military Air Systems	DE
Institute For Information Transmission Problems (IITP)	RU