CADfix Boosts Productivity for Holset

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- Mike Eastwood
Applied Mechanics Manager at Holset

Diesel engines for heavy-duty trucks and machinery rely on turbochargers for their existence. They boost power, broaden torque curves and increase fuel efficiency to such an extent that without them, diesel engines would not be able to deliver the "workhorse" output demanded of them.

Holset Turbocharger

Holset Turbochargers are engineered and manufactured by Cummins Turbo Technologies. They have set the standard for turbocharger technology and design for over 60 years. High standards of product quality, safety and superior performance are why key OEMs worldwide choose to partner with Cummins Turbo Technologies. Holset works hard to make sure these standards are upheld throughout their Aftermarket business.

To make sure customers experience the intended functionality and performance of a Holset turbocharger, they work alongside 250 carefully selected Authorized Holset Distributors in over 140 countries worldwide; served by Holset service and distribution centres in Brazil, China, India, the UK and the USA.

The Need for Analysis

As the turbochargers it produces are essential to the function of the engines in which they are fitted, the pressure on Holset to guarantee their performance and longevity is enormous. The only way to do this is to know the exact physical state of each turbocharger component while the engine is running. As it is not practical to wait until a new turbocharger has been manufactured before measurements can be made, it is no surprise that Holset relies heavily on finite element analysis (FEA) and computational fluid dynamics (CFD) to predict performance early in the design process.

Mike Eastwood, Applied Mechanics Manager at Holset Huddersfield, states, "We seldom have too much physical room to play with, so over-designing in the interests of a margin of error is not really an option. It is vital that we know as much as possible about every component's performance under operating conditions." And because such conditions are among the more extreme faced by design engineers, predictions are not left to hand calculation.

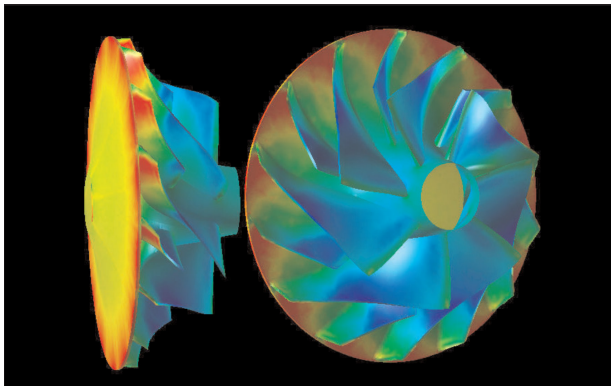
Data Exchange Bottleneck

Holset's designers use Pro/Engineer as their core CAD tool, making full use of its parametric assembly modeling capabilities. Each turbocharger component then has to be analyzed in ANSYS, while the performance as a whole is determined in a proprietary CFD package. The transition from a Pro/Engineer CAD component model to the ANSYS FE mesh required for both flavors of analysis, however, is far from straightforward, and represented a significant stumbling block for Holset.

Without a direct translator between Pro/E and ANSYS, Mike's team had to make do with the unreliable medium of IGES files. These rarely did the job satisfactorily and invariably meant extra work for somebody.

"We basically had two options when our first stab at IGES transfer failed," explains Mike. "We could go back to the designer and ask them to change the way the model was created inside Pro/Engineer, or we could try to make the changes ourselves using the limited geometry tools within ANSYS. Either way, this would be a time-consuming process and of course there was a danger that we would compromise design intent."

Things have advanced since then. The introduction of a Pro/Engineer input tool within ANSYS helped to some extent, but the real breakthrough came with the arrival of CADfix. "Even with the ANSYS import there were very few cases when we achieved a direct transfer first time round," says Mike. "More often than not further work would be required, and we would often have to spend as much as a whole working day preparing models for meshing when we should have spent that time interpreting analysis results."



Compressor wheel CFD results

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CADfix Bridges the Gap

The data transfer problems that Mike and his team encountered are not uncommon in today's solid and surface modeling engineering culture. Anyone who has had to reuse geometry created in a modern CAD system in some other software package is almost certain to have encountered an interoperability issue at some level. Reasons for this stem from the inherent complexity of defining surface geometry in space and inconsistencies in the way different systems go about such definition, particularly in the matter of tolerances. It is not unusual for a gap to appear between two "adjacent" surfaces from one modeler, for instance, simply because the second system does not consider them a close enough fit.

CADfix has been designed specifically to address this kind of problem. It offers a host of automated and interactive tools for diagnosing and repairing illegal or suspicious areas of geometry. The result is that fully defined solid models – and even assemblies – can be derived quickly from even the messiest IGES files.

Productivity Gains

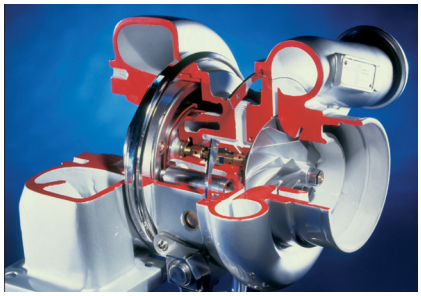
For Holset the introduction of CADfix has been a revolution in terms of productivity. Typically, data reworking that would take an entire day is now completed in an hour. "I would estimate that CADfix plays a vital role in at least two thirds of the FEA jobs we undertake," says Mike. "More models than before are now coming through the direct interface because we have looked at ways of configuring the output from Pro/E, but we still turn to CADfix more often than not."

Richard Evans, who is in charge of the CFD program at Holset, is equally enthusiastic. "We have to create FE meshes of internal airways, effectively the inverse of Pro/E models," he explains. "These are very complex shapes often with regions that taper away to nothing, and such regions are traditionally very difficult to mesh. CADfix handles this situation perfectly, and quite simply we couldn't manage without it."

The boost in productivity means that Holset's engineers can spend more time performing analyses and interpreting their results. This not only means that the final products are better engineered, it also allows more time for R&D.

Variable Geometry Turbocharger

Perhaps the most obvious example of Holset's development program – and certainly one where CADfix had an important part to play – is in the company's patented variable geometry turbocharger (VGT) technology.



Variable geometry turbocharger

Turbocharger technology has certain limitations, particularly at higher performance levels; for example, as air pressure rises, the operating range (and therefore the usable engine speed) is reduced. This leads to the use of more ratios in the gearbox and more gear-changing work for the driver. Turbo-lag is also increasingly obvious when operating at higher pressures.

Holset's ingenious solution to this problem is a turbocharger whose geometry can be changed in situ. An electronic control system governs the configuration of a surprisingly simple assembly with few moving parts – an important factor in such a hostile environment.

The effect of altering the size of the turbine according to the demands of the engine is that vehicle acceleration can be improved at low speeds, turbo-lag can be significantly reduced, and "engine braking" power can be increased. Furthermore, VGTs can be used in smaller engines resulting in lower fuel consumption, fewer gear shifts and lower, more controllable emission levels. Finally, the ability to adjust the VGT's characteristics throughout an engine's life means that performance can be maintained for longer and that emission levels in older engines can be more carefully regulated.

"I suppose it is fitting that CADfix has helped us with our variable geometry technology," says Mike Eastwood. "Our renewed efficiency should mean that we have more time for this kind of development work and we can continue to build on our reputation for innovative engineering design."

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