



CAE Calculation for Manufacturing Tolerances

Client

Europe's biggest carmaker, Volkswagen Group comprises 12 leading brands and has annual group sales revenue (2013) of €197 billion; its Kassel plant manufactures 3.5 million exhaust systems per annum.

Challenge

Identify possible improvements within a transmission to make the manufacturing process more robust, while optimising product quality.

Solution

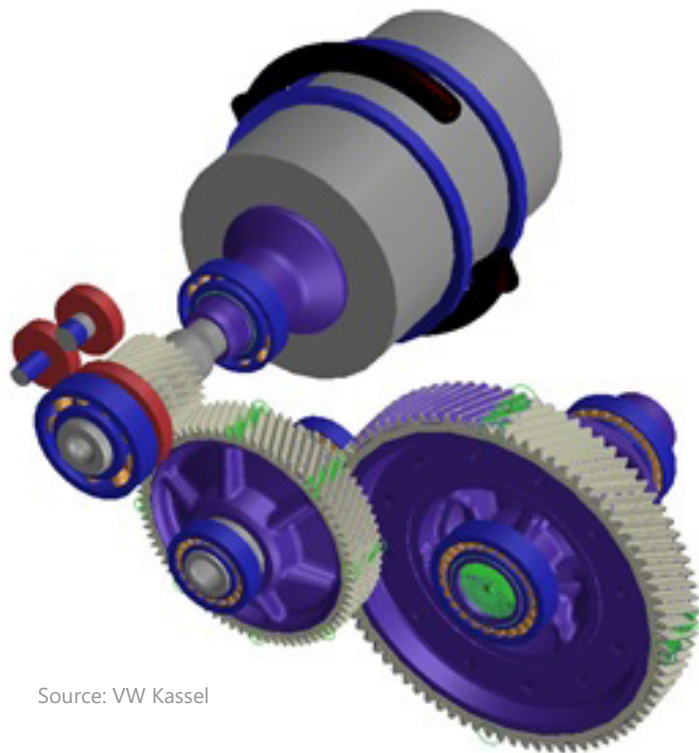
Romax software to support reliability-based design optimisation of gears; a flexible tool for modelling, simulation and analysis.

Benefits

Providing a whole-system approach, identifying changes and improvements to transmission and gearbox design to help optimise manufacturing and production costs, further support product quality, and address issues including NVH (noise, vibration, harshness).

The Volkswagen Group is one of the world's top automobile manufacturers and the largest carmaker in Europe, delivering almost 10 million cars to customers each year. This corresponds to a market share of the world passenger car market of almost 13%. Employing over 15,000 people, Volkswagen's primary transmission site at Kassel supplies almost four million manual and automatic transmissions every year, and includes Europe's largest light-alloy foundry to produce aluminium and magnesium housing components. The Kassel plant also reconditions old engines and gearboxes, and manufactures 3.5 million exhaust systems each year.

Volkswagen engineers at Kassel have used Romax software to support transmission manufacturing for more than four years. "It's important for the effective manufacture of gearboxes that you use a process that is not too costly", says Juri Kniss, Berechnungsingenieur (Calculations Engineer) at Volkswagen AG. "Some parameters are cheap to control, others are expensive. We want to look at all these parameters and examine the influence of variations in the production process. Romax provides the ability to look at the whole system, rather than individual components alone."



Source: VW Kassel



“With Romax software we can assess the effects of gear manufacturing variability within a fast and accurate simulation”

Juri Kniss

Calculations Engineer, Volkswagen Group

Reliability-based design optimisation

Volkswagen Group comprises 12 brands from seven European countries: Volkswagen Passenger Cars, Audi, SEAT, ŠKODA, Bentley, Bugatti, Lamborghini, Porsche, Ducati, Volkswagen Commercial Vehicles, Scania and MAN. Almost one in four new cars (24.8%) in western Europe are made by Volkswagen. At its Kassel plant, engineers use Romax software on a range of standard and non-standard investigations to support the effective production of manufactured gearboxes and to ensure the required quality has been achieved.

“We’ve used Romax software for more than four years,” says Kniss. “As a factory site, our focus is not to design gear sets, it’s to ensure the gearboxes we manufacture are consistently of the required quality. With Romax software we can assess the effects of gear manufacturing variability within a fast and accurate simulation.” He describes Romax software as “an important element in a ‘tool chain’ that includes other less specialised Computer Aided Engineering (CAE) packages.” In this case, engineers at Kassel use Romax software to analyse existing designs and assess how the tolerance variability of gear microgeometry will impact on the NVH of the finished gearbox. “Romax allows us to do this by integrating rapid modelling and analysis of gears, shafts, bearings and housings within a single gearbox model to predict how components interact with each other.

“We have also recently used Romax software to predict bearing preloads required for a new EV gearbox, which we achieved by calculating the interaction between three shafts and the electric motor,” Kniss explains, “and to look at which rings to mount in the factory. The housing hasn’t a great degree of stiffness, leading to complex interactions. So we want to change the bearing preloads and see the effects, to identify the correct settings to use when manufacturing the gearbox. To validate the methodology we set up a test rig to compare results and were able to see that Romax provided a good validation.”

Stator interference

As part of the same project, Romax software was also used to analyse the fit between the motor stator and the gearbox housing, to predict any housing deformations and the resulting effects on the gears and bearings.

During the gearbox assembly the stator is fitted into the housing. This results in an interference fit and a degree of deformation of the housing, which causes some displacement of the gearbox bearings. The interference fit was modelled externally and the bearing displacements then applied as preloads to the Romax model. “In this case, we had a highly detailed model that we could apply to all of the bearings, to examine the effects of the interference fit,” Kniss says, “with different shaft misalignment predictions being evident along with different contact patterns for most of the gear sets.

“We took the Romax misalignment predictions and passed them to our colleagues in Wolfsburg to support optimisation of the gears, so they could apply this to calculate new micro geometry, to reduce noise and improve durability etc.,” states Kniss.

A whole-system approach

Summarising their analysis work to date, Kniss adds, “The main benefit of using Romax software at the Kassel transmission plant is that we can build complex models that reflect the whole system, and we get good results. We can build several models if needed and use Romax to predict the effects of different tolerances so we can work out which ones we should focus on.”



Source: emobility driveline



Since the time of writing this case study, the Romax product offering has evolved. The features and benefits described here most clearly map onto our new product Enduro and Spectrum.

To find out more

contact us via marketing@romaxtech.com
or visit www.romaxtech.com
or www.volkswagen.co.uk