THE ENEMY WITHIN

The systems that keep aircraft in the air and guide them safely to their destinations are heavily reliant on electronics, both onboard the aircraft, on the ground and, increasingly, in orbit. Ensuring that these systems work in harmony with each other and with natural electromagnetic phenomena such as lightning is a vital part of the aircraft manufacturer's job

Aviation has benefited more than most industries from the information revolution. Military aircraft depend heavily on electronics. As well as navigation and flight control they also need to be able to locate, identify and pinpoint potential threats and targets. Some of these activities involve powerful laser and radar systems with significant levels of electromagnetic radiation. It is therefore vital that the various systems do not interfere with each other or compromise the safety of the crew. These are among the sensitive issues dealt with by the experts at BAE Systems.

Responsibility for BAE Systems' whole vehicle electromagnetic testing and analysis falls under the auspices of the Electromagnetic Engineering and Test (EE&T) department based at Warton, Lancashire, a department which reflects the planned change of remit from just aircraft to a broader base of land, sea and air vehicles.

Such developments are likely to put an even greater strain on the computation analysis team. "Our product portfolio already includes Nimrod and Eurofighter, both extremely complex aircraft in their own different ways," says Chris Jones, technology consultant in the Electromagnetic Engineering department. "Each vehicle we deal with has probably been designed in a number of different locations and possibly with a number of different design systems. But the analyses we perform demand a single, accurate geometric representation and the generation of this geometry is often the single biggest challenge. With new vehicles coming online it will be more vital than ever that we can maintain the integrity of our data – and fast."

Multiple modellers

Jones and his team have been using electromagnetic analysis software since it first became a viable option over 15 years ago. Even then, with the CAD market still relatively young, a survey revealed that there were no less than 17 CAD systems in use within BAE Systems. Consolidation has reduced this number significantly today but there remains a daunting diversity when it comes to defining geometry for computational analysis.

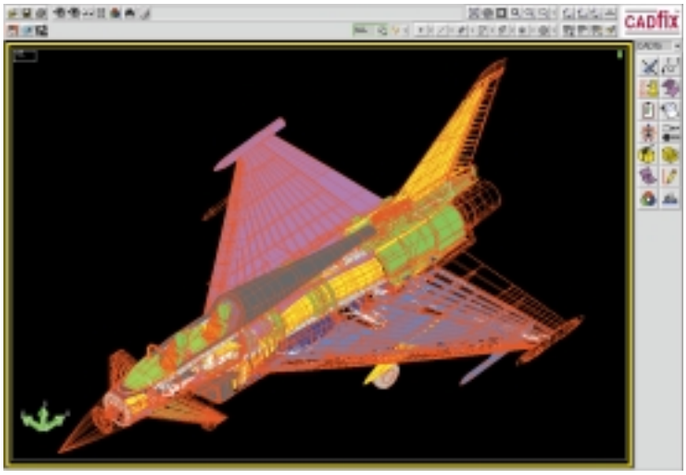
"Eurofighter is a classic example: the complete geometry comes from four different countries, Germany, Italy, Spain and the UK," says Jones. "We have to bring all this data into a neutral environment, clean it up where necessary, assign material properties, generate a mesh and then format this so that it can be used in our analysis packages."

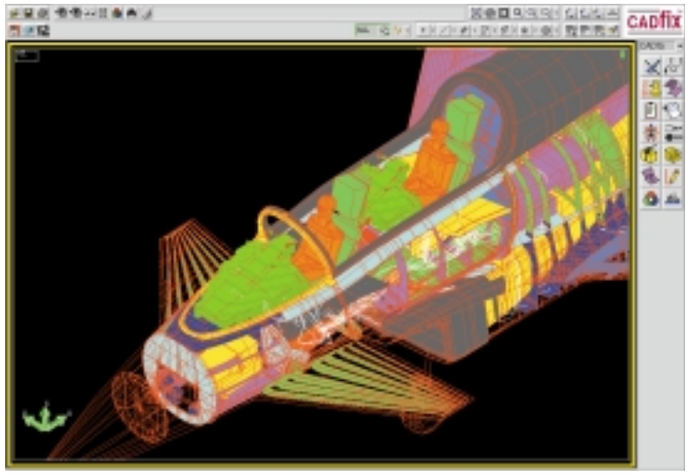
Even if there was just a single analysis package this would be problematical enough, but the different flavours of electromagnetic simulation performed at BAE Systems all demand different codes and different ways of defining mesh geometry. Analysis methods include, among others, generic transmission line matrix (TLM), finite difference methods and boundary element methods, as well as systems that have been specifically developed for lightning strike and installed antenna performance analysis.

"In effect, we go from a set of CAD systems to a set of numerical analysis codes," says Jones. "Fortunately, we have found a way to avoid a separate data processing nightmare for every combination."

BAE Systems EE&T uses CADfix, the leading data interoperability tool developed by TranscenData (formerly FEGS), as a central resource of geometric data. Because it offers a reliable link – either directly or via IGES – to every major CAD system on the market, CADfix provides the perfect platform for such a diverse range of data. And because of TranscenData's long heritage in the pre- and post-processing for FEA (CADfix's underlying technology draws heavily on FAM, TranscenData's widely used FE modeller) it offers the perfect route from raw geometry to refined, analysis-ready mesh.

"CADfix is at the heart of everything we do," says Paul Baker, a BAE Systems Computational Electromagnetics (CEM) specialist. "In effect we use it as the hub of our operation, a central resource for all the geometry we have to work on.





ABOVE LEFT and RIGHT: Meshes prepared in CADfix for electromagnetic analysis

Whatever kind of analysis we need to perform, whatever mesh we need, the starting point is always the clean geometry that's been assembled inside CADfix."

As well as providing a central data resource, CADfix also makes its presence felt in a manner perhaps more typically associated with TranscenData solutions. Before BAE Systems began using FAM – and later its successor, CADfix – the generation of the meshes on which calculations are based was essentially a manual operation and therefore a lengthy one. Now, meshes are generated directly within CADfix and the time savings are enormous: a single wing could take six to nine months previously; a whole plane can now be meshed in just three or four hours.

"Even with the powerful computers we use, an analysis of a complete aircraft can take about ten days," says Baker. "So the last thing we need is to spend ages building meshes. With CADfix we can generate new meshes in just a few hours so we are not restricted when it comes to trying a different kind of analysis."

Graphical feedback

CADfix's powerful post processing capabilities are also used to the fore at BAE Systems. "We use pretty standard mathematical software to retrieve the precise graphs and figures we need for our reports and safety checks," says Baker. "But our first port of call is always CADfix, where we can display field contours on the original CAD model.

This gives an instant picture of where we should be looking for maximum concentrations, and while this is often not much more than a 'sanity check' to make sure we're looking in the right place, it does throw up the occasional surprise."

One such revelation came when looking at the effects of a lightning strike on the cockpit of the Eurofighter.

"Our initial analysis confirmed that a modified design performed just as well as the original, but it also revealed a slight anomaly that would have been impossible to spot through physical testing," explains Baker. "It showed that, during a lightning strike a small but significant current passed through some aerodynamic strakes on the outside of the cockpit. Although this current was within safety standards, there was a very small chance that a spark could have formed at one of the strake's fasteners. Such sparking is the last thing you want in a jet fighter."

Problems like this can usually be fixed quite easily if caught early enough explains Jones:" In this case the problem was fixed with a relatively simple design modification, but without the depth of analysis we get from using CADfix it could have taken us years to spot something so subtle." C3