Simulation significantly **reduces** NDT inspection development **costs**.

A leading UK tier 1 aerospace supplier required digital engineering expertise within a project aiming to accelerate the development and deployment of composite material and process technologies. Combining expertise in simulation, optimisation and sensitivity analysis, CFMS could significantly reduce the non-destructive testing (NDT) inspection development costs.

Challenge

The increasing use of composite materials for advanced engineering results in complex inspection challenges. This is placing an increasing burden on experimental design and validation of inspections to find defects which are both |costly and time consuming. The Centre for Modelling and Simulation (CFMS) was requested by a tier 1 aerospace supplier to use our expertise in simulation, optimisation and sensitivity analysis to aid the development in an ultrasonic non-destructive testing (NDT) method for composite components.

Leveraging the versatility of our high performance compute (HPC) powered digital modelling and simulation, CFMS aimed to:

- Reduce reliance on physical experimental testing by introducing validated physics based simulations.
- Enhance the quality, reliability and detectability of NDT inspection techniques using simulation.
- Analyse many inspection configurations to ensure optimal inspection across a range of potential scenarios.

Solution

By simulating ultrasonic waves in composites, forming the backbone of the NDT inspection technique, CFMS built a model of the inspection and could predict the measured responses. This allowed the client to explore a wider range of geometries and defects, resulting in a more optimised and robust inspection.

The technique used a transducer array approach which uses sensors placed around the plate to generate images to detect defects within the array. In total 10 different plate geometries were simulated, including 2 bonded T-section geometries, with a variety of defects beyond that of the experimental data.

CFMS **saved the client over £2 million** in manufacturing costs for composite plates.

Using high performance computing (HPC) CFMS can **simulate defects in over 500 composite** plates within 2 weeks.

Using this model, our team could simulate around 500 composite plates to gain insights into the effect of thickness variation on defect image quality. This technology prevented the need to manufacture over 500 composite plates, reducing the design and validation costs.

The model developed by CFMS could also simulate sensors embedded within a composite. Through modelling the sensors at different depths and with various types of faults, it demonstrated that inserting plates into components had no benefit, preventing the unnecessary manufacturing of these difficult and expensive composite plates.

The performance of the defect imaging method depends on the sensor positioning on the plate. Using high peformance computing (HPC) CFMS assessed 60,000 sensor combinations in 6 hours to discover an optimal configuration that identified array faults. One of the plate geometries modelled was a bonded T-section, where the simulation allowed CFMS to test beyond what was experimentally tested. This inspection test was able to successfully identify defects present in the bond line of the T-section.

To replace experimental testing with simulation, it was essential to validate the model to ensure its accurate representation of reality. The model was validated against a range of experimental measurements of test pieces with known defects to ensure confidence in the results.

Benefit

This project demonstrated the ability to develop a high fidelity model of reality, enabling us to gain real world insight into the NDT method for composite plate inspection techniques. To identify all defects and evaluate the NDT process without simulation, all test cases scanned would have to be created with an extremely high level of precision.

There are a wide range of factors that can vary in manufactured components and trying to capture this variation experimentally leads to high manufacturing costs of physical prototypes for testing. With the manufacturing cost of composite plates ranging from £2,000 to £9,000, simulation proves to reduce the number of prototypes required, thereby significantly decreasing the overall time and cost for inspection. Additionally, simulation increases the quality and gives greater confidence in the inspection by enabling the examination of a wide range of defects within a shorter time period.

Feedback

The tier 1 aerospace supplier was highly satisfied with the result of the NDT model for the composite plates, leading CFMS to integrate this technology in many additional aspects of their services for the supplier.

"If I was able to compare this simulation work to any software package that could do the same work, a generalised software package I believe would not give the same quality output."

Principle NDT Research Engineer, tier 1 aerospace supplier.