

*Preliminary robust mechanical design
of Whole Engine*



VIVACE

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Preliminary robust mechanical design of Whole Engine - Introduction -

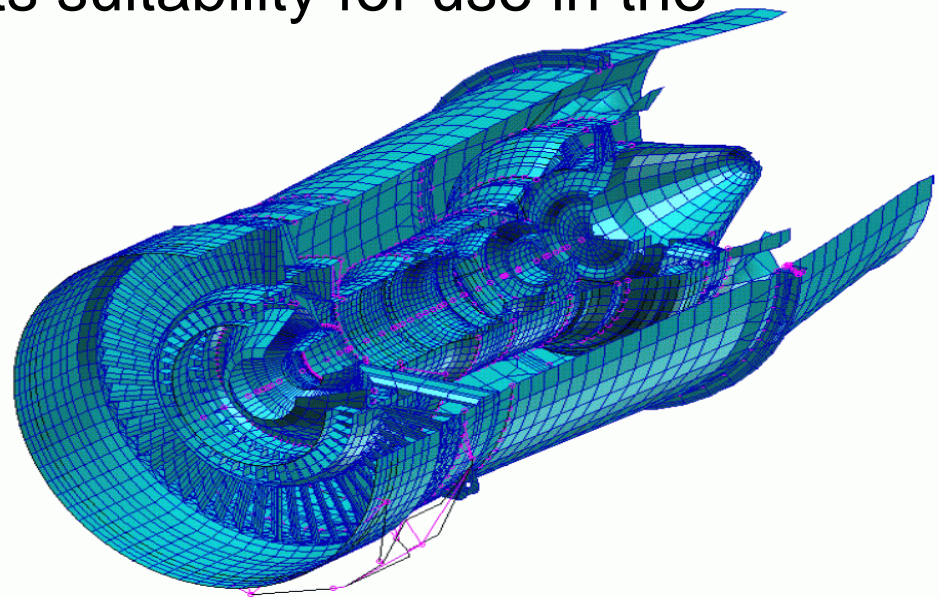
This presentation will consider robust Whole Engine Model and component design, and how this relates specifically to the preliminary design phase.



Preliminary robust mechanical design of Whole Engine - Current Situation -

Whole Engine Models such as this are a fundamental part of the design process. They enable component loads to be generated for flight cases and extreme engine events. These loads are then used to assess the design of an individual component and its suitability for use in the proposed design.

Robust design has not been considered practical before, due to the number of analyses needed to find a robust design.





Preliminary robust mechanical design of Whole Engine - Thanks to VIVACE -

- Research funded by VIVACE has identified advanced modelling and analysis methods, which can link to component geometry for rapid variable design assessment.
- This enables Robust Whole Engine and Component design to be considered. This in turn means that the behaviour of the final design will be more predictable through the engine's life.



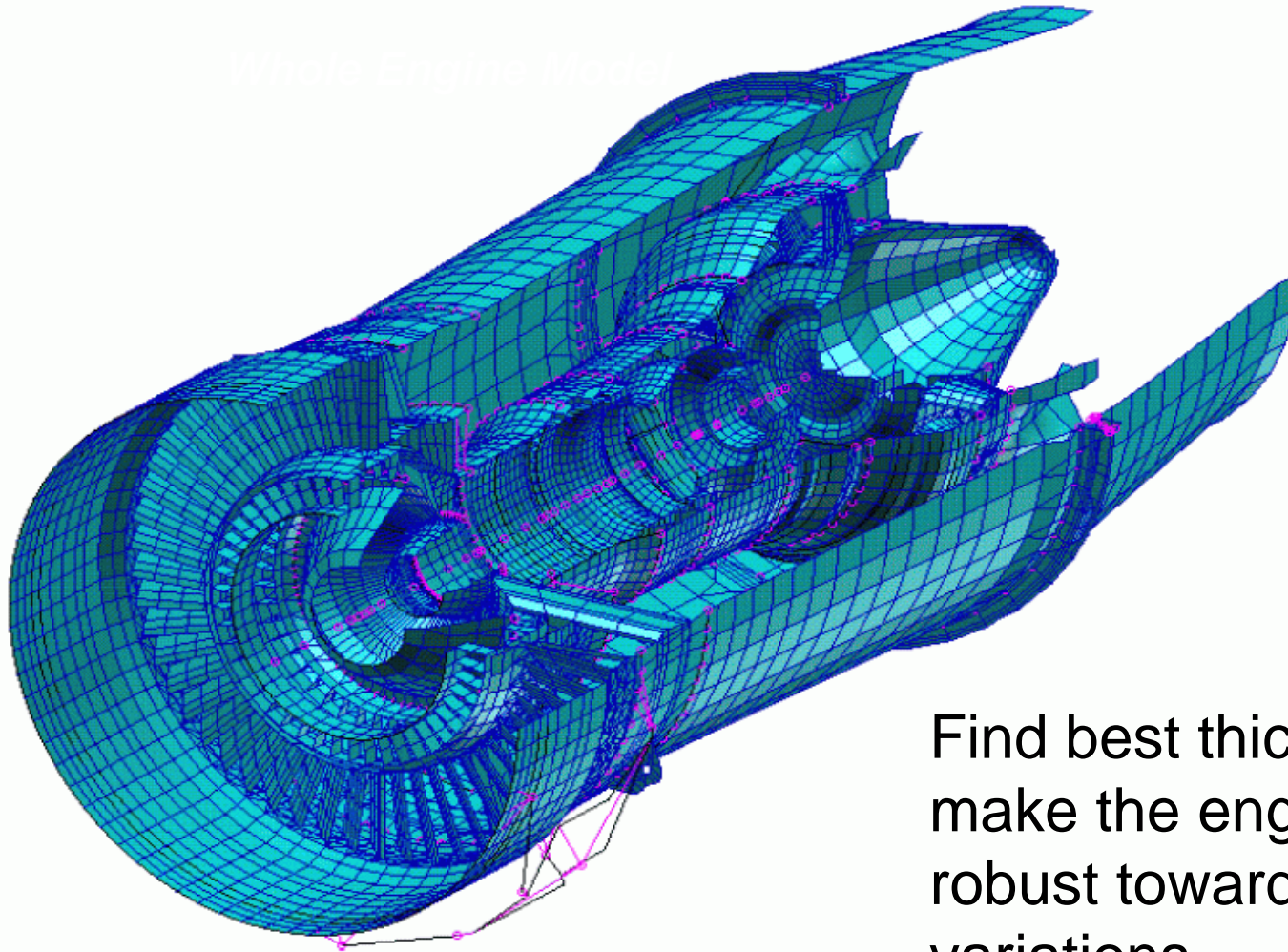
Preliminary robust mechanical design of Whole Engine - How does the Analysis differ now? -

- Scientific methods have been used which significantly reduce the computational cost (time) needed to obtain optimal solutions (from 6 months to 24 hours). This makes the research novel, interesting and practically applicable, giving an edge to the industry utilising it.
- A search tool to assist engineers in finding the most robust set of shell thicknesses has been developed.
- Ways of displaying the different objectives against each other, so they can be easily interpreted and interrogated.
- These tools have been combined and run in an automated process, taking a Whole Engine Model, varying the casing thicknesses and finding a robust solution to a known set of loads.



Preliminary robust mechanical design of Whole Engine - Whole Engine Analysis -

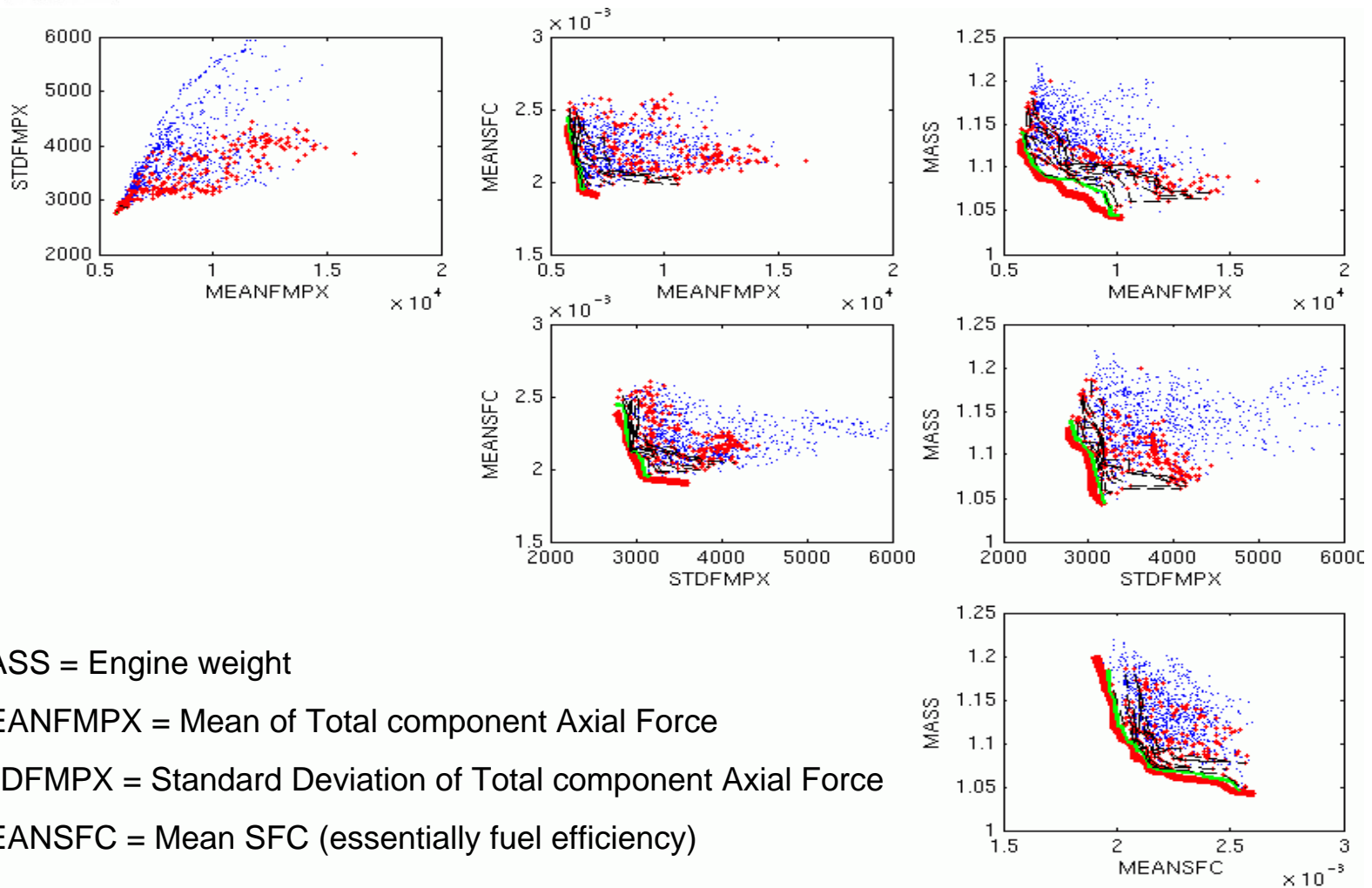
Whole Engine Model



Find best thicknesses to
make the engine most
robust towards load
variations



Preliminary robust mechanical design of Whole Engine - Typical Results 1 -



MASS = Engine weight

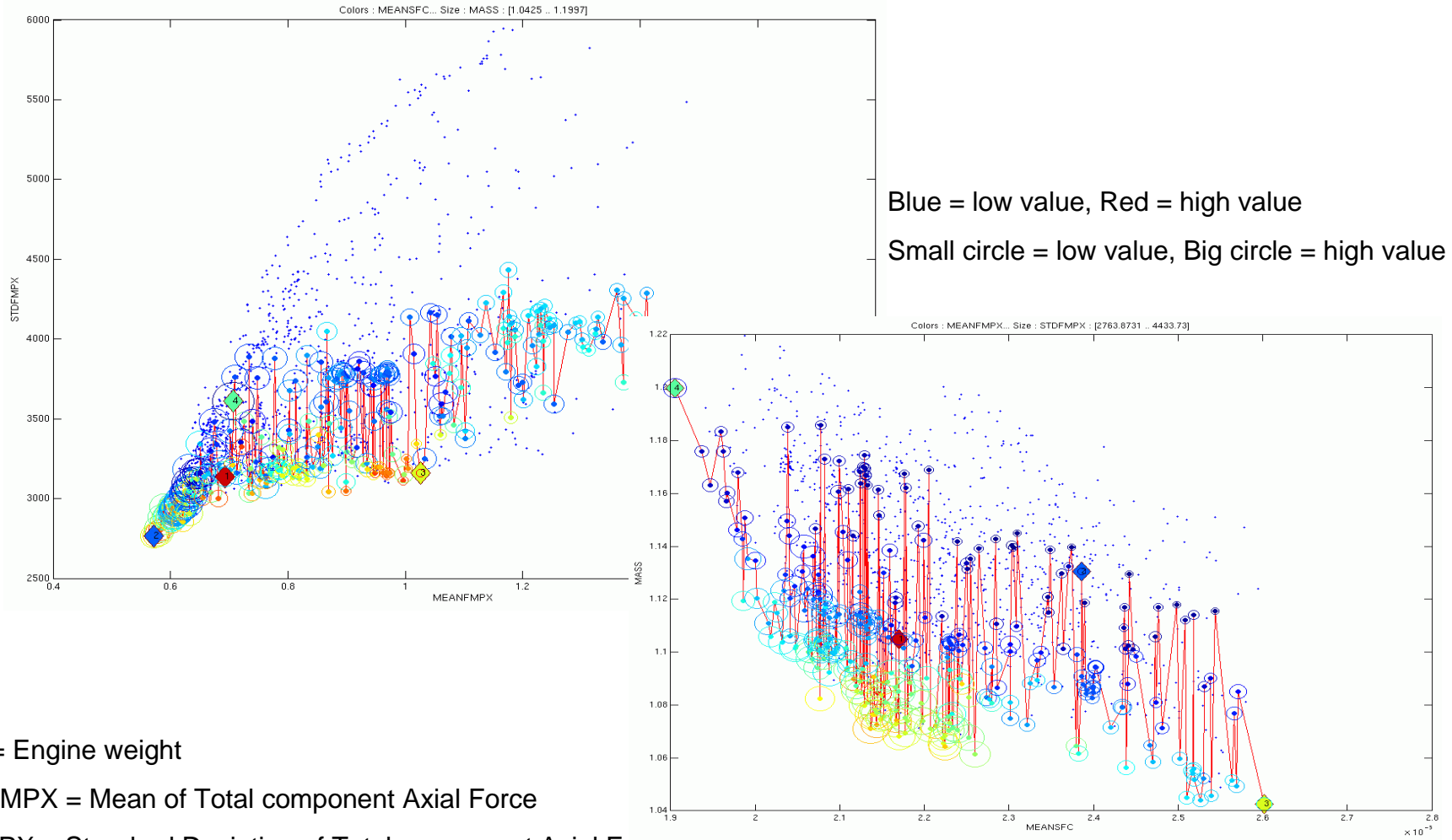
MEANFMPX = Mean of Total component Axial Force

STDFMPX = Standard Deviation of Total component Axial Force

MEANSFC = Mean SFC (essentially fuel efficiency)



Preliminary robust mechanical design of Whole Engine - Typical Results 2 -



MASS = Engine weight

MEANFMPX = Mean of Total component Axial Force

STDFMPX = Standard Deviation of Total component Axial Force

MEANSFC = Mean SFC (essentially fuel efficiency)



Preliminary robust mechanical design of Whole Engine - Limitations to the integrated process -

- Although this is a big step change in the process, it is currently limited to modifying casing thicknesses. It can not (at the moment) direct the geometry directly.

- Topology variation will now be demonstrated by Arnaud Quenardel from Snecma.