

Romax Consultancy

Delivering engineering excellence to the
global transmission industry

"Our innovation today; world's mainstream tomorrow"

Dr S. Y. Poon, CEO and Founder

With over 19 years experience at the forefront of driveline and gearbox design, we offer our clients expert engineering consultancy and conceptually advanced software. As market leaders, we have the depth, scope and experience to ensure your company excels in these areas.

We work alongside the most prominent engineering companies in automotive, aerospace, wind, off-highway and rail industries. In addition we work with cutting edge start-ups who are looking to gain market share. Our expert team has a tailored and flexible approach, working closely with our clients to meet their individual needs.

Industry Applications

Automotive

- Road load data acquisition and duty cycle condensation/definition
- Design more reliable and quiet transmissions, drivelines and axles
- Technology transfer for transmission design and development
- Design and optimisation of hybrid drivelines
- Testing rig design and supply
- Identify root-causes of transmission and driveline noise by analysis and testing
- Solve synchroniser performance and durability problems
- Supply end-of-line NVH quality testing systems
- Manufacturing process audit and improvement

Aerospace

- Predict bearing behaviour under extreme load and climate conditions
- Analyse high speed dynamic effects for gears and bearings
- Reduce transmission vibration levels through full system dynamic analyses
- Optimise gearbox weight without compromising durability

Wind turbines

- Design reliable gearboxes to meet life-time targets
- Understand and benchmark operating load and extreme load conditions
- Improve bearing choice by unique prediction of system and component behaviour
- Wind turbine large bearing design, analysis and troubleshooting
- Detailed investigation of wind turbine drivetrain failures, especially on gearboxes and bearings

Off-highway

- Bearing selection for heavy duty hydrostatic and powershift transmissions
- Predict system and bearing behaviour under mis-use conditions
- Improve bearing choice by unique prediction of bearing behaviour
- Analyse engine geartrain dynamics to improve durability and reduce engine noise
- Accurately predict gear misalignment conditions in-service

Industrial equipment

- Design for improved reliability in process machinery, material handling, power take offs, speed reducers and production line equipment
- Improve accuracy of high precision machinery by understanding and predicting system and component deflections
- Reduce fatigue failures in gears, bearings and shafts caused by vibration
- Reduce failures in gears and bearings due to precise prediction of in-service misalignments
- Meet strict environmental noise targets

Consumer and office appliances

- Improve product quality by reducing unwanted deflections
- Predict changes of working accuracy over a product's lifespan
- Increase product quality by reducing gear noise and vibration
- Simulation of complex arrangements of shafts, gears and bearings to assess complete system durability



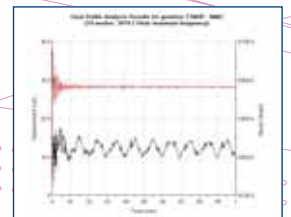
Advanced non-linear analysis of wind turbine pitch bearings



Full dynamic model of an automatic transmission



Example of an aerospace auxiliary drive gearbox



Gear rattle simulation



Drivetrain Eigen frequencies



Vehicle drivetrain analysis

Romax Consultancy Expertise

Expert team

Our strength lies in the ability to leverage the exceptional talents of our senior technical specialists for the benefit of our clients. Our outstanding Engineering Team is our greatest asset, comprised of an unrivalled combination of advanced academic expertise and real-world engineering experience. This highly resourceful team drives innovative solutions for your products.

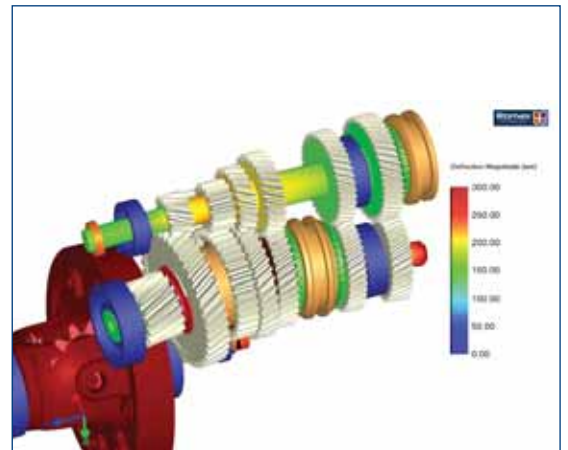


Some of our expert consultants

Complete service

We consistently apply an integrated approach across all that we do – it drives our design and analysis of drivelines and transmissions and is the foundation of our approach to consultancy. We offer our clients a truly complete consultancy service from product design, through product development to manufacturing methods. Successfully completed projects include:

- turnkey design and development
- design auditing
- virtual prototyping and refinement
- technical support
- onsite implementation of development processes



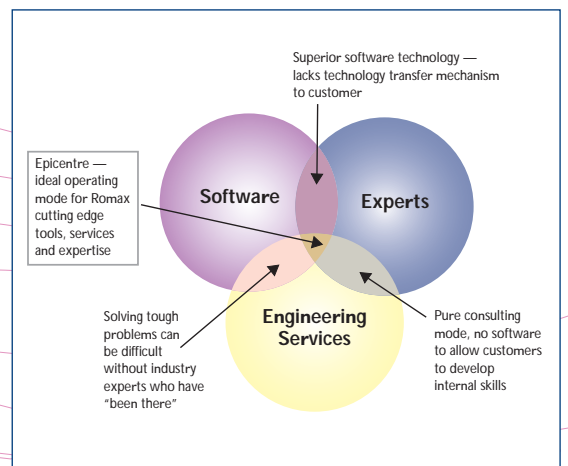
Example transaxle in deflected shape

Technology transfer

Working alongside our Engineering Team will provide you with much more than just short term gains for the project. We cascade our knowledge and experience to you to empower your engineers with cutting edge proficiency in design and development. The long term benefit has been confirmed by existing clients, who have realised sustainable growth achieved through this transfer of advanced, practical technology.

Market leading software

RomaxDesigner is the world's most complete virtual product development environment for the design and optimisation of transmissions and drivelines. Its integrated approach speeds up the design evolution process – reducing costs and time to market and therefore increasing your competitive advantages in the market place. Our engineering experts use this advanced software to meet clients' needs as part of our consultancy service.

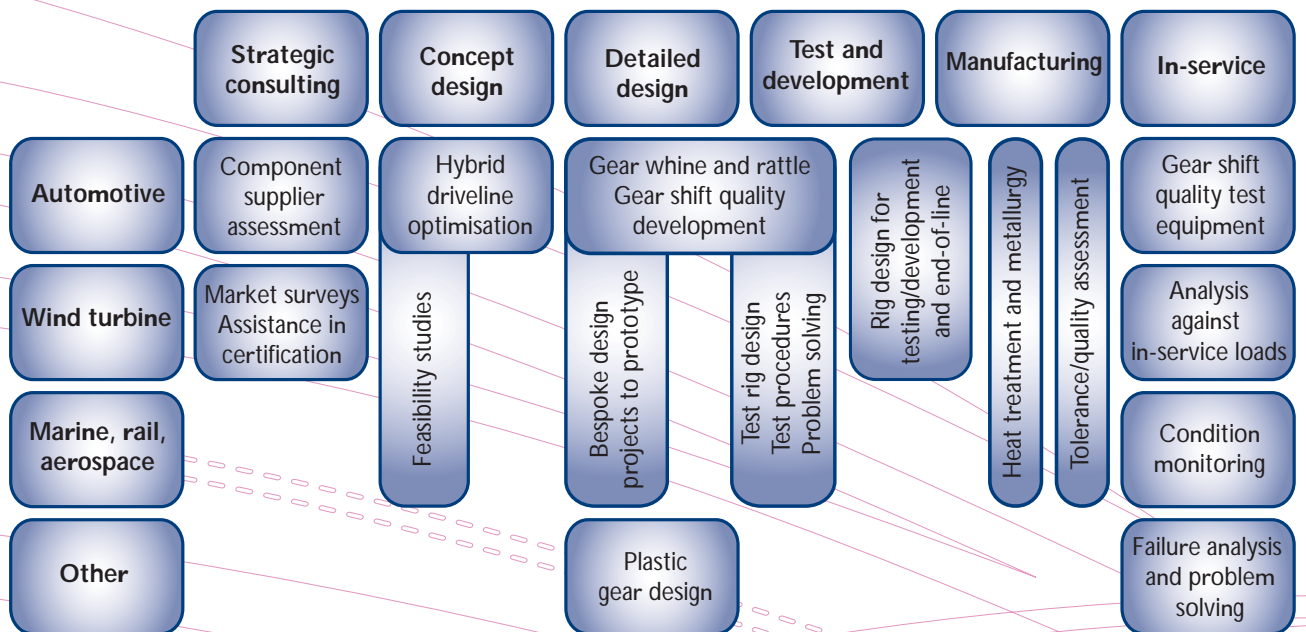


Cutting edge tools, services and expertise

Worldwide

An expanding global presence enables us to co-ordinate engineering programmes locally through our offices in UK, China, Germany, India, Japan, Korea and USA. Provision can be made for our engineers to work onsite or, alternatively, for groups of client engineers to work alongside us at the Head Office in the UK.

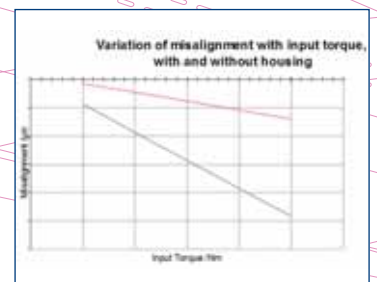
Delivering Engineering Excellence...



Benchmarking

All companies recognise the need for benchmarking competitors' products, but often this is done in a way that risks blind duplication without truly understanding the product being benchmarked. We have developed innovative techniques that give you a true understanding of the product and its merits:

- Dimensional measurement of components and modelling in RomaxDesigner
- Extraction of key performance and non-dimensional parameters relating to deflection, durability, NVH and efficiency
- Extraction of parameters for each stage of the product life cycle (concept design, detailed design and so on)
- Process for comparison against other transmissions to identify the sources of differences
- Efficiency, NVH and shift quality testing
- Experience-based critique of design features

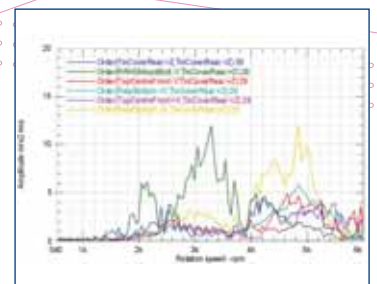


Example of data extracted by analytical benchmarking

Technical support

We offer a technical support package tailored to your needs which allows direct access to technical experts in a number of transmission related fields. This enables you to realise the maximum benefits of our products such as:

- technical support
- technical seminars
- onsite troubleshooting
- assistance at third party meetings
- staff training



Example of vibration measured from transmission during Romax testing

Dynamics

By combining our world-leading analytical capabilities with a team of consultants who have years of experience carrying out dynamic tests of transmission systems and problem solving, we offer:

- measurement equipment for loaded transmission error and end-of-line NVH performance
- gear rattle testing and problem solving
- understanding driveline transient behaviour through correlating test and analysis data
- problem diagnosis through processing of test signals and noise source elimination
- condition monitoring and problem detection through vibration measurement and analysis

... Throughout the Product Lifecycle

CAE analysis

We use state of the art analysis tools to assist in the design and development process for transmission systems. CAE analysis provides a robust, accurate and low cost method of assessing product design as an integrated part of the product development cycle. Our CAE toolkit includes the full suite of RomaxDesigner software and Finite Element (FE) packages.

- Transmission system analysis to nominal or measured in-service loads
- Non-linear system response to static loads and dynamic/shock loads
- Optimisation of component detailed design for durability, noise and manufacturing
- Sensitivity of product performance (durability, NVH and so on) to variations in manufacturing tolerances
- Component FE analysis for stiffness, structural integrity, durability and dynamics

Turnkey design projects

As the worldwide demand for geared mechanical systems increases, transmission manufacturers are facing the dual challenge of reducing time-to-market, while simultaneously delivering durable, quiet, efficient, and affordable products to their customers. We use an adaptable, risk-based process to create technically proficient and practical designs within the accelerated timeframes. The key strengths of our engineers are the ability to use:

- risk assessment techniques to define robust development processes
- highly advanced analytical tools to reduce risk in the initial design stage
- experience-based project management processes and procedures

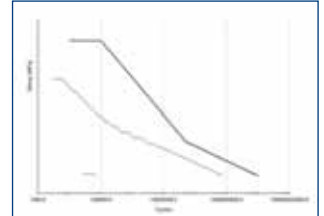
Development, manufacturing and in-service support

Our engineers have a vast wealth of experience in developing and manufacturing transmissions and supporting them in-service. This real-life experience provides an essential contribution to our design projects and also allows us to provide services that extend to cover the whole product life cycle, including:

- supply of test rig designs, test procedures, test programmes and problem solving methodologies
- transmission development programmes and problem solving
- setting component tolerances that are suitable both for manufacturing and product performance
- production line quality assessment and troubleshooting



Experience based design assessment



Durability analysis to full in-service duty cycle



Understanding the effect of manufacturing tolerances on the variation of housing vibration

Case Study: Feasibility Study and Upgrade Design Project for Global Passenger Car Manufacturer

The issue

A global car manufacturer approached Romax as they wanted to upgrade their current 104Nm transmission for a passenger car to be used with a higher torque engine. The client wanted to determine whether it was feasible to upgrade the design for use with a 120Nm engine.

The approach

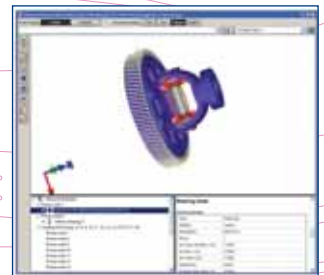
We initially carried out a feasibility study into the transmission upgrade which involved RomaxDesigner being used for gear and bearing durability analysis to ascertain whether this was feasible. We used their advanced software to optimise the gear macro-geometry to balance the gear bending and contact lives. We also optimised the casing design for stiffness and ease of manufacture. We then optimised the gear micro-geometry to minimise transmission error and maximise durability in the new design.

The results

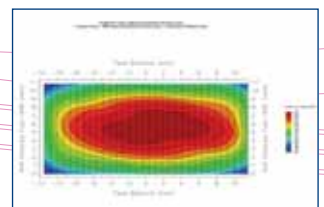
Romax's feasibility study modelled the design of the current transmission and highlighted areas where improvements and optimisation were possible. Based on the results and confidence gained from the feasibility study Romax then carried out the upgrade design project for the transmission.

Conclusion

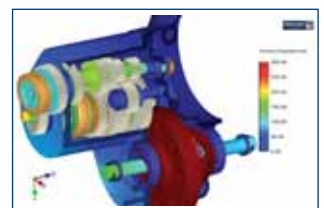
After the revised heavy duty design, the prototype of the 120Nm transmission was tested successfully and released in its country of manufacture. The new transmission is being adopted by the worldwide corporation and is now being manufactured in several global sites in units in excess of 1 million per year.



FE differential cage within RomaxDesigner



Tooth contact plot



Deflected transaxle with housing

Dual Clutch Transmissions

Dual Clutch Transmissions (DCTs) are currently seen as the crossover technology that will convert a large proportion of car owners from manual transmissions to an automatic transmission, especially in Europe & China. The technology allows the driver to use the transmission as a clutchless manual or a full automatic. There are only a select few volume producers that have introduced this technology but many more companies are looking to develop DCT technology.

Capabilities

With our experience and knowledge of the current range of DCTs under development and in production, we are able to investigate possible solutions quickly and accurately. Our software suite RomaxDesigner generates transmission models to allow the durability, ease of assembly, mass and cost to be compared while our engineering team offers the knowledge and experience to ensure accurate analysis and design success.

We provide detailed analysis of each option, including gear misalignment using our predicted shaft and bearing deflections. This is fundamental when developing and assessing the complex bearing arrangement on the concentric input shafts.

Basic bearing selection and investigation cannot be carried out by conventional "hand" calculations and RomaxDesigner provides the capabilities, speed and accuracy that major bearing manufacturers rely on. It is our knowledge and specialist tools that provide the insight that allows our clients to excel.

Romax offers:

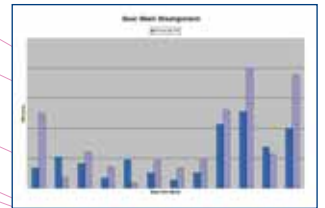
- specialist engineering team experienced in DCTs
- large range of design options produced at speed
- accurate benchmarking against other DCT systems
- in-house library of material fatigue properties to provide reliable analysis
- proven methodology for duty cycle assessment
- technical advice on all issues that affect transmission systems
- expert analysis of data which provides a reliable basis for design selection
- investigation of transient and dynamic effects
- transmission expertise



Complex loaded deflection of DCT input shafts



DCT model created by Romax as part of a customer's design project



Comparison of misalignment against benchmark transmission for concept selection

Case Study: Training on Bearing Analysis and Theory for Global Bearing Manufacturer

The issue

A global bearing manufacturer was looking to introduce new bearing products to the market for varied applications. However, the engineers using their software simulation and analysis tools to judge bearing durability and performance lacked the fundamental understanding of the theory behind the analysis. Without this they could not make experienced judgements on the results or assumptions made during calculation in order to optimise the new product designs for advanced performance and durability.

The approach

The bearing manufacturer's engineers were already using RomaxDesigner's advanced bearing capabilities and could see the benefits to be gained by working closely with Romax. There was a need to develop the theoretical knowledge within the bearing company to ensure they had the necessary understanding to develop new products and compete with other major bearing suppliers. We provided training on the fundamental theory of bearings starting with deflection, loading, stress and fatigue life methods. More advanced subjects followed such as friction, roller skew and misalignment. Our team of manufacturing specialists, each with over thirty years experience in production and metallurgy for bearings, provided seminar sessions on more practical aspects involved with bearing technology such as heat treatment, manufacturing processes and inspection. Overviews of bearing failure modes and testing practices were also covered.

The results

The training also focused on application case studies so the engineers could relate the theory they had learnt to bearing analysis in practice. RomaxDesigner software was used by the trainees to create system models from different applications, such as manual and automatic transmissions and wheel bearings. The trainees were given the opportunity to develop confidence and experience to discuss knowledgeably with their engineering customers any bearing performance issues related to these applications.

Conclusion

The engineers that have undergone the training have integrated back into their design and research teams and are making a significant contribution to the development of new products and enhancing the company's analytical skills. The benefit of the training has been quickly seen by the management and regular groups of new engineers have been coming to the UK to benefit from the knowledge transfer services and advanced expertise that Romax offers.



Bearing analysis and theory training at Romax

Hybrid Drivelines

In the last few years, as awareness of environmental issues has grown, consumers' interest in buying and driving 'greener' cars such as hybrids has also grown. This ethical enthusiasm has been in addition to the increasing requirements of CO₂ emissions legislation, however, it may still not be sufficient to increase the hybrid vehicle share high enough to reduce the impact of the overall car fleet on the environment.

To also be attractive to wider consumer groups such as American SUV drivers and Indian economy car owners, hybrid vehicles must not only be the ethical choice, but must also become the most economical choice.

While hybrid engines offer significant reductions in fuel consumption and emissions which makes them more economical to run, and manufacturers can enjoy a smooth transition from a conventional driveline, the comparison and rating of hybrid drivelines currently presents many challenges which keep the price of hybrid vehicles higher than conventional vehicles.

The results

- Hybrid drivelines must be fully optimised to achieve their potential and provide full benefits
- This optimisation must take place at both the driveline level and at the subcomponent level
- Variety of operation modes (including reversed energy flow in recuperation) make hybrid systems complex
- The huge number of possible driveline structures makes finding the right solution time consuming

Today's solutions

The conventional approach to hybrid vehicle development involves running many variation simulations to see the fuel consumption in all relevant scenarios. This time-consuming and costly approach can be avoided through understanding the affect of internal mechanisms on fuel consumption.

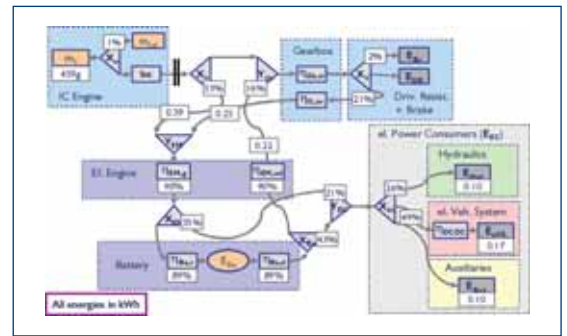
Our approach

The RomaxHybrid approach involves running a minimal set of simulation runs for representative scenarios. The subsequent analysis enables the understanding and prediction of system behaviour in a wide range of different scenarios. We can support the rating and selection process of hybrid configurations through the following services:

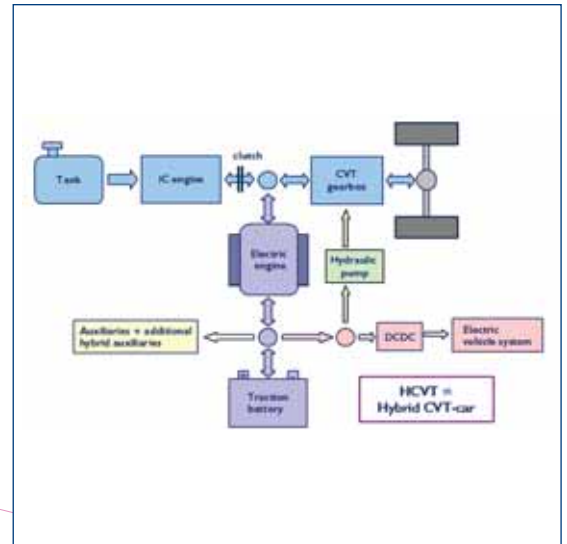
- Comparison of energy flow diagrams
- Component or function-wise comparison of efficiencies with their sensitivities
- Information about the optimisation level
- Fuel impact table for different components or functions, explaining the different fuel consumption
- Driveline simulation and energy flow analysis
- Hybrid configuration rating using energy flow analysis
- Early gearbox feasibility studies of durability and NVH
- Gearbox efficiency optimisation
- Investigation of transient and dynamic effects

Benefits of using RomaxHybrid

- Support for the selection of best hybrid driveline layout
- Hybrid concept evaluation and sensitivity studies
- Optimised system efficiency
- Optimised gearbox in hybrid drivelines
- Support for innovation in hybrid concepts



A new approach of analysing energy flow and efficiency in hybrid concepts



Driveline configuration rating using energy flow analysis



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About Romax Technology

Romax Technology offers integrated solutions for noise, vibration, harshness [NVH] and bearings analysis through software tools, process, training and engineering services to major OEM and Tier 1 suppliers in the automotive, aerospace, wind energy, industrial equipment, rail and marine industries around the world.

The company's pioneering full-system flexibility and integrated software package encompasses 20 years of development and benchmarking in partnership with major OEMs and extensive research in conjunction with top academic establishments. Romax's customised and 'off-the-shelf' software provides customers with the tools for 'right-first-time' transmissions and driveline design and analysis.

Romax Technology's engineering teams are integrated with its advanced transmission software development and service offerings include benchmarking, concepts generation, issue investigation and resolution, analysis and detail design through to production. Romax offers agile issue resolution with a flexible team approach dedicated to individual projects with execution available remotely in the UK or locally with the customer.