Case Study

Aerospace

Airbus

Simulation driven fuel systems design

“Flowmaster is a design tool used by our engineers on a daily basis to investigate the fluid mechanics of the fuel system. It helps us understand how changes to the fuel system design will affect performance, and the simulation results are frequently used in conjunction with test results in certification reports for the fuel system”

Ellis Griffiths, Head of Fuel Systems, Fluids Mechanical. Airbus UK

On 3 February 2004, a Singapore Airlines A340-500 entered the record books as the world’s longest non-stop commercial flight from Singapore to Los Angeles.

Sipping on their gin and tonics at 35,000 ft the majority of the passengers were blissfully unaware of the effort that went into designing the system that was working tirelessly away under their feet - the aircraft’s fuel system.

Keeping the four Rolls Royce Trent R553s turbofans constantly supplied with fuel is only part of its job. The fuel system plays an important part in managing the aircraft’s centre of gravity, ensuring the aircraft’s fuel consumption is optimised.

To ensure compliance with the aviation authorities and meet the aircraft’s design requirements, Airbus UK has applied its extensive expertise to optimise its fuel system design processes, which is also proving invaluable on current programmes such as the A380, A400M and A350.

Challenges faced by the fuel systems team include ensuring a system performs as intended, and that the impact design changes have in other areas of the aircraft on system performance are quantitatively understood.

Using the right combination of test and simulation at the right stage of the process has enabled Airbus UK to exceed its design requirements and meet critical project milestones.

For the past twelve years fuel systems engineers at Airbus have relied on Flowmaster, a 1D fluid system, to provide fast and accurate results that help them to focus on critical rig testing before flight testing commences.

Essentially there are five phases involved in the fuel system design process:

- Definition
- Detailed design & manufacture
- Equipment & subsystem test
- System integration
- Aircraft testing.

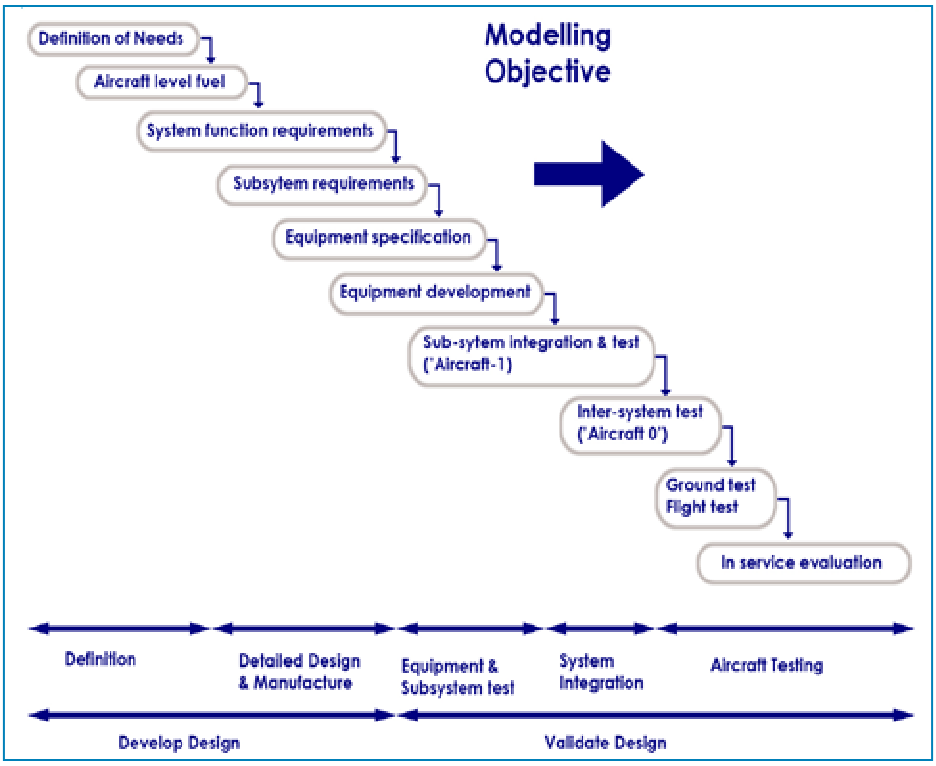
In the definition phase of the project, tank design data is supplied to the fuel systems team from a dedicated tank-modelling group.

The main parameters are tank volume, fuel height and Centre of Gravity (CG) data. This data provides a starting point for building fluid mechanical performance models to investigate the system performance for the refuel, defuel, jettison, CG & transfer, venting and engine feed sub systems.

By using Flowmaster, fuel system engineers can quickly ensure the correct fuel flow rates, pressures and flow distribution to and from the eight (A340-600) or nine fuel tanks (A340-500). They can also determine the refuel and defuel sequencing of the tanks.

This becomes important when you consider the refuel rates of approx 200,000 litres of fuel for an A340 – 500/ 600 are 33 minutes and 30 minutes respectively when 3.45 bar is applied to all of the four refuel couplings. There's a lot of fuel moving through the system in a short space of time.

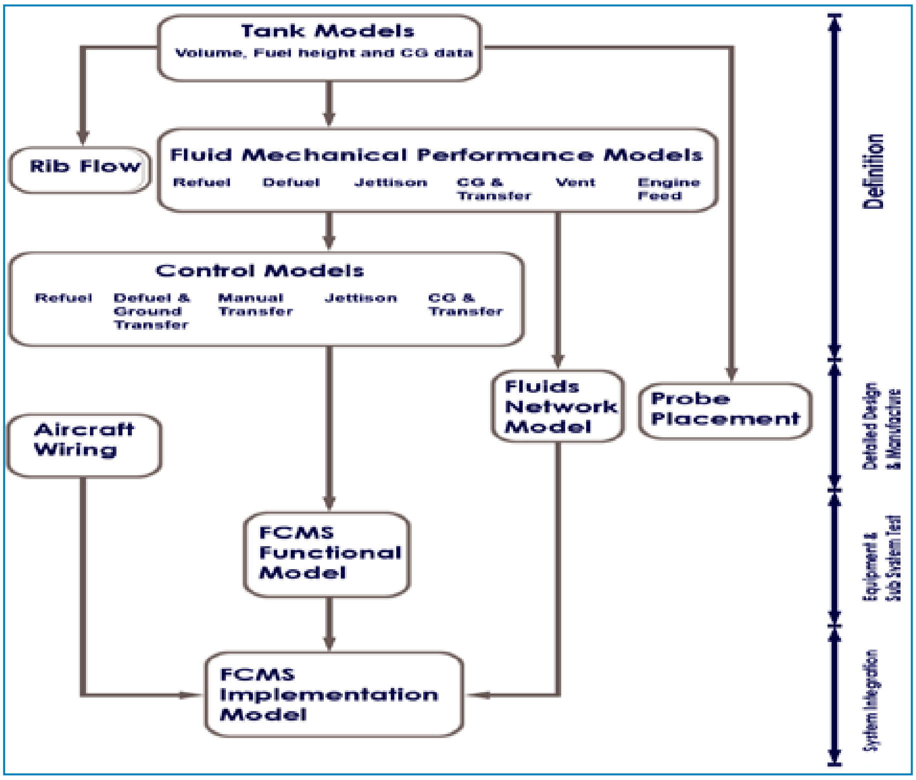
The fluid-mechanical performance models are then used as part of an integrated fuel simulation, which includes system control logic of pumps, valves, etc., together with simulated cockpit displays. This allows the control engineers to perform realistic flight scenarios. Using this simulation, specialists assess both the performance of the system and the operability (crew drills, Electronic Centralised Aircraft Monitoring displays, warnings and cautions, etc.).



Fuel System Modelling Process

Once the fuel system team has confirmed that the functional requirements can be met by the proposed fuel system layout in the definition phase, the next step is to add more detail to the subsystems by incorporating actual equipment data, such as pump curves and loss curves, for fittings and valves.

Maintaining version control of the fluid systems models and data in line with the aircraft design version is a critical activity. To achieve this Airbus has made use of Flowmaster's CADLink API's (Application Programming Interface) and a third party company to develop a rules based link program between the design environment and Flowmaster. This allows version control to be done in one place, the design environment, and all the associated geometry and data is automatically exported via the third party application directly into Flowmaster.



Models Inteaction Diagram

This automated link gives Airbus an effective tool to provide results quickly to other engineering teams. It is especially useful when designing fuel systems in composite wing structures. Because the design freeze occurs much earlier in the design cycle for a composite wing the ability of the fuel team to quickly verify the implication of structural changes on the fuel system performance is important.

The results from fluid system performance models have helped Airbus focus their fluid-mechanical rig testing where it is most appropriate.

Subsystems, which can be adequately and accurately modelled in Flowmaster, do not need extensive rig testing prior to aircraft test. In some cases, confidence in Flowmaster performance has been verified by a comparison of model, rig and aircraft tests.

Fluid mechanical rig testing remains an important tool in the overall verification and validation process.

By developing an overall test strategy, which optimises the uses of simulation, rigs and aircraft test, Airbus has reduced the risks associated with system development, and provided an environment which allows rapid and early assessment of fluid mechanical performance.

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