Dassault Aviation

AEROGUST M30 Progress Meeting

23rd - 24th November 2017, INRIA Bordeaux

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Industrial constraints :

- The certification process requires the aircraft to be gust-resistant on its entire flight domain (JAR 25-341)

  ⇒ Discrete gust computations over :

  - 22 gust conditions (11 conditions in the y and z direction),
  - 15 flight points covering cruise and dive speed,
  - 14 mass cases,
  - 2 aerodynamic configurations,
  - with and without flight command system, etc.

  } ~ 12,000 cases

- The gust computations are included in a larger spectrum of maneuvers during the certification process (around 60,000 cases to be computed).

- The timespan dedicated to these computations is usually restricted to 3 to 4 weeks.

⇒ The average maneuver computation should not exceed 5 minutes.

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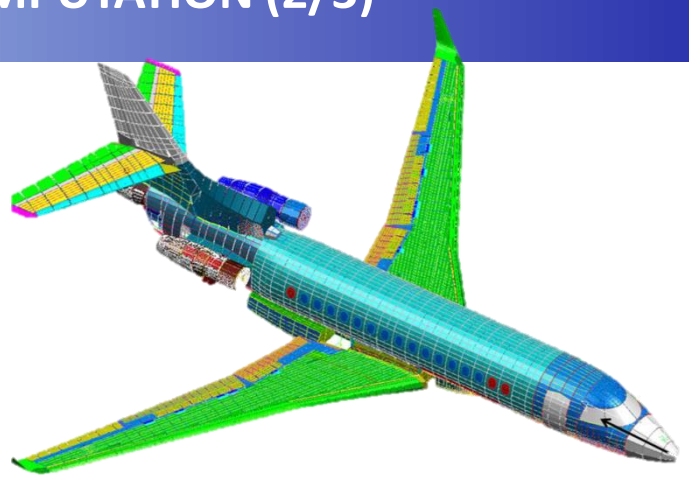
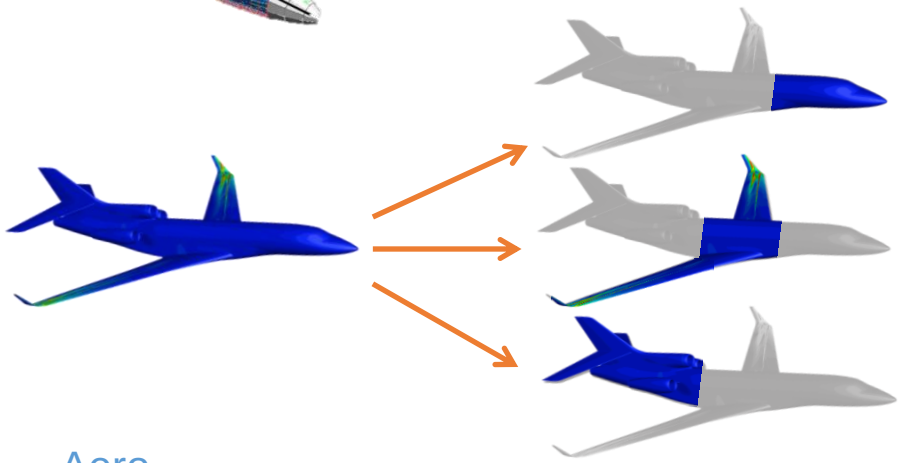


Discrete gust computation strategy :

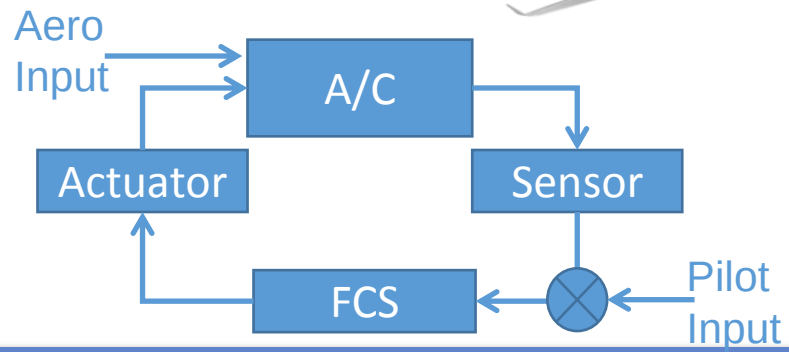
- Reduced Order Model based on
  - General FEM of an aircraft
  - Unsteady CFD for aeroelastic effects

- Aerodynamic inputs (for a vertical gust)
  - Angle of attack effect : unsteady CFD computations for various Mach numbers and reduced frequencies
  - Adjustment with respect to WT tests, experiences based on previous aircrafts in flight measurements
  - Gust penetration effect (angle of attack) successively applied on aircraft forward, middle and backward parts.



- Non-linear Flight Command System
  - Computations carried out with FCS to take into account longitudinal and lateral stabilizing effects

  ⇒ Time-domain computations required



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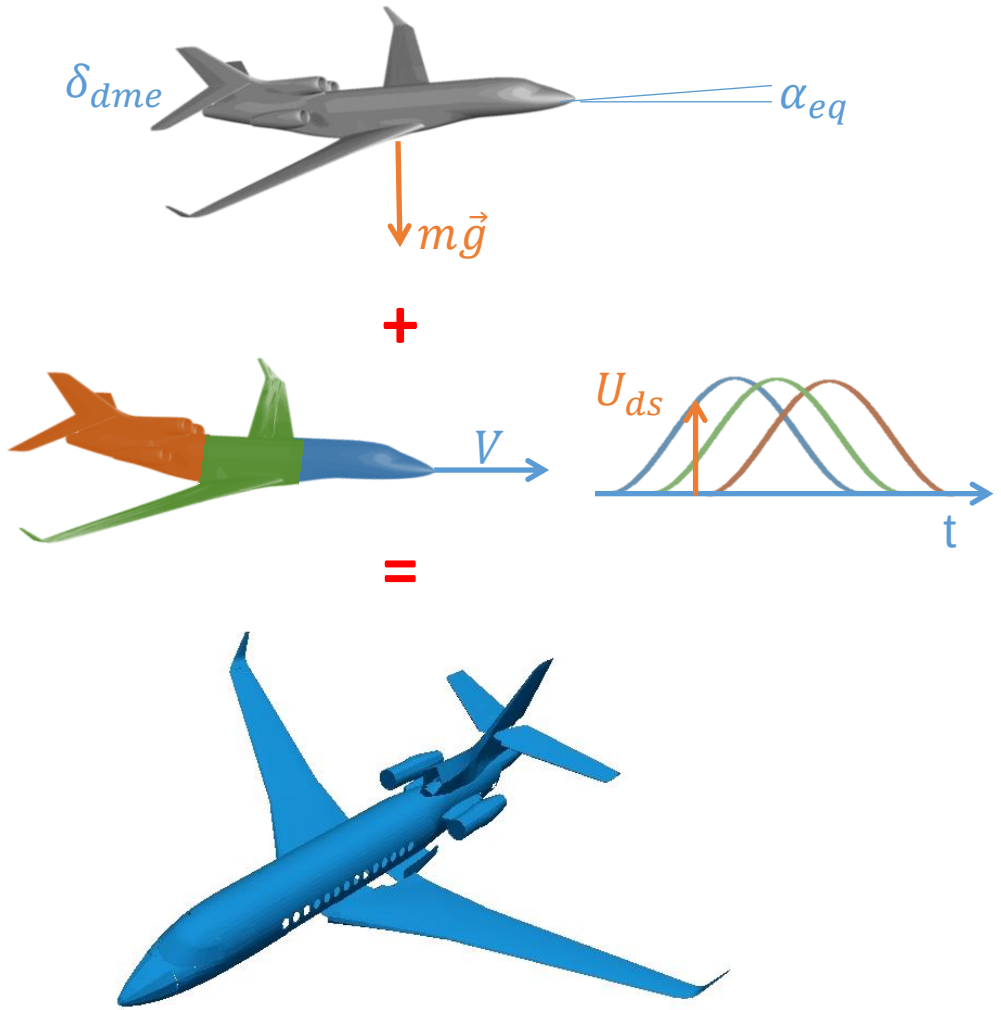
Discrete Gust computational steps :

- Aircraft 1G-equilibrium : static computation of angle of attack and elevator deflection to balance vertical load factor of 1G and no pitch rate.

- Aircraft response to the discrete gust : time (with FCS) or frequency (without FCS) response of the ROM to the gust input (modulation of the 3 partial delayed aerodynamic effects by the gust speed).

- Superposition of loads due to 1G-equilibrium and discrete gust.



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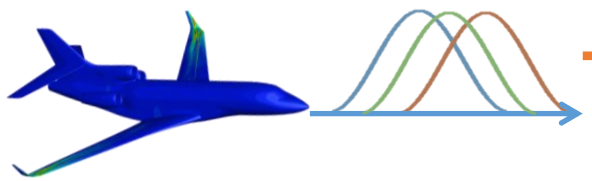
Turbulence input

Computation

Increasing complexity

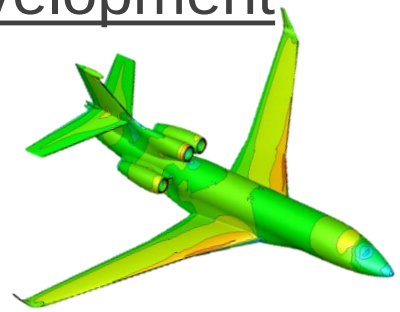
Today



3 delayed partial effects

ROM

In development



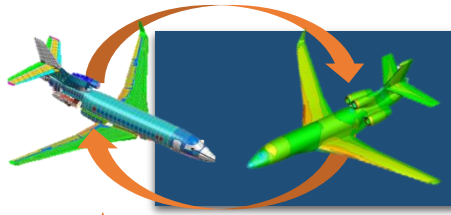
Pressure field for each time step

\+

Rigid « flight mechanic » model (non-linear α, β)

Flexible ROM

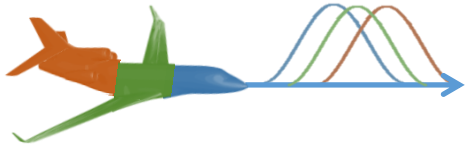
Restricted to most severe cases

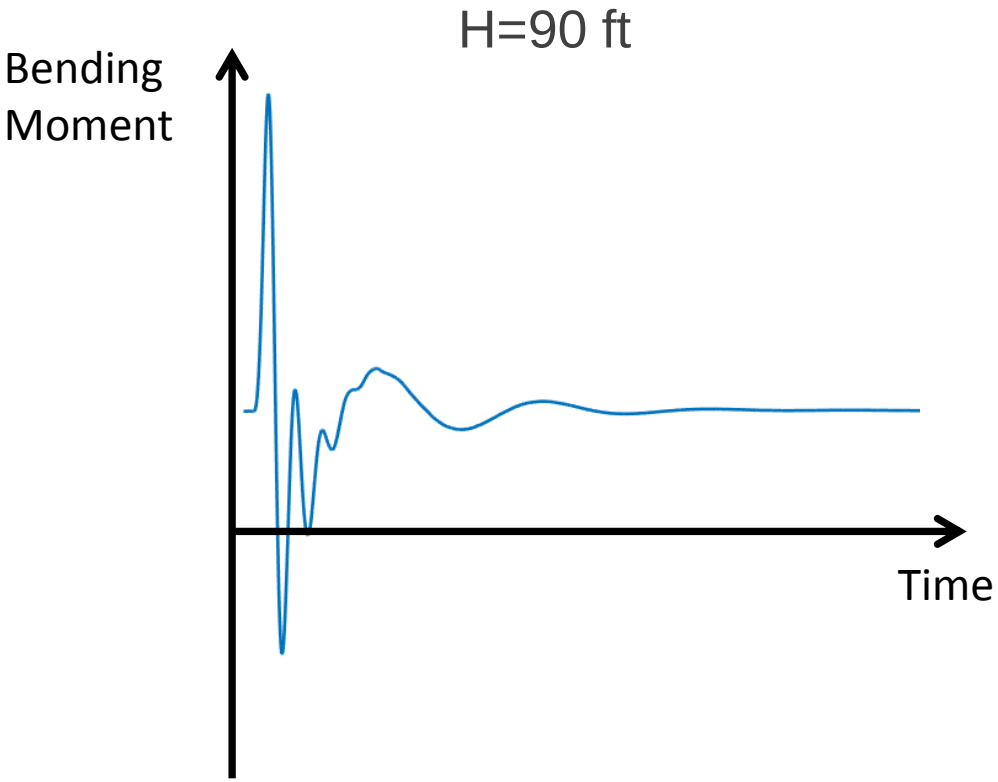


CFD/CSM time coupled simulations (restricted to a small number of cases)

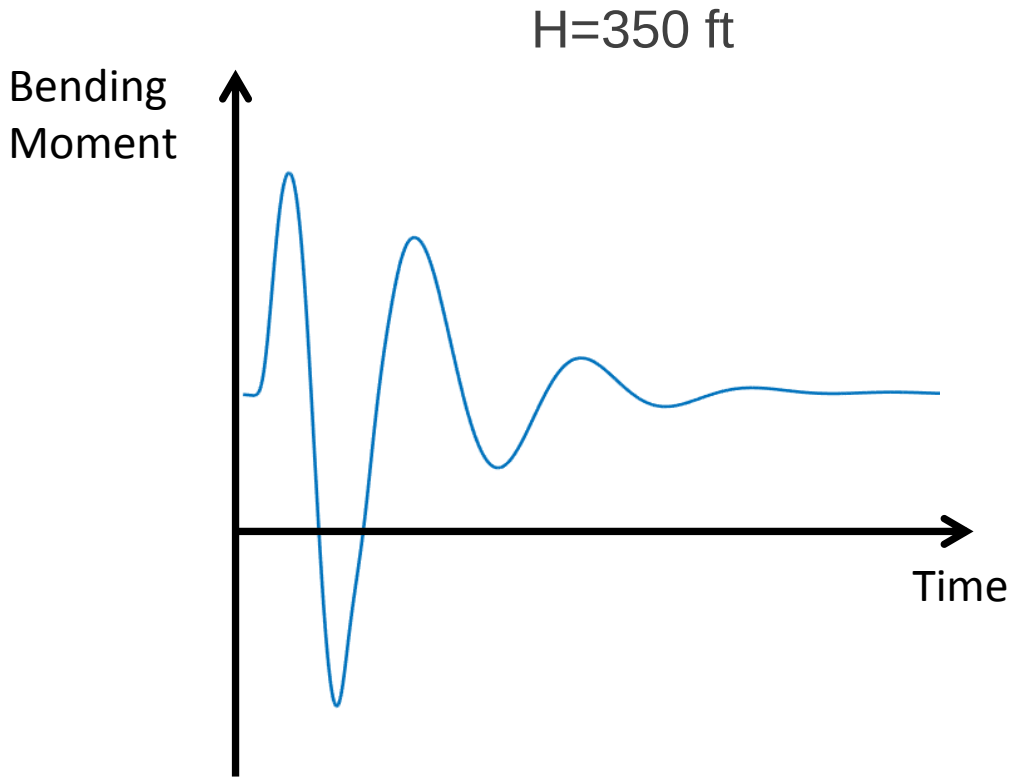
★ Aerodynamic tuning based on aerodynamic databases, WT tests, in-flight experience

Wing bending moment vs time :





Response driven by elastic deformations



Response driven by flight mechanic motion

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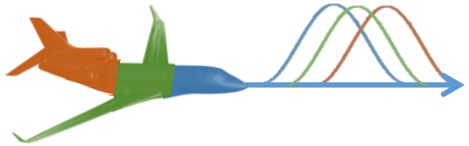
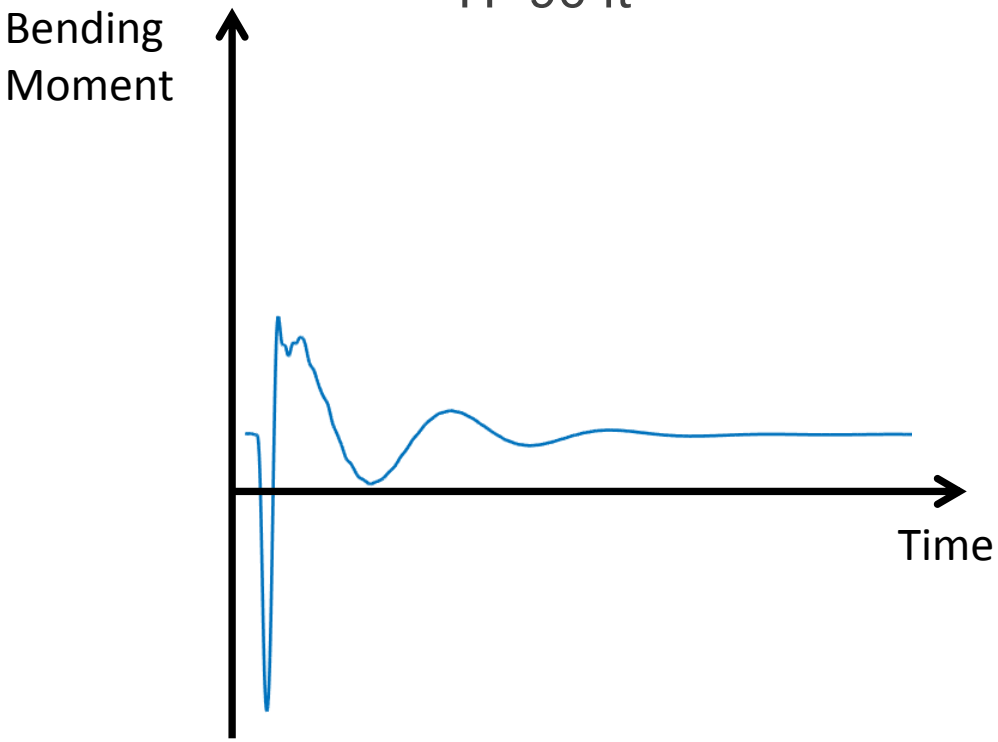
Horizontal tail bending moment vs time :

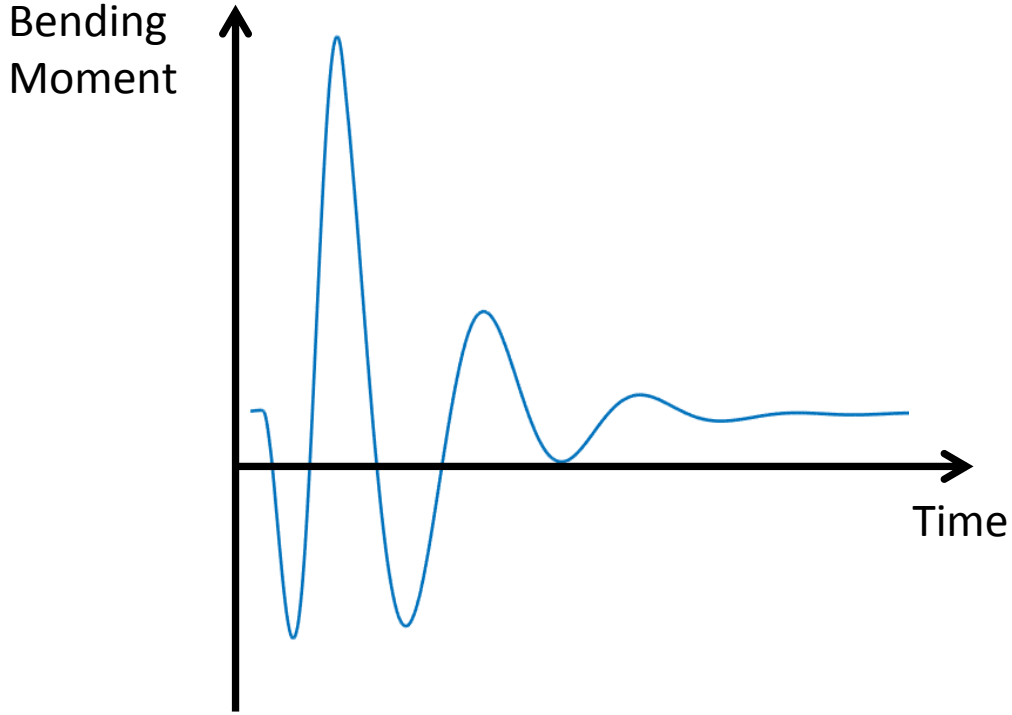


H=90 ft



Response driven by elastic deformations

H=350 ft



Response driven by flight mechanic motion

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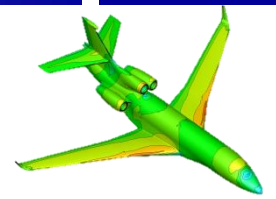
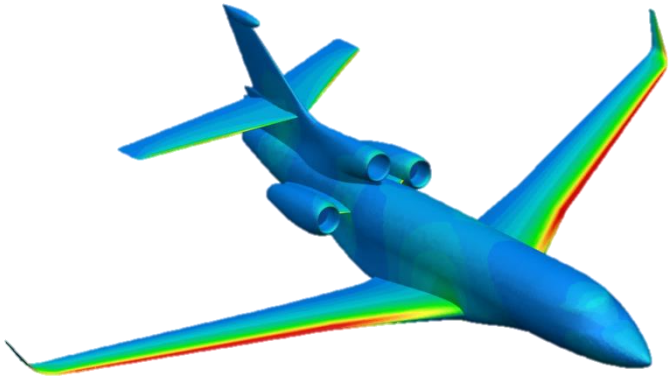
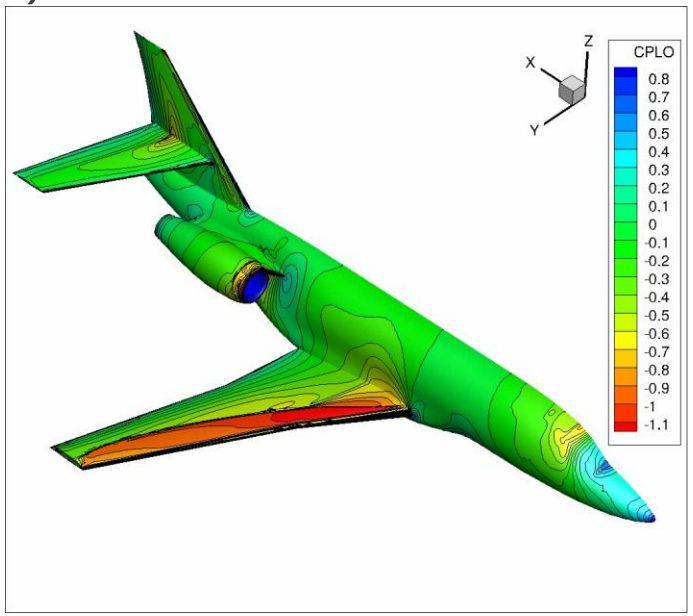


Creation of a reference case for future comparison :

- Aerodynamic : CFD Navier-Stokes (time or frequency domain) incidence effect for several frequencies.
  No aerodynamic adjustment performed.





Set up of the computational framework to treat new turbulence input :

- Computation of the aerodynamic pressure field for each time step
- Adaptation of the loads computation tools to integrate those fields and perform a time-response computation

The research leading to this work has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement number 636053.