CETIM – Technical centre for mechanical industries

Innovating in mechanics: CETIM uses RomaxDESIGNER to help clients avoid gearbox failure

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Alexander Vadnal,
Design Engineer - Power Transmission
CETIM

France’s CEntre Technique des Industries Mécaniques (CETIM) was created in 1965 to help mechanical and engineering companies gain new ways to speed up technical progress and so improve business performance, with stronger links between scientific research and industry helping improve product quality and competitiveness. Today, CETIM employs 700 people at three main sites at Senlis, Nantes and Saint-Étienne, plus four regional offices and two overseas subsidiaries. To better support client needs in transmission, notably through failure analysis and redesigns for optimized gearboxes, the organisation has used Romax software since 2012.

“Our mission is to link academic research with its practical application in industry,” says Alexander Vadnal, Design Engineer - Power Transmission. “In effect, we’re a pool of specialist resources and technical skills - and innovating lies at the heart of our strategy.” For power transmissions, key activities include on-site instrumentation, failure analysis, test bench engineering, and working to optimise the gearbox design and redesign through to turnkey prototypes.

Client

France's Technical Centre for Mechanical Industries bridges the gap between scientific research and the practical application of new technologies and approaches in industry; with 700 employees, they produce an annual turnover of €115 million euros.

Solution

RomaxDESIGNER software provides a 'whole-system' approach within a single easy-to-use tool, including advanced modelling, simulation and analysis capabilities, and extending to dynamics and NVH issues.

Challenge

Ensuring a strong link between the latest scientific research/technical developments and their practical application to benefit industry and commerce, as well as continuing to enhance CETIM's internal expertise and capabilities.

Benefits

A more powerful 'global approach' in analytics means CETIM can better support diverse mechanical and engineering clients in design, development, testing, failure analysis and optimization via redesign of transmission and gearboxes – helping those organisations save money, improve operations and enhance business performance.

"We first used RomaxDESIGNER for failure analysis, and that remains our main use," says Robert Shandro, Failure Analysis Specialist – Power Transmission. "We can collect all the clues, understand what happened, then propose some form of design evolution to contain the failure or suppress the risk of failure."

Why Romax?

"We use RomaxDESIGNER to identify causes of failure through simulation: to reveal the origin, build more effective predictive models, explore what went wrong in the design, and so propose modifications and improvements." Vadnal says, "Failure analysis should identify the precise areas you need to focus on to improve a product. Because you can have many different types of failures – lubrication problems, incorrect dimensioning, other design oversights – you need to be able to analyze the real working conditions of a transmission. The main reason we chose Romax was that it enabled us to analyze a problem or failure using a 'whole system' perspective - taking the entire system into account, including casing. You can also explore problems around dynamics, looking at noise and vibration, while always including the complete environment." RomaxDESIGNER has, over time, provided CETIM with faster and more accurate results relating to: modelling of bearings; internal geometry, non-linearity, preload and clearance; gear mesh simulations; micro-geometry, shafts and deflections; impacts on load distribution and misalignment; influence of the environment; housing and stiffness; and analysing complex load cycles.

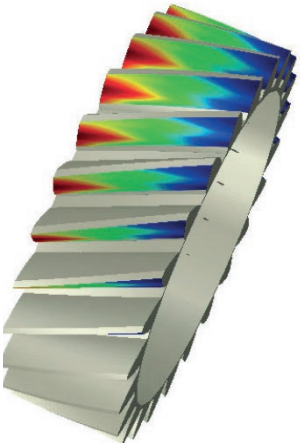
Innovation in action: reducing gear damage and costs

Shandro and Vadnal provide an example of how CETIM expertise and Romax software led to measurable benefits for a client. CETIM became involved with a scientific research vessel that was experiencing alarming vibration problems from its 2.2metre-span twin-motor drives, used for two 3.9m propellers. "Vibration levels were extremely high, up to 25mm/s RMS on some bearings when the recommended level was 10mm/s RMS," Shandro says.

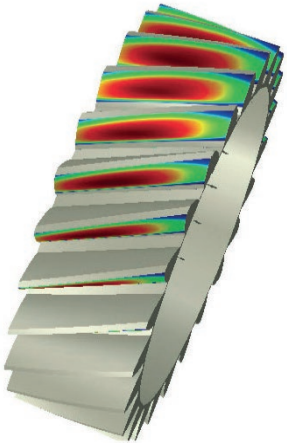
The subsequent damage on the gears and bearings meant a new gearbox had to be installed every three months. In addition to the cost of replacement parts, each day the vessel is immobilized in port costs the operators €200,000. "They'd replaced gearboxes three times when they called and asked if CETIM could help. So, we did our failure analysis at scheduled stops, observing and assessing gears, bearings and shafts in the first gearbox in Trinidad and Tobago, and the second in Curaçao. After Romax analysis, we met to discuss options."

The first and most difficult option was completely changing the gearbox, including the design. The second, also complex, was changing the casing design to make it stiffer. The customer, however, wanted a quick solution. "The third option was to modify the micro-geometry of the gears. Our calculations found the gearbox casings weren't stiff enough, causing deformation that changed the position of gears: the main cause of failure. We could prove this to the customer, with our Romax analysis alongside photographs, contact patterns and measurements showing the same deformations of 0.5mm: very significant for this type of gear." CETIM's modifications reduced vibration from 25 to 3mm/s RMS – "by a factor of 7-8 times, clearly a major success. Before our help, the vessel was lucky to last six months before replacing a gearbox. Following our work, the engines and gears have run non-stop for over 18 months."

Vadnal concludes, “As for future plans with Romax, we’re interested in focusing on dynamics and exploring NVH, initially as an internal project. To summarise, it’s really the ‘global’ approach that makes all the difference and having all those capabilities in a single tool. We can combine a whole-system view with component-level detail if we wish. We gain time and reduce errors.”



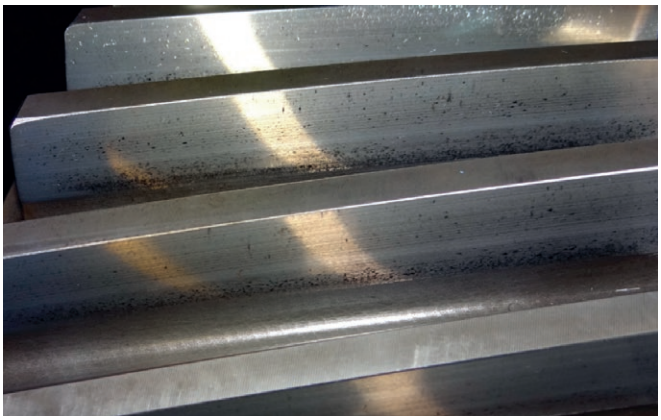
RomaxDESIGNER highlights poor gear contact pattern



Applied micro geometry improves gear contact pattern in simulation

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 products Romax Enduro and Romax Spectrum.

Gear suffering tooth breakage



Redesigned gear still performing well after 2 years

Hexagon is a global leader in sensor, software and autonomous solutions. We are putting data to work to boost efficiency, productivity, and quality across industrial, manufacturing, infrastructure, safety, and mobility applications.

Our technologies are shaping urban and production ecosystems to become increasingly connected and autonomous – ensuring a scalable, sustainable future.

Romax, part of Hexagon's Manufacturing Intelligence division, provides world-leading solutions for the design, analysis, testing and manufacture of gearboxes, drivetrains and bearings. Learn more at romaxtech.com. Hexagon's Manufacturing Intelligence division provides solutions that utilise data from design and engineering, production and metrology to make manufacturing smarter.

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