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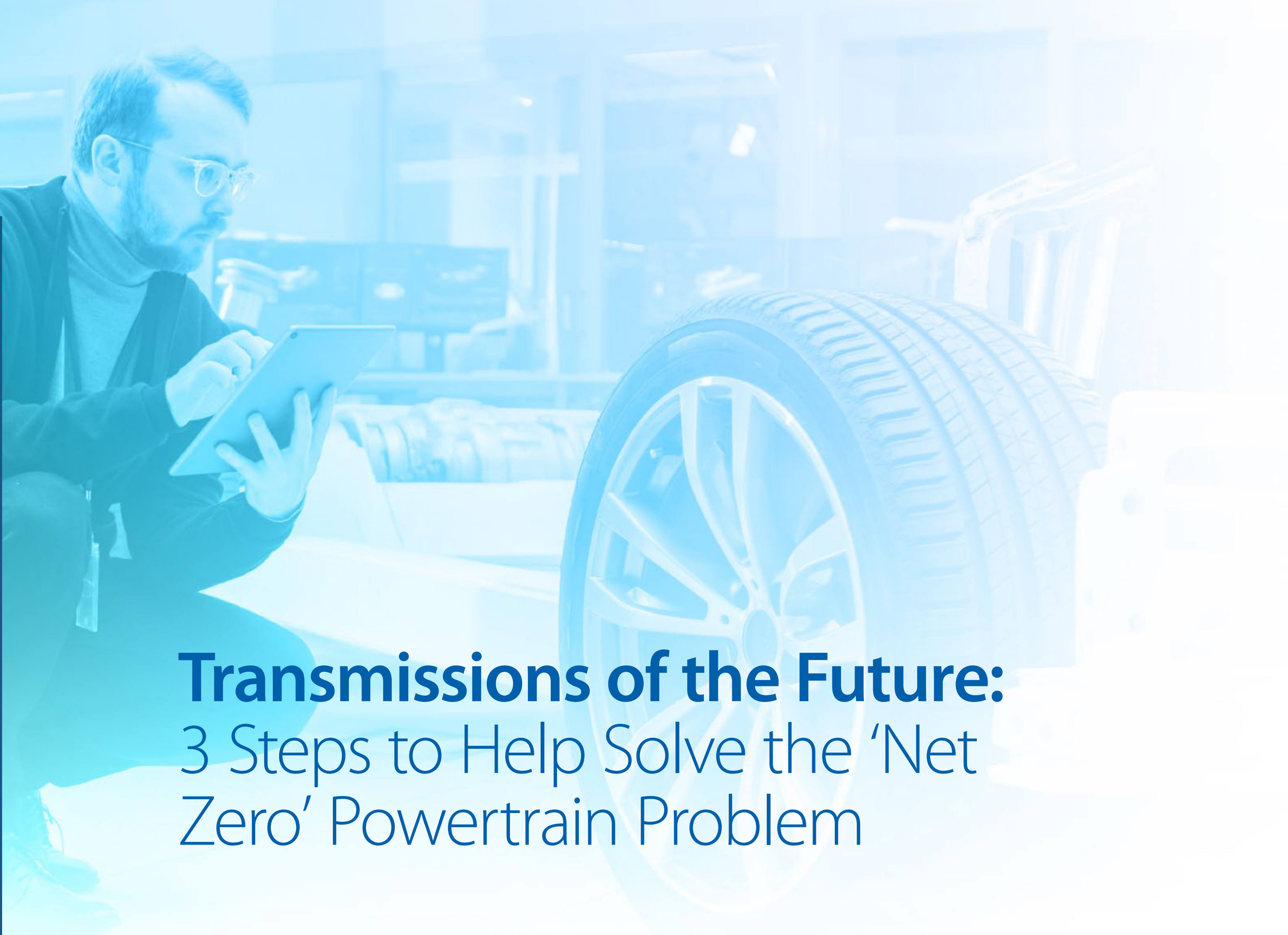
Transmissions of the Future: 3 Steps to Help Solve the 'Net Zero' Powertrain Problem



Transmissions of the Future: 3 Steps to Help Solve the ‘Net Zero’ Powertrain Problem

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Background

We are at a pivotal moment in the evolution of electric vehicles. As recently as 2010, annual sales were close to zero. Now, it's the hottest sector in car manufacturing, with pure-electric and hybrid-electric plugins making up 10.79% of all new car registrations in the UK. By 2035, electrics could be the only type of new vehicles on sale. Manufacturers are racing to keep up.

This revolution is occurring because of one inevitable truth: electric vehicles have zero tailpipe emissions. As such, they form the backbone of the British government's Net Zero pledge and the real and ambitious drive to meet carbon-neutrality targets worldwide.

A key indicator of where the market is heading is just how quickly electric vehicles (EVs) and hybrid electric vehicles (HEVs) are becoming a common feature in people's day-to-day lives. In September 2020, there were 164,100 'pure' electric cars on the UK's roads and over 373,600 plug-in models including hybrids. Choice—previously slow to grow—has mushroomed in 2020 as debuts from Peugeot, Honda and Mini all arrived. Consumers can now buy city cars, large family cars, hatchbacks, estates, SUVs, executive models, sports coupés and commercial vans on a fully electric basis.

The sheer potential for the growth of the EV market is a solid justification for Original Equipment Manufacturers and component suppliers to get a slice of the action. There's cash on the table for those who can acknowledge specific customer pain points, and offer credible engineering solutions.

For example, 98% of the EVs on the market have a single-speed transmission. For motorists, this is a different and potentially unfamiliar driving experience, and electric opens the door to previously hidden noises coming from the heater, the tyres, or the road that potentially are unpleasant to customers.

Of course, when you pull any one lever in vehicle design, a series of up and downstream levers must be pulled in response. The challenge for transmission manufacturers is to figure out how to transfer torque to the driven wheels in order to get more range, efficiency and performance—without increasing manufacturing complexity or cost. Because if there's one thing we know about consumers, it's that high costs translated into high purchase prices are the biggest barrier to EV uptake.

This white paper explores the biggest challenges faced by OEMs and suppliers around the issue of net-zero powertrains. Then, we'll offer solutions that should see the industry moving beyond current constraints towards the transmissions of the future that are a real box-office hit.

> *"98% of the EVs on the market have a single-speed transmission. For motorists, this robs the car of the dynamic phases of speed that a manual or geared automatic offers, and opens the door to previously hidden noises that potentially affect the customer experience."*

The Current State of the Industry

The electric transmission race is just getting started

Transmission has always been a critical part of every vehicle running on our roads today. Consumers make purchasing decisions based on a vehicle's fuel economy, speed, acceleration and driving comfort, and these factors are very closely related with the choice of transmission on offer.

Emissions-reduction targets may change all that.

In EVs, transmissions have a much smaller influence in a consumer's buying decision than with a petrol- or diesel-powered vehicle. A conventional internal combustion engine (ICE) operating between 1,000 and 6,000 RPM needs a transmission to act as an intermediary between the engine and the wheels, keeping the engine in its power and fuel-efficiency bands.

EVs, on the other hand, can have their electric motor operating beyond 20,000rpm and use a single-speed transmission. Since electric motors are able to produce consistent torque across an extensive RPM range—EVs can generate 100% of rated torque at near stall, for example—a multi-speed transmission might only create inefficiencies. Added weight, perhaps, or additional production costs.

This is the reason why the EV/ HEV transmission market is a hotly debated topic in the automotive industry today.

The green ambition

Why is electric mobility so important right now? Simply, it's all down to the global push to reduce worldwide carbon emissions, about a fifth of which come from road transport.[1]

Electric vehicles are a greener option than fossil fuel. Unlike petrol or diesel, they do not emit any CO_2 while driving. If the production of batteries and electricity is based on renewable energies, then pure electric vehicles are carbon-neutral in the broadest sense.

In all major economies, carmakers are being prodded, incentivised or threatened to move away from fossil fuels very quickly.

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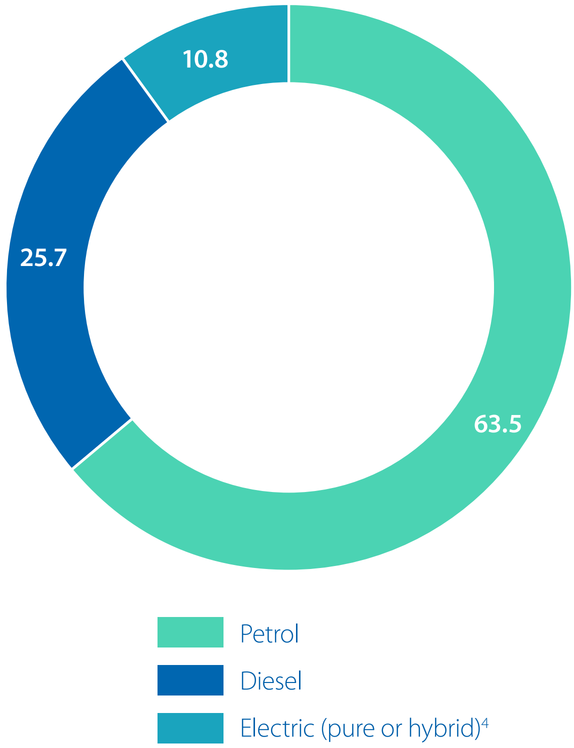
1 *Office of National Statistics, Road Transport and Air Emission, 16 September 2019*

"The number of diesel car registrations plummeted 81% in Q2 2020, with petrol cars declining by 72%."

UK passenger car registrations in 2020 (%)



The EU has capped permissible CO_2 emissions to 95 grams per kilometre in 2020, with a further reduction to 59g/ km expected by 2030. In comparison, China's limits are set at 117 g/km (2020) and 93 g/km (2030). North America's current targets are set at 50 mpg for 2025, following passenger-vehicle Corporate Average Fuel Economy standards. This is equivalent to 99 g/ km.[2]

Here in the UK, the government plans to slash emissions to roughly half of 1990 levels by 2025, and to reach 'net zero' greenhouse gas emissions by 2050. It plans to ban the sale of new conventional petrol and diesel vehicles as early as 2030—with a clean up of old vehicles following shortly after.[3]

The electrification race is on.

Today's powertrain landscape

There are four main powertrains currently on the market. Here's how they stack up against key environmental, performance and economic metrics.

Internal combustion engine: soon to be killed off?

Petrol and diesel ICEs are the dominant powertrain. Globally, ICE-powered vehicles still make up 98% of sales.

However, behind this headline there's a murkier picture. On the one hand, further emission regulations will have a major downward drag on the market. Diesel is already banned in multiple jurisdictions and several countries have announced target end dates for ICEs—Norway by 2025; UK, Israel, India and Denmark by 2030; Canada and China by 2035.

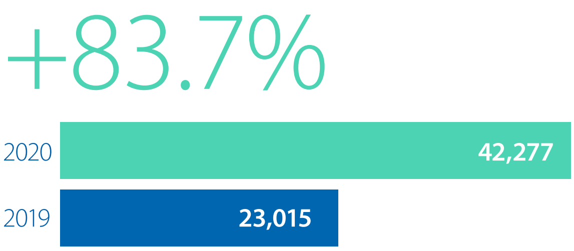
The number of new diesel car registrations is already plummeting in the UK, down 81% in Q2 2020 compared to the previous year. Petrol car sales declined by 72%.[5]

On the other hand, the type of ICE vehicles that people are choosing to buy may tell us a lot about current consumer purchasing preferences. CO_2 emissions from ICE vehicles actually rose for the third year in a row in 2019, up to a high of 127.9g/km. This is far above the 95g target manufacturers must meet for EU sales in order to avoid stiff fines.

According to the consumer group Which?, the record rise in emissions is down to consumer demand for bigger, heavier cars.[6] Performing tests on 292 models released since 2017, the consumer watchdog found that the latest generation of cars produce 7% more emissions than those manufactured to earlier standards. Surprisingly, the biggest culprits are large petrol hybrids, which are kicking out 31.7% more CO_2 than older models.

2 *International Council on Green Transportation, CO_2 Emission Standards for Passenger Cars and Light Commercial Vehicles in the European Union, January 2019*
3 *HM Government, The Road to Zero, July 2018*
4 *Statista: Passenger car registrations in the United Kingdom between 2016 and 2020, by fuel type, May 2020*
5 *Department for Transport, Vehicle Licensing Statistics: 2020 Quarter 2*
6 *Which? New cars emit more climate changing CO_2 than old, according to Which? Tests, 28 February 2020*

PHEV car sales, year-to-date



For auto manufacturers, there may be lessons here. Consumers, it seems, prefer a large and powerful drive. There could be opportunities for suppliers who can help achieve these preferences while meeting emissions goals.

In the hybrid sector, innovations in lightweight materials and components could go a long way to cutting emissions in the larger classes of car.

Hybrid electric vehicles: the reliable choice?

HEVs have a conventional engine alongside an electric motor and a battery which, together, capture and re-use braking energy. The small, low-range electric powertrain is ideal for stop-start city driving and low-speed cruising, with the petrol engine cutting in as the speed increases.

Within this category, mild hybrids are the entry-point to electric powertrains. The small battery (mostly 48V) is there to help efficient electrification elements, such as start-stop and regenerative braking, and to help the petrol or diesel engine perform more economically. But the car cannot drive on battery power alone. Plug-in hybrids (PHEVs) hold a significantly larger battery and a more powerful electric engine. They can recharge the battery through regenerative braking and plugging into an external power source. Plug-ins have a typical range of 20 to 40 miles today (and possibly 40 to 60 miles in the future), and so are designed for a significant share of pure-electric driving.

PHEV car sales shot up by 138% in 2020. Year-to-date, the plug-in hybrid market is up 83.7%, with 42,277 new PHEVs having been registered so far in 2020, against 23,015 at the same point in 2019.

Overall, however, the hybrid market is not increasing as rapidly as pure electrics. Where PHEVs have, on average, made up at least 66% of all plug-in cars sold since 2015, since March 2019, that position has switched to EVs being the dominant electric powertrain. According to the Society for Motor Trader and Manufacturers, this is partly due to the premature removal of purchase incentives for PHEVs. Company drivers failing to charge their fleet, thus increasing emissions over ICE-only vehicles, were largely responsible for the fall in government backing.

In line with Net Zero, the UK government will ban the sale of new hybrids from 2035.

Battery electric vehicles: fixture, not fad?

Battery electric vehicle (BEV) sales surged between January and October 2020, with the Society of Motor Manufacturers and Traders figures showing a 168.7% rise year-on-year.[7] That pushes the number of pure-electric cars on UK roads to more than 164,100 at the end of September 2020.[8] BEV models make up 5.5% of all new cars sold in the UK in 2020 (so far)—up from 1.7% for the whole of 2019.

Looking outward, 2020 has been an extremely positive year for the BEV car market globally. In 2019, sales passed 2 million units for the first time, up by 144% on the previous year. Surprisingly it's China, the world's biggest polluter, which now accounts for half of the

"BEV models make up 5.5% of all new cars sold in the UK in 2020 (so far)—up from 1.7% for the whole of 2019."

7 Society of Motor Manufacturers and Traders, Car Registrations, October 2020
8 Next Green Car, Electric Car Market Statistics, 8 October 2020

"BMW, Toyota and Daimler are leading a group of 13 companies across the world, investing $10 billion over the next 10 years in developing hydrogen technology and infrastructure."

world's pure-electric sales; supported by $60 billion in state subsidies.

Still, despite record sales, BEVs make up for just 2% of global car sales. In the EU alone, for CO_2 emission targets to be met, the BEV and PHEV market share would need to reach a combined 10% by 2025 and 22% by 2030, assuming BEVs make up more than half of sales.[9]

A dense network of charging infrastructure will be required to enable this level of market penetration. Here, we have a chicken-and-egg problem. If there's nowhere to recharge a car, why own one? And if there are not enough BEVs around, why build recharging stations?

The Committee on Climate Change's 'Net Zero' report [10] sets out a number of scenarios for each of the core infrastructure networks. During the 2020s, the aim is to expand the passenger EV market, including the deployment of 12,000 rapid EV charging points on the strategic road network which can provide a charge to 80% of capacity in around 30-50 minutes. Currently, the majority of the UK's 19,700 charging points are Level 2 chargers taking 3-4 hours to deliver the same charge. [11]

Fuel cell electrics: still not delivering on their early promise?

Fuel cell electrics operate like a BEV, except they produce electricity using a hydrogen-powered fuel cell, rather than drawing electricity from a built-in battery that can be plugged into an external power source. In other words, hydrogen cars have their own efficient power plant on board and can produce the electricity themselves.

For the time being, hydrogen cells have a longer range than pure-electric cars. A full hydrogen tank will last around 300 miles. This makes them well-suited to applications with high power and long-distance requirements, such as trucks and commercial vehicles.

It's fair to say that hydrogen hasn't taken off in the automotive sector. Manufacturers are still experimenting with hydrogen powertrains and we're years away from a mass roll out. One reason for this is the surge in uptake of plugins—when BEV/ PHEV sales are so strong, it's easy for manufacturers to prioritise this technology over more experimental tech.

Yet, hydrogen-powered cars are not expected to replace EVs. Instead, hydrogen will complement electric power especially in the heavy goods sector, where performance is hampered by battery capacity. BMW, Toyota and Daimler are leading a group of 13 companies across the world, investing $10 billion over the next 10 years in developing hydrogen technology and infrastructure.[12]

In the UK, government spending undoubtedly will switch to truck and van fleets—at some point. But this is unlikely to be before the 2040s, when the first rollout of 800 hydrogen refuelling stations is planned.

9 *Deloitte, Battery Electric Vehicles, New Market, New Entrants, New Challenges, 2019*
10 *Committee on Climate Change, Net Zero–The UK's Contribution to Stopping Global Warming, May 2019*
11 *Next Green Car, Electric Car Market Statistics, 8 October 2020*
12 *University of Bath, Is this the end of cars as we know them?, 5 June 2020*

How Transmission Manufacture Could Be Improved

While consumer preferences are increasingly leaning towards clean transport solutions, many seem not willing to compromise in key criteria, such as range, performance, efficiency and, of course, cost.[13]

Range anxiety—the fear that a battery will run out of juice while driving—is repeatedly cited as the greatest psychological barrier to electric powertrains, followed closely by price. All low-carbon vehicles demand a premium in the market, but buyers are not necessarily willing to pay this premium for the 'green' gains.

What this tells us is that current engineering solutions are lagging behind what consumers want and expect, and that is a fundamental barrier to getting major uptake of the tech. Regardless of how legislation forces the issue, fundamentally, EVs will need to get a lot cheaper and go a lot further on a charge, if they are to achieve maximum market penetration before the 2035 switchover.

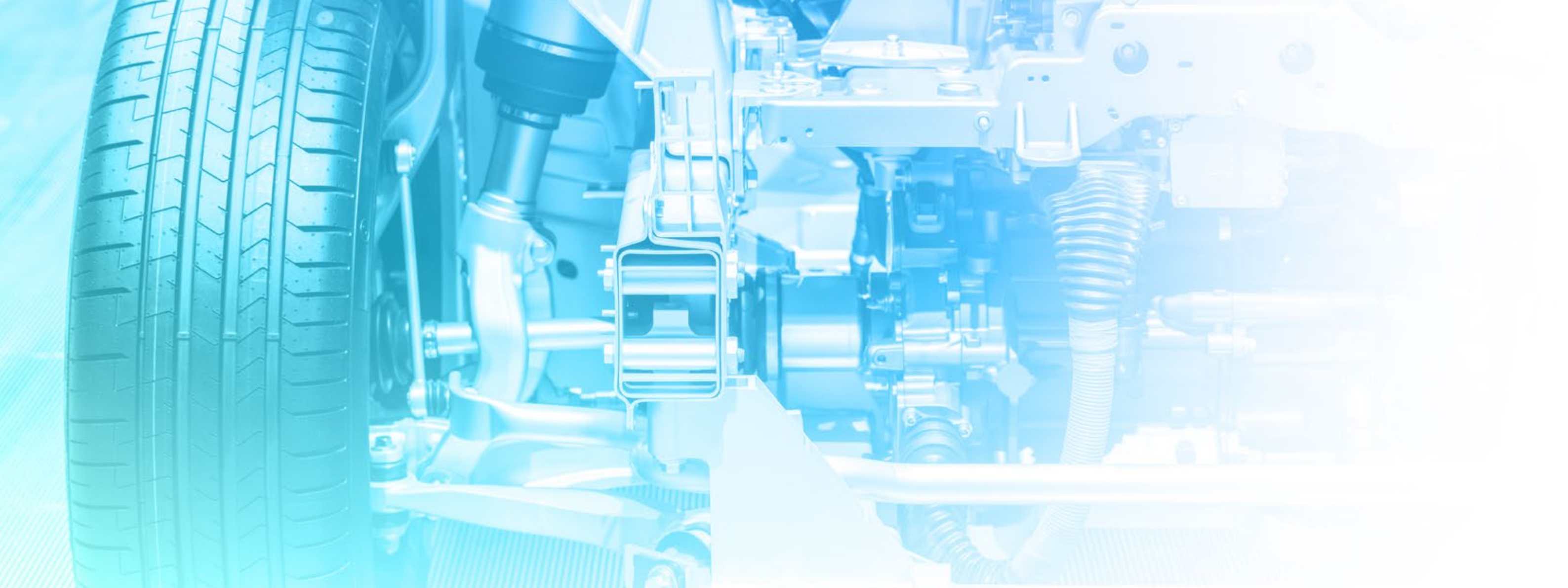
The pressure is on OEMs and suppliers to innovate over the hurdles and bring supply chain costs down.

Range anxiety

Most EVs can cover between 150 and 200 miles on a single battery charge. Tesla's single-speed transmission Model S has the highest range on the market at 396 miles,[14] but it comes with a hefty price tag. However, even within the high-performance class, range depends on various factors. Lithium-ion batteries are very temperature sensitive and can become sluggish in winter when the mercury drops, for instance, and using the radio or air conditioning will also drain the juice.

"It makes sense to design all components of the driveline to be as efficient as possible and to coordinate them flawlessly with each other. In this way, even small optimisations can bring about a noticeable increase in efficiency."

13 See, for example, YouGov/ Aviva Car Master Survey, March 2019
14 Tesla, Model S specs, accessed 7 November 2020



Research tells us that most motorists don't drive more than 60 miles per day, yet this does not quash range anxiety. Climate concerns aside, people expect their vehicles to be capable of making an extended journey, drive well and look great before investing—and rightly so.

Increasing the battery capacity is not enough to get EVs to drive further, and can result in greater vehicle weight and less space for passengers. It makes more sense to design all components of the driveline to be as efficient as possible and to coordinate them flawlessly with each other. In this way, even small optimisations can bring about a noticeable increase in energy-conversion efficiency, resulting in an extended range for the same battery size.

This makes the challenge clear: quell range anxiety and charging times, and you may find that significantly more customers choose EVs as their next vehicle.

Noise, Vibration and Harshness

Noise, Vibration and Harshness is the unholy triumvirate: a measure of how much unpleasant sensory feedback the car delivers in motion. A sexy V8 engine may be loud, for example, but it is NVH minimal because the noise is not unpleasant—this engine has been designed to have a noise quality that motorists enjoy. Electric vehicles sit right at the other end of the scale. With motor speeds exceeding 30,000 RPM, they emit an audible high-pitched whining noise that is difficult to mask. This is not desirable for customers.

> *"Too often, sound reduction is an afterthought or an additional cost element on the production line."*

Mechanically speaking, cancelling out noise comes down to one of two basic approaches: absorbing as much as possible or better, not creating the noise in the first place.

Sound dampening can be achieved by placing rubber-like sound dampening material fixed to various points along the chassis. Other solutions involve sampling the frequency and amplitude of the noise and using the sound system to pump out polar-opposite sound waves, so the two frequencies cancel each other out. However, for this to work, you have to know the exact head heights of all the occupants, otherwise the polar-opposite noise adds, not subtracts. Doing that for all occupants is virtually impossible. Even when it works, the result is an eerie silence, which may be equally unpalatable to the consumer.

The ultimate aim, then, is to not create the noise in the first place. It is far more costly to fix a noise problem than to design the drivetrain in a way that eliminates the primary contributors to NVH issues.

Tools are available to identify the sources of NVH excitement and to mitigate them from the outset—it is good practice to use them before making design choices.

At the other end of the noise spectrum, is the issue of silence. For blind and visually impaired people who need acoustic signals in order to be able to move safely and independently in traffic, silence can be life-threatening. It is also problematic for other vulnerable road users such as children, senior citizens or cyclists. One study from the United States National Highways Transportation Administration[15] found that EVs and hybrids are 37% more likely to be involved in pedestrian accidents than their conventional counterparts because pedestrians can't hear an EV coming. When it comes to cyclists, that statistic jumps to 57%.

15 *National Highway Traffic Safety Administration, Incidence Rates of Pedestrian and Bicyclist Crashes by Hybrid Electric Passenger Vehicles: An Update, 2011*

The solution is to install an acoustic warning system for low-noise vehicles. This is an artificially generated sound that resembles an internal combustion engine. It is emitted at low speeds to inform road users about the vehicle. From speeds between 15 and 20 mph, the rolling tyre and wind noises of EVs are generally loud enough to take on this role.

Despite these concerns, too often, sound reduction is an afterthought or an additional cost element on the production line. Half measures might be taken which could lead to embarrassment, for instance, a customer lifts a bonnet and sees a sound insulation jacket wrapped around the powertrain. Ultimately sales will drop and vehicles will be sent back to showrooms. Yet achieving recording-studio levels of sound insulation is hardly desirable either, as the measures inevitably will impact the car's price and performance. It's a balancing act.

For engineers, solving the challenges of tuning out unwelcome sounds is a priority, if consumers are to be persuaded to plug into the EV revolution.

Heat management

The lithium-ion batteries that work in electric vehicles have a long shelf life and high energy density, and can withstand many charging cycles. But they also get very hot and, in combination with small and close-coupled EV engines, can lead to calamitous failure at high temperatures. As batteries become more energy dense and the requirement to get cars charged up and back on the road swiftly increases, the heat problem is likely to become more acute.

The current cooling standard is liquid, similar to that used for ICEs. The biggest upside is that the same liquid cooling loop can be used to direct heat away from all the hot sources in the power electronics such as the motor or inverter—and the recycled heat can be used to provide warm air for the passenger cabin.

Still, liquid cooling systems treat the symptom and not the cause. Developments in new battery cell chemistries may lead to substantial breakthroughs, although progress may be some time off. In the meantime, manufacturers will have to work harder and smarter to develop thermal-reduction solutions that can be produced quickly and cost-effectively and extend service life.

Hybridization

In the hybrid sector, it is fair to say that electric motors have found their way into conventional transmissions

as a bolt on. Most design challenges are the result of a discord between the two. When two systems have different firing frequencies coming in, for example, they will not work in harmony. The problem can theoretically be solved with more gears that swap smartly between the two systems, but that enhances downstream problems like NVH. Designing a hybrid from scratch, such as the Prius, removes some of these issues—but at what cost?

For partially electrified drives, OEMs should be pushing for increasing degrees of integration with a move towards dedicated hybrid transmissions and increasing electrification over time. In the eyes of regulators, hybrids are seen as bridging technology until cars are fully powered by electricity.

Performance vs cost

One of the biggest gripes about EVs and HEVs, aside from range, is they lose 'oomph' at higher speeds. This is a perception thing. EVs are at maximum power from about 30% rev-range upwards, and the power is more or less constant. Obviously, it is not possible to beat maximum power, so an EV produces maximum 'oomph' by definition.

The problem is, consumers are used to 'revving-up' the engine to reach peak power and torque. They have been driving this way for more than 100 years, and EV engineers have their work cut out if they are to overcome these ingrained behaviours.

Companies like Tesla have already been hard at work making ICE-beating performance a reality in luxury-class vehicles. The one-speed transmission Model S boasts an unheard-of acceleration from zero-to-60 miles per hour in 2.3 seconds, and top speeds exceeding 160 mph. There's some whizz-bang technology going on here—but it's far too expensive for customers in the family and subcompact markets.

Across the supply chain, the challenge is to achieve a good gear ratio in a small installation space with optimal weight and economic efficiency. Transmissions of the future must support cars that go faster or farther or both, while costing no more than competing models. It's only when the cost of ownership is no longer a barrier to purchase, that BEVs will become a sensible, reasonable option for any new car.

The Three Steps

1 Model

Use software to model the entire driveline and evaluate their interactions during the powertrain integration in the chassis. Modelling lets you make one tiny adjustment and see the entire downstream impact, solving key technical challenges quickly and reducing time to market.

2 Simulate

Do as much as possible in the virtual environment, slashing development times and reducing expensive mistakes. Test a system before building it, balancing key controls such as range, driveability, NVH, fuel economy and comfort more safely and cheaply than in the real world.

3 Integrate

Manage complexity better by ensuring an efficient interplay of mechanical, electrical, and electronic components. Integration requires a sharing of knowledge and resources across models and technologies (acoustics, cost engineering) while preserving trade secrets. This helps EV/ HEV manufacturers who have different suppliers building different parts.

Achieve Cost Excellence

The focus is set on providing joined-up engineering from the beginning of development. Work hand-in-hand across the supply chain to pool data, save time, become faster and, ultimately, lower manufacturing costs.

Towards a new value chain

ICE technology has been around for over 100 years and there's a tremendous amount of knowledge standing behind it. Electric, by contrast, is still very new. Manufacturers are learning as they go and lessons must be learned quickly, and cheaply, if the industry is to achieve an acceptable time to market.

On the surface, building a new architecture may seem easy. Yet it can take time and effort since engineers often must abandon old ways of doing things, and develop new capabilities. Once, transmission designers were great mechanical engineers. Now they must add software engineering to the skillset, using software intelligence to optimise hardware components and coordinate them perfectly to pull maximum efficiency out of the design.

> *"Manufacturers and suppliers must work together from the start to ensure the precise design for manufacturing consideration from day one."*

The fact is, transmission hardware costs a lot to produce, test, change and integrate. More joined-up thinking in the design phase, and doing as much as possible in the virtual environment, leads to less expensive mistakes and reduced development times.

The three concepts we present are built around the concept of virtual engineering: Model and test components and hypotheses; simulate to remove the need for real-world trials early in the development phase; integrate knowledge and resources and transfer it across the supply chain. All potentially will lead to cost excellence and further increase EV performance.

Model

As the mechanical content of EVs decreases, the electronics and software content increases. This requires the use of a digital toolbox to operate alongside conventional product engineering. Familiar tools such as PLM, cPDm, modelling, simulation and manufacturing integration will sit alongside new virtual calibration and virtual validation solutions. Together, they will be central to innovations in this sector.

While most manufacturers use software to solve key technical challenges, the degree of functionality and the extent to which they use it varies widely. Modelling software, designed to optimise individual aspects such as battery, drive and weight, and the system as a whole, can fully automate the workflow and alter the way cars are built, vastly reducing the time to market.

With modelling, you essentially tear down, benchmark and reproduce all components and interactions in order to identify the main sources of energy loss, NVH and heat creation in your transmission at any operating point. From there, engineers can improve the design—while performing many more iterations when compared to traditional approaches.

It's expected that all transmission engineers will follow a modelling process to make predictions and corroborate their electric vehicle powertrain designs.

Simulate

Achieving a high-performance powertrain requires tackling several competing control objectives, such as energy consumption, NVH, driving comfort and battery state-of-charge preservation. It is far more expensive to address deficiencies after the hardware is in place, and commitments have been made, than it is to problem-solve in a virtualised environment.

Simulations mimic what's going on for a motorist in real time. For instance, you can seek to maximise the (virtual) driver's comfort by playing with the physics of gear design to avoid severe vibrations. By simulating throttle tip-in tip-out maneouvres and so on, you can simulate drivability and balance it with energy consumption and performance—significantly reducing the required number of prototypes and tests and eliminating expensive mistakes.

On average, £24,000 per minute is lost in downtime when issues are found much later in the production line. Simulation reduces the risk. That makes it a crucial aspect of electric powertrain design.

"On average, £24,000 per minute is lost in downtime when issues are found much later in the production line."

Integrate

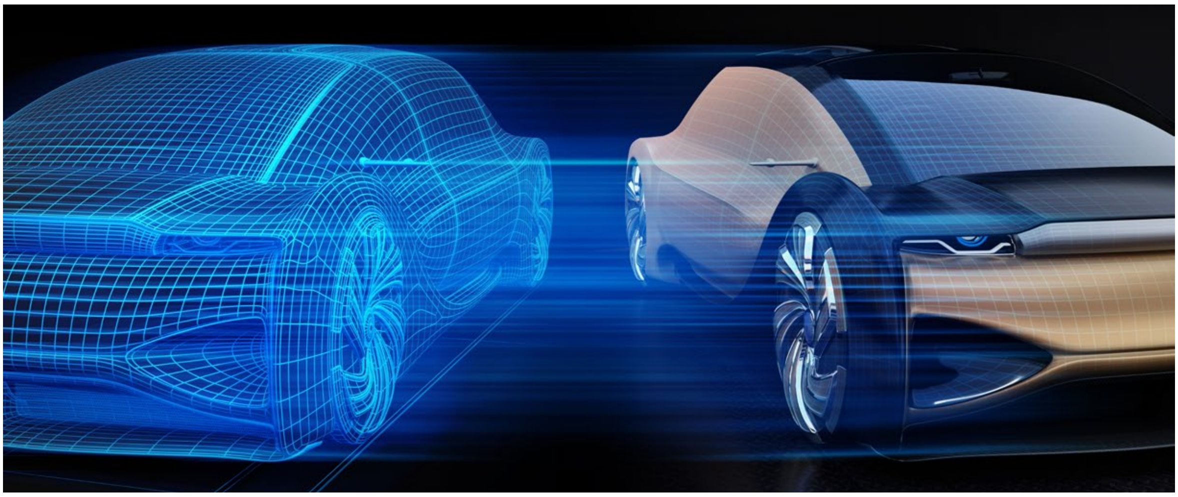
There's a clear trend towards higher integration levels in EV manufacturing. The electric drivetrain, consisting of electric motor, inverter, transmission and heat exchanger, merge to form a complete system that can offer major efficiency gains in terms of weight, range and cost. It is possible that this very elaborate assembly will be supplied directly to the vehicle manufacturer for installation in the vehicle.

Yet, with so many models of EVs, HEVs and components now under development, the number of possible configurations has increased—and so the complexity. Managing this challenge requires a holistic view. Why? Because we know that engineering costs (and thus the profit centre) flow to the bottlenecks—the individual components that limit the efficiency of the whole system.

Sadly, within the auto manufacturing industry, there is a clear lack of common-source data. Not everyone in the supply chain has access to all the models and numbers, and that leads to educated guesses and half-measures being taken. For example, if there is one supplier for the motor and a second supplier to bolt the motor to the transmission, who would be responsible for NVH? When clear lines of accountability are absent, finger pointing is inevitable. And it can be a legal minefield.

Comprehensive whole-system understanding and cost leadership is key. Manufacturers and suppliers must work together from the start to ensure the precise design for manufacturing consideration from day one.

In this context, integrating all available data sets on transmission layout design and dimensioning can be a huge advantage, especially as the growth potential of the EV market lures new players into the supply chain. Suppliers in the aerospace and defence industries might see opportunities to throw their hats into the ring, and the knowledge they transfer has the potential to solve a wealth of technical challenges in terms of reliability, noise control, efficiency, economy and cost.



Achieve cost excellence

High market and time pressure is forcing all manufacturers to develop electric transmission concepts with high maturity, short time-to-market and low development cost. Once, auto manufacturers would produce large numbers of a single engine type on the production line. Today, many different models are produced on a single line and the increasing number of models on the market calls for greater flexibility.

Modelling, simulation and integration are powerful answers to the demand for shorter times to market and flexibility for manufacturing organisation.

Modelling and simulation tools come into play at the beginning of a product's life cycle. They shrink development times dramatically by making it possible to virtually observe the dynamic behaviour of all components, in all driving conditions, shortening periods on test beds. Faults can be detected early and eliminated without having to make expensive prototypes. Integration is the tool that adds efficiency. The linkage of information—which previously has been separate—makes it possible for manufacturers to pool knowledge across different suppliers building different parts.

The focus then shifts to simultaneous engineering from the beginning, and ever-closer cooperation between OEMs and suppliers, who now need to get involved in each other's design and development processes much earlier than before. Software facilitates this process. With this approach, the manufacturer's production processes become faster, more flexible and more economical. Complexity and therefore the production cost can be kept within strict limits—achieving cost excellence right across the supply chain.

Summary of Learnings

1

The U.K. Government has committed to ban the sale of new conventional petrol and diesel vehicles as early as 2030—with a clean up of old vehicles following by 2050. Electric vehicles have zero tailpipe emissions and thus form the backbone of the government's Net Zero strategy.

2

Currently, 10.7% of all new cars sold in the UK are plugin electrics, a massive leap from 2019 figures driven by the surge in sales of battery-powered electric vehicles which are up 168.7% year-on-year. It's a booming market with huge potential for manufacturers and suppliers.

3

For consumers, there are many roadblocks to electric vehicle ownership. The usual suspects are to blame: price, range, performance and driving comfort. It's therefore essential the supply chain has the infrastructure, technology and solutions in place to overcome barriers and meet future demand for electric car use.

4

Transmission hardware costs a lot to produce, change, test and integrate. More joined-up thinking in the design phase, and doing as much as possible in the virtual environment, leads to less expensive mistakes and reduced development times. This involves three steps: model, simulate and integrate, to achieve cost excellence through time savings and lower manufacturing costs.

Concluding Remarks: *Driving Forward*

Despite promising forecasts, electromobility is still in its infancy–not only in terms of market share, but also in terms of technology. Breakthroughs are coming, but electric vehicles will only live up to their role as the beacon of carbon-neutrality if manufacturing costs fall, the range-per-charge grows, and customers are given a better driving experience at a significantly lower price point.

Together with alternative drivetrain concepts, transmission components have to adapt. Product complexity is noticeably decreasing, and OEMs may seek to squeeze cost levels as much as possible in this component cluster. Yet the requirements for individual attributes, such as transmission acoustics and system cooling, is increasing substantially. And it's only when all components of the driveline are operating at peak efficiency, and are perfectly coordinated and precision-integrated with each other, that an optimum balance of performance and cost can be achieved.

We are sure that transmissions of the future will be highly integrated units and much simpler than they are today. But the way we go about making them simpler is extremely complex. OEMs and suppliers need intelligent solutions for their powertrains and drive units–designed, tested and validated virtually–to implement the integrated units of tomorrow, in a modular form and, above all, economically, in a short space of time.

Those that do so put themselves in pole position when competing for dominance in the next era of powertrain technology.

The race is on.

About Ricardo Software

At Ricardo Software, we develop and license virtual engineering software and technical services to global brands in the automotive, rail, motorcycle, off-highway, defence, energy and environment industries.

We help users create, analyse and optimise complex physical systems and designs to reduce R&D costs and confidently bring new products to market faster.

To find out more about how Ricardo Software can help your business can gain cost excellence, contact us at:
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Creating a world fit for the future

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