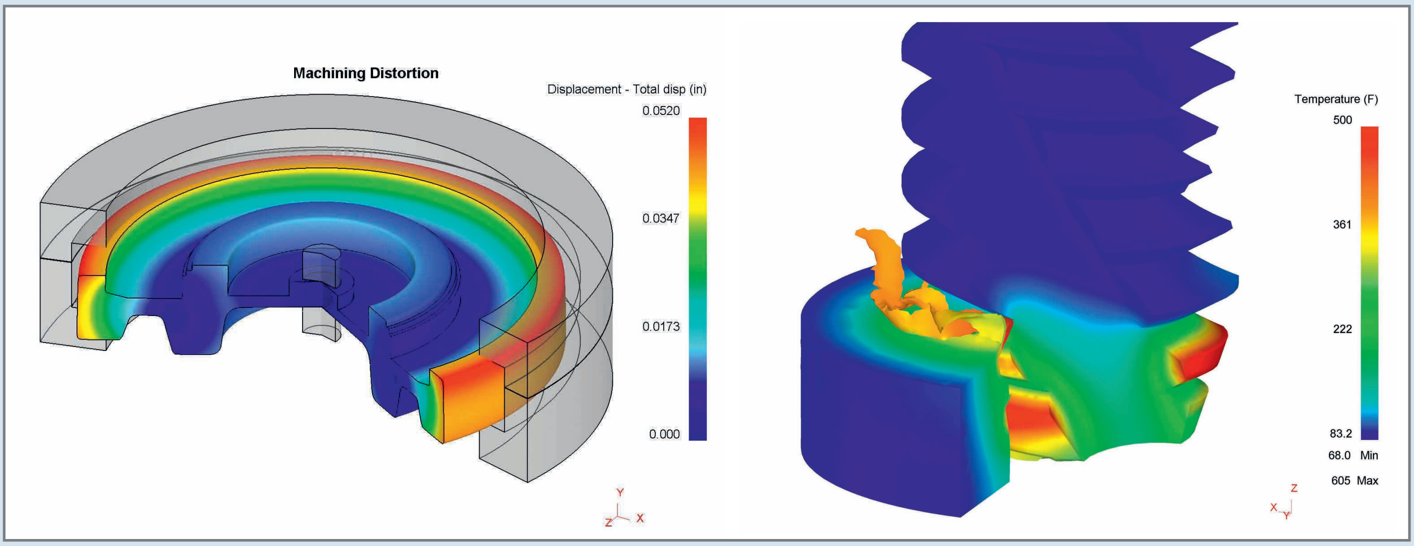
Simulate to innovate

Wilde Analysis' managing director, David Deakin explains how aerospace companies can gain more leverage by using the latest simulation software tools to optimise their manufacturing processes.



Simulation optimises the manufacturing route: Wilde Analysis uses the DEFORM software to simulate machining processes and metal forming

An increasingly global aerospace industry now sees many Western-based suppliers going head to head with their low-cost overseas counterparts. So how can they best compete?

One answer may mean focusing on the production of the most advanced or most demanding parts, where the costs associated with ensuring the quality and method of manufacture are a significant part of the overall unit cost.

Wilde Analysis believes that simulation techniques can play an important part in ensuring that parts are produced to a required standard and in an efficient way. Many of us are aware of simulation techniques such as finite element analysis (FEA) and computational fluid dynamics (CFD) being applied to product design and the aerospace industry was a pioneer during the 1960s.

These techniques are now used extensively in product development for applications such as checks on structural integrity or pressure drops in fluid applications. However, fewer people are aware of the application of these and similar techniques to design and optimise the manufacturing processes and how they can deliver benefits in areas such as metal forging, machining, heat treatment and the injection moulding of plastic parts.

Wilde distributes and uses the DEFORM software developed by Scientific Forming Technologies, of Columbus, Ohio to simulate metal forming. Most components are produced by a number of forming techniques and may typically involve several combinations of operations, such as rolling, forging, machining, and heat treatment.

The simulation of any one of these processes is technically demanding, but is now used extensively by many manufacturers, some of whom will not commit to making tools to produce a new part without first 'proving' the process using simulation. These simulations require advanced techniques including the modelling of non-linear materials, large displacements, evolving contact surfaces and material removal in a multi-physics environment.

Having mastered the modelling of a single process, the technology is now being applied to multi-stage modelling to simulate multiple operations. This presents many new challenges and for some applications it's still at the research stage. Nevertheless, current technologies are now being used to optimise manufacturing processes.

An example is the recently completed 'automated simulation tool for optimising the manufacturing route including friction welding' project. Funded by the Technology Strategy Board (TSB) and undertaken in conjunction with Rolls-Royce, Nottingham University and Birmingham University, the project was used to develop a user-friendly software tool allowing non-simulation specialists to undertake simulations of the manufacture of disks and shafts for turbines.

Future efficient lightweight aero-engines will rely on the next generation of high temperature materials. However, they present new manufacturing challenges, particularly in joining where friction welding has been identified as a key enabling technology. Sponsored by the TSB, the Process Modelling for Tomorrow's Engines (PROMOTE) project is a collaborative project involving Rolls-Royce, Wilde Analysis and the Universities of Nottingham and Birmingham, which was tasked with capturing the state-of-the-art in materials and process modelling and implementing it in an end user-focused software tool.

Promoting the coating

Another example of the kind of research which is helping to develop knowledge in this area is the 'Multiscale Modelling for Multilayered Surface Systems' (M3-2S) European project. Wilde is a partner in the 'virtual test for rapid evaluation of engineered surface coatings' project, working with Imperial College, Strathclyde University, Birmingham University and a number of other collaborators across Europe.

The objective is to develop a software system to model the coatings of cutting tools, with the ultimate benefit of increasing tool life and reducing production costs. This particular application required the development of novel techniques to undertake multi-scale modelling, including the modelling of atomic bonds.

Significant progress has been made during the past decade in the development of multi-functional surface systems to meet ever-increasing demands for high performance engineering components operating under severe working conditions. Micro-indentation hardness tests are widely used in the evaluation of candidate coating systems for high load-bearing applications.

The project's pioneering collaborative research into the advances in multi-scale simulation techniques and modelling of mechanical damage has demonstrated faithful duplication of test results. This now makes it possible to replace mechanical tests with computer simulation – at least as a pre-screening technique – to identify, from a wider range of alternatives a shortlist of candidate coating systems for particular applications. This reduces the required scope of physical prototype testing, thereby reducing time to market. Furthermore, simulation can both provide insight into the evolution of surface damage, which may suggest mitigation measures and improvements to surface system design.

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