2.2 Setting of Wing Target Loads

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Abstract (Technical Topics and Desired Outcomes): The aircraft design process proceeds through a series of maturity / decision gates. At the early stages of this process the design parameters are very fluid and uncertain and are progressively tightened and addressed in ever increasing detail as the design is converged. At maturity gate (MG) 5 the global parameters of the design (i.e. shape and structural layout) are converged. The concept is now validated and frozen. At this stage the aircraft (a/c) 'target' loads are set - see Fig. 2. Design loads are the limiting loads that an a/c (or a/c component) must be designed to withstand. Clearly it is important to limit the risk in setting these target loads. If the target loads are underestimated, then expensive re-design is often required incurring the costs and penalties arising from programme delay. If the target loads are overestimated then the a/c will be heavier than need be at the risk of not meeting customer performance guarantees.

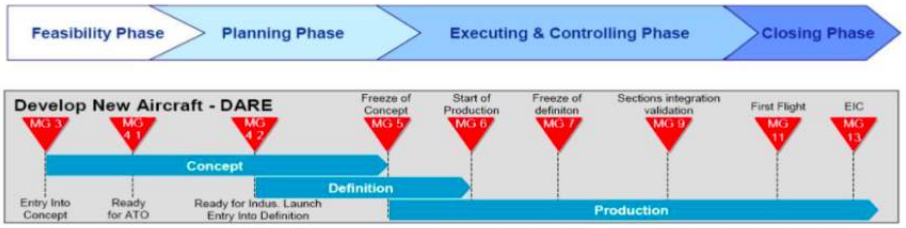

Figure 2: Airbus Aircraft Development Process.

Objectives: The process underlying this challenge is the Aero-Loads-Stress process, shown diagrammatically in Fig. 3. Each of the aerodynamic scenarios is analysed using a combination of low and high-fidelity CFD plus wind tunnel test results. The resulting loads for a specific design configuration are used to design the associated structure required to sustain the loads (in this case by varying the wing cover thickness. The internal structural layout is held fixed). This step alters the flexibility / stiffness of the wing and consequentially also the deformation of the wing under the applied forces (e.g. twist). For steady manoeuvres, the aeroelastic loop is iterated until it converges and the a/c is in equilibrium under the converged forces (lift and moment) and given mass distribution. This process must be performed in principle for all the loading conditions (although search algorithms may assist in converging rapidly onto the extreme region of loads

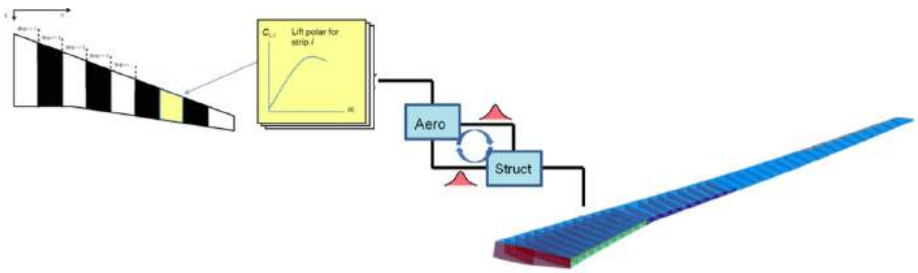

Figure 3: The Aero-Loads-Stress Process.

space) and the limit loads identified. The cover thickness is then optimised (minimal thickness) to sustain this loading resulting in a wing weight. The analysis process by which the limit loads on and a/c or component are established is very complex and computationally demanding. A very large number of conditions across the loads envelope must be considered.

UQ&M Aspirations: Can formal UQ&M methods be deployed to improve and underpin confidence in setting target loads thus reducing conservatism and the weight of the a/c or component? The key benefit to flow from a demonstrable UQ&M capability is improved confidence levels in the target load setting decision gates. The current use case has been designed to exercise most of the challenges of applying UQ&M to the setting of target loads whilst simplifying the range of conditions to be considered, i.e. it is not entirely realistic but is sufficiently testing. The focus is the setting of aircraft-in-flight target loads and the range of aerodynamic loading scenarios to be analysed is reduced by the following simplifications. Within Airbus it will not be acceptable to introduce intrusive methods, and thus the UQ&M capability must be able to wrap around existing processes.

Resources Available for this Problem:

- The simplified loads analysis model, GT-QHL, is constructed within MATLAB. It allows 'plugin' data and UQ&M methods.
- The reference aircraft model underlying the analysis is based upon the NASA developed Common Research Model (CRM), an open reference aircraft for CFD and wind tunnel validation studies.

References:

1. Full problem details can be found here: Setting of Wing Target Loads. A presentation will be given on the first morning of the Study Group.