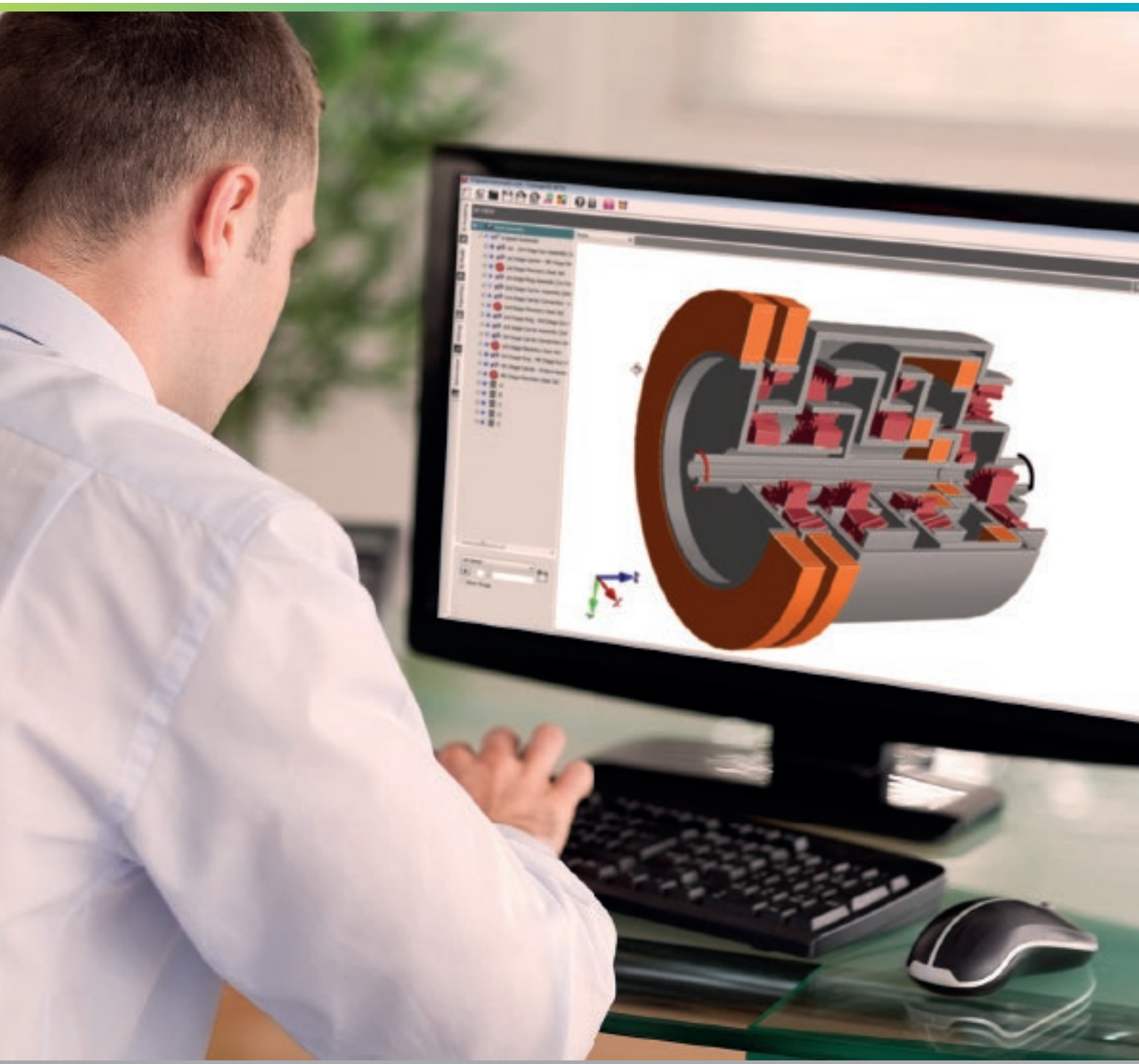
HEXAGON | Romax TECHNOLOGY

White paper

Right First Time: optimising designs at planning and concept stages

Gaining new capabilities to select the right options in product planning and concept design – to more successfully underpin future design, development and manufacturing



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Introduction

While detailed design processes have been successfully improved in recent years, notably through CAE technologies, the concept stage still offers significant scope for improvement. In the intensive period at the start of development, the imperative is to ensure quality and rigour in product planning and target setting, followed by speed and focus in assessing the best concept design options - all of which drive the ultimate success of a product. If choices made at the planning and concept stages are wrong, they can be difficult and costly to fix later. This means high quality concept design is essential for the entire process to continue smoothly and cost-effectively. However, serious flaws and missed design opportunities continue to be revealed too late in driveline design and development to correct easily. Even worse, such issues might only emerge after a product has gone to market, requiring expensive warranty intervention.

The ability to reveal, explore and resolve issues far earlier lies behind Romax's Right First Time approach. To focus on the key issues, balance multiple criteria and requirements and support more informed decision-making on the options available, Romax applies powerful and appropriate modelling and analysis software earlier, together with improved processes. This ethos aims to create higher quality and more innovative driveline products, bringing them to market at lower cost than previously thought possible.

Focus on critical design issues earlier

Imagine optimising gear ratios in seconds rather than days, or providing housing designers with accurate bearing force information to finalise housing designs far earlier? Concept design is a stage when you can truly innovate. Adopting the Right First Time approach as early in design and development as possible will, in simple terms, enable more focused, rapid and accurate gearbox concept modelling and analysis, with improved processes and fewer errors, achieving higher product quality at lower overall development costs. Risks can be better understood and controlled, with innovation fostered through greater visibility and collaborative working.

'A landscape for innovation'

Concept design offers driveline engineers, designers and analysts a genuine landscape for innovation. Armed with knowledge of the performance of earlier designs, and the capacity and capabilities of existing manufacturing processes, the complete design space is available. So what's holding you back, given that virtually anything's possible? From here onwards, every decision brings an associated constraint and risk – or benefit. This is why robust validation through effective analysis and simulation is so important. The reality is that, until recently, a more rigorous and appropriate approach to modelling, analysis and decision-making has not been possible at the product planning and concept design stages.

The opportunity:

- Reduce rework and speed up time to market: assess many more design options more quickly and efficiently
- Improve accuracy: eliminate errors caused by data re-entry between multiple software packages
- Work more productively, make more informed decisions and reduce the demands on expert engineering resources
- Perform component sizing and selection as part of a professional engineering toolset, rather than in-house manual approaches like spreadsheets

Barriers to success

The limited nature of analysis tools used in product planning and concept stages means problems and errors are discovered at a later stage - detailed design, prototype testing or even manufacturing. The cost of rectification later, and especially as part of a warranty exercise, can be extremely expensive. Of course, some errors may arise later in the process, but many are locked-in at an early stage.

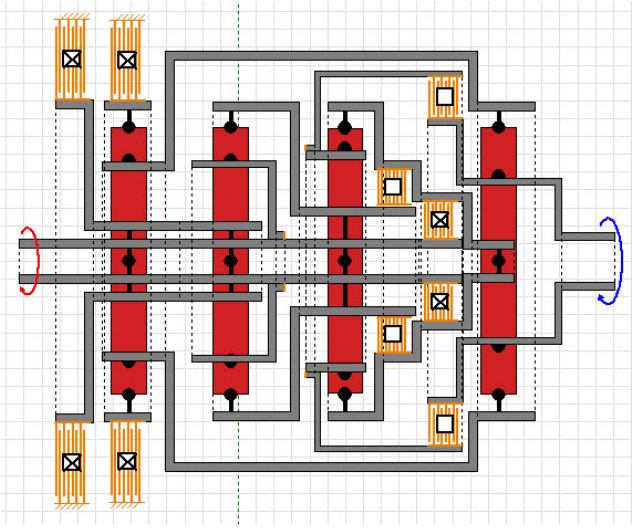
A fragmented approach

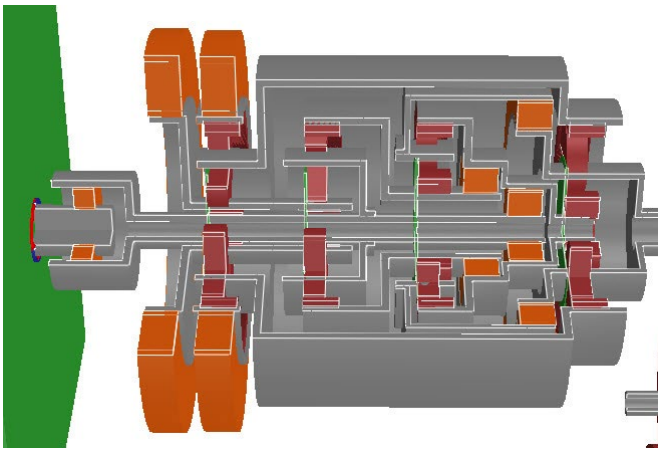
Concept design is, for good reason, typically led by the most experienced and capable engineers, but has also tended to rely on a fragmented process, with siloed teams and inadequate tools. Even at the concept stage, designers should be considering and balancing issues of, for example, shaft and gear layout and centre distances, gear and bearing sizing, housing loads and packaging constraints, as well as manufacturing processes and operational outcomes of performance and noise and vibration (NVH).

Today, this normally means using a wide range of disconnected systems, processes and ad hoc methods, from manual calculations and spreadsheets to computer aided design packages of varying degrees of quality – and in which successive iterations are typically required. Such an approach inevitably creates bottlenecks in data translation, while interpretation errors can be a frequent occurrence. In addition to the process fragmentation within the organisation, such bottlenecks are even greater between OEMs, system manufacturers and component suppliers who should be able to exchange data during the product development process. Once again, we see constraints imposed on the process due to the inflexibility and lack of openness offered by the tools and technologies available; it is crucial for open data exchange to be possible between concept design, CAD and detailed design tools.

Risk-averse designs: stifling innovation?

Another factor is that concept designers and engineers may feel the need to exercise an unusual level of caution in their efforts to innovate, limiting the potential of the design in order to avoid risk of failure at a later stage. Indeed, in addition to leading to longer product development time scales with inevitably higher costs, such a risk averse/over-constrained design approach typically results in low innovation output at a time when competition for low cost, innovative, high reliability and high efficiency drivelines is increasing.





Automatic Transmission

Take a different approach

"Analysis and simulation early in the design process led to 90% of products meeting quality and cost targets and on-time launch." - Aberdeen Research

The design, operational and process benefits of adopting a strategy of early simulation within the design and development cycle were investigated in a research project carried out by Aberdeen Research (2010). This demonstrated across a range of companies that performing analysis and simulation early in the design process led to 90% of products meeting quality and cost targets and on-time launch. Similarly, the avoidance of many design issues that would otherwise have been found later in the process, where rectification is more difficult and costly, led to a 6% reduction in production cost - and a margin improvement of greater than 15% for products in their first two years in the market.

The message is: model early, and model appropriately

The results presented by Aberdeen Research concur with the experience of Romax engineers in the field and of our customers. The point is simple: the key elements that can enable future opportunity and success in driveline design and development are precisely the same key elements that represent major shortcomings in most current concept engineering approaches. For example: how to deal with a fragmented and siloed approach that inevitably creates serious bottlenecks in the process. In pushing the computer aided engineering (CAE) tool chain right back into the concept engineering stage, Romax engineers have shown that effective and appropriate (i.e focused and targeted) simulation at this point acts as a spur not only for innovation but also for practical problem-solving. This approach has a ripple effect on product quality that extends right through the later stages of design and development, right through to manufacturing. Engineers can better evaluate and so optimise design choices in terms of key measures such as quality, performance and cost. Just as important is the ability to work from an integrated platform and a shared frame of reference to exchange ideas, share design and results data, to not only support innovation through collaboration but also minimise the risk of interpretation errors caused by standalone 'islands of analysis'.

Focus even earlier: product planning and target setting

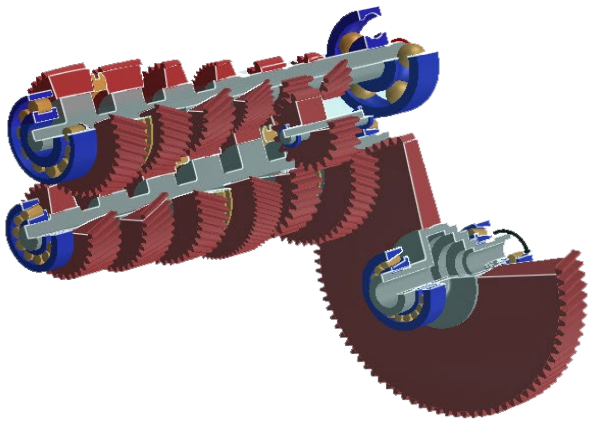
Even prior to any design work, applying a similar approach means engineers and designers can have greater confidence that the targets and specifications agreed and set for a product are as competitive, challenging and innovative as they need to be, while still being realistic and balancing key criteria around quality, performance, robustness and cost-to-manufacture. By using powerful analysis and simulation methods at the product planning and target setting stage, more robust and sophisticated comparisons can be made with, for example, the performance of previous designs and with competitors' products. In this way, the parameters of the product specification can be optimised and so targets set in an informed and intelligent way. Even before the design process formally begins, conditions have been set to maximise the potential for a more innovative, high quality and so highly competitive product to emerge.

Use the right tools for the job – at the right time

Modelling and analysis specialists can be difficult and expensive to source, and retain in the workforce. These highly skilled individuals should ideally be focused on the most challenging and important tasks. Analysis methods and CAE simulation software have continued to develop and become more sophisticated, however, the level of specialist skill and expertise required has tended to be reduced. This means that the latest generations of designers are entering the drivetrain workforce with high expectations of smarter design tools and only a limited hands-on experience of specialist analytical skills.

Today, small and specialised teams typically handle analysis projects. However, channelling all analysis requirements through a specialist resource such as this can contribute to the artificial organisational bottlenecks that slow development and can stifle innovation. For faster-paced design work, where it is critical to rapidly iterate and analyse designs, layout and packaging options, more 'basic' analysis and simulation methods should be available for use directly by designers. This is achieved by providing a suite of production CAE tools that is valuable and accessible to both to the design teams working on concept production programmes, and to the analysis experts engaged in advanced research studies.

The other key factor in such an approach is ensuring a management strategy (and senior management understanding) that actively encourages improved cross-functional and inter-organisational working and communication – extending to third parties if needed – and all supported by a flexible and open technology platform that promotes easy and secure data sharing and collaboration.



Manual Transmission

Which comes first: simulation or CAD?

When approaching a definitive design, CAD models frequently become the basis for product geometry and design data exchange; concept design occurs when such models either do not yet exist or have not reached a level of maturity that permits their use for this purpose. Some companies prefer to establish the geometric parameters of concept design in CAD before concept engineering activity. However, such an approach again risks locking-in sub-optimal design decisions at an early stage in the process. It arguably makes more sense to build initial CAD models based on the insight and intelligence gained through concept stage simulation.

However, there are many far wider process considerations in large organisations that can drive preferences on CAD use. In any case, to provide an effective framework for integration between analysis and CAD – extending into the earliest stages of concept design – open data exchange between concept design, CAD and detailed design tools is vital. This approach facilitates robust and effective data exchange between CAE, CAD and other external or in-house design tools. In this way, the 'tool chain' is able to support more innovative design work while supporting effective data sharing and more efficient working regardless of the process preferences of any stakeholder.

Making it happen

Developed by engineers and designers, Romax Concept is designed to enable users to build-up a gearbox, transmission or driveline model faster and more effectively than by using any other method currently available. Adopting a whole-system rather than component level approach, and fully integrated with other Romax products to simulate driveline performance, Concept enables faster system layout design and component sizing and rating, so moving organisations closer to a Right First Time design environment.

> "To meet increasing customer expectation and faster development cycles, GKN Driveline has to get Right First Time to the required product performance, and Romax helps us achieve that – so we can continually improve our methodologies and products for our customers."
>
> Theo Gassmann, Vice President Advanced Engineering, GKN Driveline

Transform the effectiveness of concept engineering

Key features of Concept focus on usability and accessibility. For example, a drag-and-drop interface enables more experienced engineers and designers to assess many different design options quickly and efficiently. At the same time, built-in templates allow less experienced engineers and designers to rapidly investigate the suitability of designs. Durability, performance, noise and efficiency can all be calculated and examined from the same model.

Activities supported include:

Vehicle performance simulation

- Simulation tool to predict vehicle behaviour
- Identify optimal gearbox ratios to achieve desired performance

Bearing force prediction and recommended bearing selection

- Built-in bearing databases from the world's leading bearing suppliers
- Prediction of bearing forces to pass to housing designer
- Bearing selection tool uses simulation results to suggest appropriate bearings
- Enables sizing and selection of bearings at the earliest stage of design

Detailed gear design, manufacture and rating

- Optimise gear ratios to achieve required performance
- Guided step-by-step approach to design and analyse gears using detailed parameters
- Comprehensive design tool for spur, helical and planetary gears
- Automatic optimisation ensures suitability of gears for specified application

Cost, efficiency, durability and NVH estimation

- User-defined models produce unit cost estimations
- Gear and bearing durability predictions
- Assess NVH performance at a far earlier stage of the design process

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.

Learn more about Hexagon (Nasdaq Stockholm: HEXA B) at hexagon.com and follow us @HexagonAB.