Designing dynamics of tomorrow means designing the future. Therefore requirements for automotive suppliers are growing consistently. Consumption, emission, weight and installation space should be reduced, whilst safety and driving dynamics should be increased. To achieve these high aims, innovative problem solving and a dependable business partner is required. Here, ZF takes on responsibility and develops in partnership with automakers complete driveline solutions, which will be perfectly adapted to existing systems. ZF claims a leading role when it comes to making the dynamics of tomorrow more powerful, secure, comfortable and efficient.
Innovative driveline technology for modern cars

ZF axle drives are robust, comfortable in terms of power transmission and with innovative and future-oriented technology help to reduce fuel consumption. With its progressive and innovative product concepts, ZF is well equipped for tomorrow’s driveline systems.

Automatic climate control, parking aids, navigation systems or sports seats? The list of expectations set by today’s drivers on their vehicles can be almost unlimited. But there are some questions which even the most avid car freak is unlikely to ask: Which powertrain ensures that the engine power can develop effectively and economically on the road? Which axle drive unit provides quiet performance and ride comfort, also making an active contribution to safety? We are pleased to say that car manufacturers are increasingly coming up with one answer: An axle drive system from ZF.

Reliable partner for content customers
The satisfaction of the end customer, which the automotive industry can notch up not least thanks to ZF driveline technology confirms the quality of ZF products. This is the motivation for an on-going development and for seeking out further improvements. ZF’s ambition is to continuously improve the quality and performance of the drivelines and to make a significant contribution to conserving resources.

Worldwide production with future
In order to continuously fulfill the requirements, ZF has built an excellent base of operations in the field of axle drive systems with its production sites in Thyrnau, Gotha (Germany), Gainesville and Marysville (USA), as well as Shenyang (China). In addition the ZF Group has access to an enormous knowledge pool: decades of experience in the field of driveline and chassis technology have contributed to the fact that ZF is today one of the world’s largest and most capable automotive suppliers. ZF thinks today of tomorrow’s technology, with innovations of great value. Innovations which represent added value to ZF customers and to the driver.
Engageable systems are being used increasingly in the active version. These systems are only activated when required and offer additional safety and comfort. The second axle is automatically engaged before slippage occurs – normally the case when setting off. The driving characteristics can also be influenced through the active distribution of the drive torque between the axles when cornering.

Further advantages are offered by torque vectoring systems, such as the ZF Vector Drive® rear axle drive unit. Here the torque is distributed variably and asymmetrically to the left and right wheels on the rear axle. This creates new possibilities for driving dynamics and improves the safety reserves.

Four-wheel drive is not the same as off-road. There are fine differences between the various four-wheel drive concepts.

Whereas the four-wheel drive was once just intended to improve off-road capability and traction, modern all-wheel drive systems emphasis is put on driving dynamics and safety. The all-wheel drive technology employed therefore varies depending on the type of vehicle. The spectrum extends from the manually operated dog clutch and the central differential for permanent all-wheel drive through to selectable systems with multidisc clutches and modern torque vectoring. The assemblies and system modules developed by ZF are closely orientated to customer requirements and matched to the specific demands of the relevant application. At the same time, the typical product features of ZF’s axle drives are maintained.

Four-wheel drive systems for four-wheel platforms in "standard" vehicle architecture

With this concept in vehicles in which the engine is arranged in the longitudinal direction, the transfer box distributes the power to the axle drives from where the power is transferred to the wheels. ZF supplies axle drive systems consisting of the front and rear axle drive units and, where required, the associated CV and prop-shafts. Optionally, an electromechanically locked rear axle drive unit or the VECTOR DRIVE® can be employed.

With modern vehicles in this category, the axle drives must satisfy very high performance and quality demands, whilst being optimised for weight and compact packaging. These are the normal demands on a tailor-made axle drive solution from ZF.

Axle drive systems for four-wheel platforms with front transverse architecture

The engine transmission unit arranged transversely above the front axle lends its name to this design. The four-wheel variant is usually derived from a frontwheel drive basic vehicle and includes the additional items of power take-off, rear axle drive unit, prop-shaft and CV-shafts. Within these systems, one can differentiate between variants with a central differential, i.e. permanent four-wheel drive, and in the meantime dominating versions with a controlled variable coupling which is usually fitted to the rear axle drive unit (torque on demand). The assemblies and system modules developed by ZF are closely orientated to customer requirements and matched to the specific demands of the relevant application. At the same time, the typical product features of ZF’s axle drives are maintained.
ZF already has today the driveline technology of tomorrow

Reduction in consumption, less CO₂ emissions, alternative drive-line concepts – all topics which now and in the near future will have a decisive impact on developments in the automotive field. ZF innovations in the field of axle drive technology contribute to these developments.

Conflicting above goals are concerns such as additional comfort, driving dynamics and safety. ZF develops products in both directions and is combining these requirements with innovative technology. The objective is the continual improvement, both in the individual components and in the complete system. Examples of this are the rear axle drive unit VECTOR DRIVE®, which provides more dynamic response as well as safety, or the development of the electrical axle drive unit, which has already staked a claim to the future with its environmentally friendly drive concept. Also improvements in detail result in progress for the overall system. For example, angular contact ball-bearings help to reduce fuel consumption and welding the crown wheel to the diff cage saves installation space and weight.

Innovation: VECTOR DRIVE®
The VECTOR DRIVE® rear axle drive really comes into its own on corners, when the drive torque in distributed asymmetrically between the two drive shafts by the electromechanically actuated multiskid brake of the modulation transmission. The right and left hand wheels then accelerate at different speeds which adds to the effectiveness of the steering function. This can increase the amount of steering on corners in order to compensate for understeer (top picture). Alternatively, it can be used to prevent breakaway of the rear of the vehicle (bottom picture).

Innovation: ZF Electrical Axle Drive Unit
The electrical axle drive unit comprises a mechanical reduction transmission with two spur gear stages and bevel gear differential as well as a parking lock acting on the input shaft. The axle of the electric motor is arranged in parallel with the drive axle of the transmission and therefore represents geometrically and also functionally an integrated unit together with the two-stage, non-shiftable reduction transmission. Through the design of a common central housing with a cover on the ends of the transmission and electrical machine, as well as the use of the motor shaft as the transmission input shaft, a range of functional advantages are produced, such as the reduction of bearing and interface points. This leads to an improved performance in relation to consumption and noise behaviour and to a reduction in the weight of the electrical axle drive unit.

The high demands made on the transmission acoustics for electric vehicles are satisfied by a gear design which has been specially optimised for noise.

Innovation: ZF AWD-Disconnect System
ZF has developed a new AWD Driveline with AWD-disconnect function, which results in fuel-economy improvement between 3 to 5 percent. The new ZF AWD-Disconnect System is solving the target conflict between AWD performance and additional fuel-consumption due to AWD. Disconnect means that always when no AWD function is required, there will not just be no torque transferred to the secondary axle, but also the speed-dependent losses due to friction and oil churning will be avoided. Compared to a conventional AWD system the Disconnect system can therefore reduce the friction losses by up to 90 percent. The mode change between 2WD and 4WD is performed by an operation strategy on the move, fast and seamless for the driver. Thanks to an RDU with a twin-clutch, traction and driving-dynamics are improved as the drive-torque can be distributed between the rear wheels as appropriate.

Alternatively to the high-end system with synchronizer in the PTU and a twin-clutch RDU, ZF also offers less complex and therefore more cost-efficient systems with AWD-Disconnect function.
Axle drive systems for driving pleasure at customer’s option

Sportily agile or comfortable and cosy. Differing demands are made on the driveline depending on the style of driving. For different types of vehicles and installation situations ZF has developed suitable units which are perfectly matched to the vehicle design - irrespective of whether a sporty SUV or a luxury limousine is involved.

Perfect technology for each type of vehicle
As variable as vehicle concepts are, as individually ZF axle axle drive units can be adapted to automaker’s requirements. All ZF axle drive units have one thing in common:

they are not only rugged, weight-optimized and high-performance, they are also characterized by smooth running, a low noise level and vehicle-optimized design.

Low noise level
The precisely ground-finished bevel-gear teeth, the low imbalance levels and specially matched rubber mounts also ensure good acoustic properties. So, the powerful ZF axle drives ensure a low noise level.

Saving but only on weight
In conjunction with consequent component dimensioning in line with the stresses involved, the housing, which is manufactured completely in aluminum using a special split-line concept and integral rubber mounting bushes, gives an unequalled performance-to-weight ratio. Thus, the problem of increasing weight of cars is solved. Through integration of functions and deliberate material usage ZF makes axle drive units more lightweight. This lightweight construction rewards axle drives substantial advantages in competition on the international market.

Vector Drive® rear axle drive: intelligent torque distribution
As the drive torque is distributed to the left or right-hand wheel individually, the VECTOR DRIVE® rear axle drive provides better driving dynamics and enhanced safety. And, with its planetary construction, the rear axle drive even delivers when the engine has no traction, i.e. in cases where the driver is not accelerating, such as when descending winding mountain roads. It also prevents tire slip when setting off on all kinds of road surfaces, which reduces wear and tear and improves the vehicle’s traction.

RDU rear-axle drive unit
with aluminum housing for use in passenger cars with permanent all-wheel drive. Due to the distribution of the torque between the front and rear axles, it was possible to design the RDU in an appropriately small size, which in conjunction with the aluminum housing and the welded crown wheel leads to a very low weight.

RDU-EM rear-axle drive unit
with an electromechanically operated axle differential lock. A multidisc set is driven by the electric motor through a reduction transmission and a ball ramp, producing a continuously controllable differential torque, enabling an increase in performance to be achieved through improvements to the traction and driving dynamics.

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Quality in each vehicle class
Research and development is the basis which leads to capability in everyday use. Practical use highlights those who are capable of holding their own at the top level of the car industry. The demands made of all modern vehicles are very high, but are even more stringent when cars in the top class are involved. ZF has proved that it can respond to the manufacturers’ strictest requirements – both with SUVs and middle to luxury class vehicles. The quality characteristics of ZF for axle drive systems have to fulfill sophisticated requirements.

High efficiency
The use of viscosity optimized synthetic oils and improved friction bearings in combination with design provisions to reduce churning losses enables minimized axle drive losses. This contributes to the reduction of fuel consumption.

Competitiveness
In conjunction with the modular kit principle and the optimized assembly and manufacturing concepts, the design of the housing to utilize the advantages of economical die casting methods provides the prerequisites for a competitive position in the market. This is emphasized by a broad market presence with central development and regional production sites. Thus, ZF offers its customers the necessary flexibility and capacity to be able to successfully respond to market cycles.

Reliability
100 percent noise and leakage testing of the fully assembled units and lifetime lubrication with synthetic oil provide reliable drives which are maintenance-free over the vehicle lifetime. Durable and rugged units are the result of our innovative development work.

FDU front axle drive unit for use in all-wheel drive passenger cars. A small installation width is achieved due to the longitudinal partition of the aluminium housing. The drive unit is mounted to the side on the internal combustion engine.

RDU rear axle drive unit for passenger cars with standard drivelines. The RDU has an aluminum housing with transverse split line which has been specially adapted to the environment in the installation space with integral mounting brackets and rubber support. Apart from a range of various axle transmission ratios for covering various engine versions, as well as the open differential, the RDU can also be fitted with a ZF multidisc self-locking differential.
Consistent zero-defect strategy
Expertise in research and development, precision and quality in production and assembly. The result is durable and rugged axle drives which are admirably suited to market demands and represent efficiency and reliability.
Partners can depend on ZF. Therefore, on-going inspections are undertaken and documented during volume production to guarantee constant production quality. ZF quality management is based on the zero-defect strategy, removing the customer’s need to perform incoming inspections and allowing for direct delivery to the assembly line.

Fulfilling diverse demands at best
The greatest challenge to axle drive systems is the wide spectrum of requirements which have to be covered. On the one hand ride comfort, quiet performance and smooth operation in everyday road traffic are demanded and on the other hand the drive line must be able to take the highest stresses over rough terrain.

Differential with welded crown wheel
By joining the differential cage and crown wheel by means of a laser-welded seam savings in both installation space and weight are made in comparison to the classical bolted joint.

Specialist center for bevel gears
Since time immemorial axle drive units from ZF have been characterized by the excellent production quality of the individual components – particularly the bevel gear sets. The site at Thyrnau has been systematically established as the specialist center for bevel gears within ZF. Apart from the passenger car segment, precision bevel gears are produced for agricultural and construction machinery, railway technology, bus axles as well as for special applications. Computer aided production takes place either on highly automated machines or in manually loaded machining centers depending on production volumes and number of variants. With the know-how collected in Thyrnau, an additional bevel gear set manufacturing site has been established in Marysville (USA).

Progressive technologies regarding production
State-of-the-art production technologies are employed – for example, the dry milling of the bevel gear teeth, the grinding of the tooth profile for the best smooth running and load-bearing properties or the integrated noise test to ensure the best acoustic values. Marking the components by means of laser labeling facilitates component identification and tracing.
Research and Development to Secure Mobility

Innovations are not a purpose in themselves for ZF; they must pay off, for manufacturers, fleet owners, and drivers, but also for the environment and society. Each new development must prove itself among the conflicting priorities of these criteria.

The ZF Group benefits from an international network of development centers: The main development locations are Friedrichshafen, Dielingen, Passau, Schweinfurt, Schwäbisch Gmünd, Northville near Detroit (USA), Pilsen (Czech Republic), and Shanghai (China). Worldwide, more than 7,100 employees work in Research and Development. Corporate R&D coordinates and supports the activities at the development center in Tokyo (Japan). Every year, ZF invests approximately five percent of its sales in Research and Development. With success, because innovative products from ZF set the standards for state-of-the-art technology – again and again.

Development work at ZF is organized according to decentralized and central functions. The divisions and business units focus on markets and product expertise, ensuring customer-centered, competitive technological product development. Corporate R&D works with a strong emphasis on basic research and theory and supports the functional development areas in the divisions.

Groundbreaking innovations

Over the past years, this partnership has produced product innovations that have since become benchmarks in the industry: Just some examples are 9-speed automatic transmissions for cars as well as hybrid transmissions and hybrid management for cars and commercial vehicles, or the transmission systems TraXon for CVs. Groundbreaking innovations from ZF are in use today not just in passenger cars and commercial vehicles on the road, but also in all kinds of craft on the water and in the air.

What’s more, the innovative power of ZF is set to increase in the future. Proof of this is already provided by the number of patents pending:

A look at the statistics of the German Patent and Trademark Register shows that ZF occupies 8th place among applicants for patents – on a level with many large automotive manufacturers. Each year, the research departments successfully complete more than 10,000 projects, covering the full range from basic research through to product applications. This high project volume is necessary to ensure mobility in the future. The trend toward hybrid solutions already shows that green drive technology is very complex. The same goes for pure electric drives and lightweight design engineering. Currently, ZF engineers are conducting pioneering work on alternative materials, broader approaches in design and testing, and new production processes.

ZF axle drives at the Thyrnau location

Supported by fundamental research at the group’s own research and development center, the specialized development of ZF products is carried out at our Thyrnau location. In cooperation with the vehicle manufacturer, exact matching of our products to the vehicle characteristics and customer specifications is assured. Continuous improvement is thereby no flowery phrase, but a thousand fold approved reality.
Our enthusiasm for innovative products and processes and our uncompromising pursuit of quality have made us a global leader in driveline and chassis technology. We are contributing towards a sustainable future by producing advanced technology solutions with the goal of improving mobility, increasing the efficiency of our products and systems, and conserving resources.

Our customers in the automotive and industrial sectors welcome our determined focus on products and services, which provide great customer value. Improvements in energy efficiency, cost-effectiveness, dynamics, safety, and comfort are key to our work. Simultaneously, we are aiming for continuous improvement in our business processes and the services we provide. As a globally active company, we react quickly and flexibly to changing regional market demands with the goal of always providing a competitive price/performance ratio.

Our independence and financial security form the basis of our long-term business success. Our profitability allows us to make the necessary investments in new products, technologies, and markets, thus securing the future of our company on behalf of our customers, market affiliates, employees, and the owners of ZF.

Our tradition and values strengthen our managerial decisions. Together, they are both an obligation and an incentive to maintain a reliable and respectful relationship with customers, market affiliates, employees. Our worldwide compliance organization ensures that locally applicable laws and regulations are adhered to. We accept our responsibility towards society and will protect the environment at all of our locations.

Our employees worldwide recognize us as a fair employer, focusing on the future and offering attractive career prospects. We value the varied cultural backgrounds of our employees, their competencies, and their diligence and motivation. Their goal-oriented dedication to ZF, beyond the borders of their own field of work and location, shapes our company culture and is the key to our success.