Driving Towards a Sustainable Future
The internal combustion engine (ICE) will continue to dominate the automotive market for the next decade. However, the increasing gap between energy consumption and available resources, together with tighter legal restrictions concerning pollution, is creating increasing demands for improvements to existing automotive technologies and the development of 'green' alternatives.

Energy efficiency and environmental sustainability are the main criteria for future developments and are the primary driving forces behind the optimisation of efficiency in the traditional combustion engine and the development of the ‘new’ automotive sectors – hybrid and electric vehicles.

The potential for hybrid and electric vehicles as alternative powertrain concepts is growing, and electrics and electronics are likely to be the main drivers of automotive innovations into the foreseeable future.

Schaeffler Group Automotive is already successfully working in partnership with several leading automotive manufacturers to develop innovative solutions to improve the energy efficiency of ICE-powered vehicles.

At the same time the Group is also involved in the ongoing development of concepts and components for the next generation of hybrid and all-electric vehicles.
Your automotive development partner

A thorough understanding of the systems that comprise the entire automotive drivetrain combined with comprehensive engineering and manufacturing skills enable Schaeffler Group Automotive to perform continuous development work with and for our customers.

We have a track record stretching back over 60 years of creating solutions that meet the needs of the conventional automotive industry. Our experience and skills are now being applied to meeting requirements for reduced fuel consumption and emissions whilst increasing performance and driving pleasure and improving the active and passive safety of ICE-powered vehicles.

At the same time our automotive know-how is increasingly focused on meeting the challenges for alternative automotive technologies including hybrid and electric-powered vehicles.

The Schaeffler Group possesses all the key competencies necessary to meet these challenges. Hybrid and electric vehicle technology will play an increasingly vital role in the automotive industry, and Schaeffler Group Automotive is well equipped to support the requirements of OEMs in this sector.

Our sustainability code

Our work in the automotive sector is increasingly targeted at protecting the environment by creating components and systems that reduce both fuel consumption and decrease CO₂ emissions.

We also practice what we preach. The Schaeffler Group has made a commitment to sustainable business practices by establishing a corporate Code of Practice throughout the world. We are dedicated to complying with stringent environmental standards and all Schaeffler Group locations throughout the world are certified in accordance with ISO 14001. Many facilities, even those outside Europe, have also been validated to the stricter EMAS (Eco-Management and Audit scheme) standard.
Eco-engineering for ICE

Innovative engineering solutions from Schaeffler are helping manufacturers of traditional ICE-powered vehicles to produce more compact, lighter weight vehicles that deliver improved fuel consumption and lower CO₂ emissions.

**Lightweight balancer shaft**

Another unique bearing solution from Schaeffler is the INA lightweight balancer shaft and rolling bearing assembly, the weight of which has been optimised to help improve engine efficiency and reduce overall fuel consumption. By replacing conventional plain bearings on the balancer shaft with needle roller bearings and a raceway directly on the shaft, friction is reduced by up to 50% over the whole speed range. Weight distribution in the assembly is optimised, enabling the width of the bearing raceway to be cut by more than a third in the non-loaded zone, reducing the weight of the components.

**UniAir Valve Control**

Another groundbreaking development by Schaeffler, working in partnership with Fiat Powertrain, is UniAir, the world’s first fully variable hydraulic valve control system which reduces vehicle fuel consumption and cuts CO₂ emissions by up to 25%. UniAir provides improvements in the start-up, part load and acceleration behaviour of a vehicle. During the start-up phase hydrocarbon emissions are reduced by up to 40% and nitrous oxide emissions by up to 60%. The system also offers a greatly improved driving experience through more power, higher engine torques and optimised engine response.

**Wheel bearing**

A prime example of this innovative approach is the new FAG wheel bearing, designed to be more compact and 10% lighter than its predecessor. The new bearing provides simplified mounting via a unique self-centring axial spline design which helps to reduce manufacturing costs. Having four lighter wheel bearings on a vehicle also reduces the unsprung masses which improves the driving characteristics and contributes to a reduction in CO₂ emissions.

**Ball Roller Bearing**

The ball roller bearing is another unique concept from Schaeffler that has been adapted for use in wheel bearings. All areas of the conventional rolling element ‘ball’ that are not under load have been removed, resulting in the ‘ball roller’ – a ball that is flattened on both sides and is 30% narrower. The particularly slim shape of the ball roller allows an increase in the number of rolling elements, resulting in higher load ratings and longer service life. This development has already been adapted for use in vehicles with a new four-row wheel bearing which provides higher load carrying capacity and enables more compact designs to be achieved. It is particularly attractive for use in driven axles, where less friction and the lower mass of the bearing and wheel carrier make a significant contribution to reducing fuel consumption and exhaust emissions.
CO2NCEPT-10%, a joint project between Schaeffler Group Automotive and Porsche, provides a practical demonstration of how optimised engine, chassis and transmission components and systems allied to the latest technological developments can successfully reduce both fuel consumption and CO₂ emissions.

Using a Porsche Cayenne with a V8 engine as the demonstration vehicle, the project achieved an overall saving of 10% in both fuel consumption and emissions compared to existing production models.

In the project, Schaeffler was responsible for the design and testing of components while Porsche managed system co-ordination and validation for the entire vehicle.

To achieve the savings, a number of modifications were made to the vehicle. The engine accounts for 5.8% of the reduced fuel consumption and associated CO₂ emissions. Most of this was achieved through modification of the VarioCam valve control system, where hydraulic cam timers were replaced with electromechanical equivalents, and the use of optimised switching tappets on the intake side.

Cross system optimisation of valve train, belt drive and chain drive components achieved a further 1.7% in savings. The use of Schaeffler double-row angular contact bearings in the front and rear axle differentials instead of the existing tapered roller bearings, reduced frictional resistance significantly and generated a further 1.1% of fuel saving.

A further 3.2% reduction in fuel consumption was achieved by replacing the hydraulic roll stabiliser in the chassis with an electromechanically controlled equivalent and by using low-friction wheel bearings.

CO2NCEPT-10% is a practical demonstration of how co-operation between component suppliers and automotive manufacturers can achieve remarkable results in improving vehicle performance to meet the requirement for greater fuel efficiency and reduced atmospheric pollution.
Whilst Schaeffler Group Automotive is bringing its expertise to bear on improving the eco-performance of ICE-based vehicles, it is also closely involved in the development of innovative technologies and components for the new generation of hybrid and electric vehicles.

Highlighting these efforts is the Schaeffler Hybrid, created as a part of an advanced development project. Based on a Vauxhall Corsa, the unique hybrid vehicle demonstrates a variety of vehicle configurations to enable comparison of a variety of vehicle driving conditions.

It is equipped with a volume-produced ICE plus an electric motor and two wheel hub motors. These can all be switched on and off to provide data on a wide variety of driving conditions, ranging from classic operation using the ICE, through operation as a parallel or serial hybrid to operation using the electric motor only. The ICE can be used to power the vehicle or can be coupled for use as a range extender. The energy store – a 16kW lithium-ion battery – is charged via the range extender and/or by a plug-in external power supply.

The central electric motor, developed by IDAM (INA Drives and Mechatronics) is connected to the automated manual transmission, which incorporates LuK clutch products, by means of a toothed chain that drives the front wheels. The wheel hub motors, each of which has a power output of 50kW and a torque output of around 530Nm, were also developed by the Schaeffler Group and are compact, high performance units that integrate wheel bearings, drive and brake.

The Schaeffler Hybrid brings together development activities of a number of Schaeffler divisions including INA, FAG, LuK, IDAM and AFT and, whilst this is a concept vehicle that is not destined for mass production, it effectively demonstrates the contribution Schaeffler can make to the new automotive technologies.
Innovative hybrid bearing technology from Schaeffler UK has enabled engineering consultancy and electric vehicle manufacturer Delta Motorsport to design and build an all-electric road car that is capable of 0-60mph in less than 5 seconds and has a top speed in excess of 150mph.

The Delta E-4 Coupe is a stylish 4-seater, 2 door coupe that boasts a class-leading range of more than 200 miles on a single charge and has acceleration comparable to a Porsche 911 Turbo.

The key to this impressive performance is the direct-drive electric motor that powers the car. Designed in partnership by Oxford University and Oxford Yasa Motors to meet Delta Motorsport’s performance requirements, the new design, axial-flux electric motor generates well over 600Nm of torque while only weighing 23kg.

Bearings were absolutely critical to enabling the modular design of the Yokeless and Segmented Armature [YASA] motor. Ultra Low Energy Vehicles such as the E-4 Coupe rely on lightweight components and standard bearings would have been too big and too heavy. However, following detailed discussions, Schaeffler UK engineers were able to offer a specially designed hybrid double-row angular contact ball bearing with a split inner ring, that would meet the demanding criteria of reduced weight and cross-section.

This was the breakthrough that Delta Motorsport needed to fulfil its ambition to develop a highly-efficient, plug-in battery electric car that is stylish in design, financially viable and is capable of overcoming the ‘range anxiety’ of many potential purchasers.

The challenge for Schaeffler’s engineers was to keep the bearing as narrow as possible to meet the dimensional constraints of the design envelope inside the YASA motor, whilst at the same time offering a commercially viable bearing solution within a very tight timescale.

Following intensive design calculations, Schaeffler proposed a single hybrid bearing that met the key design criteria and could also be competitively produced in volume.

The special hybrid bearing delivers the insulation qualities required for use in electric motors, and the addition of a non-contact shield doubled the life-expectancy of the grease, further enhancing the performance of the bearing.

Dr Tim Woolmer, whose DPhil at Oxford University, led to the creation of the YASA motor, said: “The partnership between Delta and Schaeffler helped to create performance prototypes of the motors very quickly. The design has proven to be so robust at high torque and high speed conditions that Oxford YASA Motors have adopted it as part of the next generation design being finalised for higher volume production.

www.delta-motorsport.com
Schaeffler Group Automotive has been working in close partnership with many of the world’s leading automobile manufacturers for over 60 years, helping to develop innovative products and solutions to meet the demands of a changing world.

It all started in 1949 with the development of the INA cage-guided needle roller bearing, a lighter, more reliable and more compact bearing that could be used at higher speeds than conventional bearings. This was the first product in an ever-expanding automotive component portfolio which now spans a huge range of technological innovations ranging from valve-lash adjustment elements and fully variable valvetrains to chain and belt drive systems.

The Group’s involvement with the automotive industry expanded still further with the formation of LuK in 1965. Its original goal was to produce diaphragm sprag clutches for the successor to the VW Beetle. Today, one out of every four cars in the world has a LuK clutch, and LuK is a recognised world leader in the development of both conventional and future-oriented dual-clutch transmission systems and alternative drivetrain concepts.

In 2001, when FAG became part of the Schaeffler Group, its automotive expertise increased still further. FAG produces bearings for transmissions, clutches, McPherson struts and sprung seats. However, its real speciality is wheel bearings and in this area it focuses on the integration of mechanical and electrical components.

This combined expertise is now being successfully applied to meet the challenges facing the automotive industry in the 21st century and to deliver solutions that satisfy the demand for greater fuel economy and lower emissions whilst still improving the overall driving experience.

**Automotive innovation for over 60 years**

**E-mobility concepts and components**

**All-Electric**

Based on a Skoda Octavia all-wheel-drive car, the Schaeffler Electric Vehicle delivers a top speed of 150km/h and a maximum operating range, before re-charging, of 150km. The vehicle uses two electric differentials with full torque vectoring capabilities, providing additional power of up to 3kW. This highly efficient system has been designed for incorporation in existing electric differentials.

**High speed ball bearings**

Specially developed for electric motors, these bearings operate at double the maximum permissible speeds of standard bearings.

**High frequency one-way clutch**

Designed to allow high coupling and uncoupling speeds, the HF clutch has a maximum engaging frequency of 100Hz.

**High speed planetary gear set**

17% lighter and with 20% higher permissible speeds than current designs.

**Lightweight spur gear differential**

Compared to the standard, the new unit requires 70% less axial space and is 30% lighter. It also provides a 7dB acoustic improvement and produces 50% less friction in the main bearing.