ARTIFICIAL INTELLIGENCE
ZF teaches cars how to think

SAFETY
An algorithmic guardian angel

DELIVERY 4.0
New solutions for logistics

DIGITALIZATION
ALL CHANGE!
ZF ON ALL CHANNELS

ZF news is published on a wide variety of platforms.

For more on the world of ZF, check out our website at www.zf.com. In our online magazine, you’ll find videos, photo galleries and background stories covering all the latest ZF activities. As a global technology company, we also have a presence on all the most popular social media channels. Follow us on Facebook, LinkedIn, Twitter or YouTube and you’ll always find the most up-to-date info on ZF, as well as more general news on mobility and technology.

“A 130 years after the car was invented, we’re re-examining and reinventing mobility from first principles.”

Are you aware that we’re currently living through a revolution? Since it was first invented more than 130 years ago, the car has steadily evolved into what it is today. But now a positive storm of change is sweeping through the world of mobility as we know it. New types of drives, new kinds of automation are developing at a breakneck speed that has more in common with time-lapse movies than gradual evolution. Brand-new players are demanding entry to the hallowed halls of the long-established automotive industry, and seemingly unequal partners are working together on revolutionary new ventures.

The catalyst for this transformation is digitalization. Our personal and business lives are increasingly permeated by digital products, services and processes. Not only is digitalization speeding up the pace of automotive development – in many cases it is also delivering the tools we need to build totally new solutions. Digitalization is what makes smart systems networking possible, without which self-driving cars would remain a pipe dream.

For a long time, ZF has been striving to make its own, tried-and-tested mechanical products smarter – hence more efficient and safer – by networking them together. To overcome this challenge, ZF is not only building up in-house expertise, but also acquiring new, highly specialized knowledge through investments and joint ventures. For instance: one of the reasons we took a stake in technology company Ibeo Automotive Systems was so that we could jointly develop a new in-vehicle lidar system for environmental recognition. This is crucial for autonomous driving.

Just as crucial is the use of artificial intelligence (AI), because it will enable the driverless cars of the future to learn from every yard of road they cover. However, the electronic control units (ECUs) in widespread use in today’s cars are overwhelmed by the data processing and analysis required by AI systems. This is why we have entered into a joint venture with AI computing company Nvidia – so that together, we can bring the processing power of a supercomputer to automotive and industrial applications.

These are just two examples of how digitalization both poses challenges, but also delivers solutions, to our company, our customers, and tomorrow’s mobility systems. To gain an even better understanding of the revolution catalyzed by this fascinating value driver, I warmly invite you to explore the whole subject of “digitalization” in this latest issue of our magazine.
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A mobile future – made by ZF

Oasis is the visionary e-mobile jointly created byZF and Swiss think tank Rinspeed to highlight the priorities for urban transportation in the future. These include: electric driveline, automated driving functions, integrated safety systems, plus exceptional agility and versatility – of both the concept vehicle itself and potential future applications based on the underlying platform. Oasis is the first vehicle in the world to be based on ZF’s Intelligent Rolling Chassis (IRC), a ready-to-drive platform concept for urban passenger and transit vehicles. Producing zero local emissions, the IRC is exceptionally agile thanks to innovative front-axle kinematics. Intelligent networking means the chassis is already set up for tomorrow’s driverless city traffic. This makes it the ideal platform for innovative vehicle concepts devised by both new and well-established mobility providers (turn to page 36 for more details).
ZF’s RG 40 TP drive system delivers an acceleration torque of 20,220 newton meters and a torque of 40,000 newton meters. As a transmission, it fulfills the demanding conditions required to drive the Kuka KR 1000 titan, the world’s first six-axis, heavy-duty industrial robot with open kinematics. The robot is capable of moving workpieces weighing up to 1,000 kilograms – such as steel beams or aircraft components – rapidly and precisely over distances of up to 6.5 meters in any direction.

Durmazlar Panorama
Single-stage hypoid transmission

The new Panorama low-floor streetcar manufactured by Durmazlar is characterized by completely flat floors and large windows on all sides. The streetcar is equipped with ZF’s single-stage hypoid transmission, a single-wheel drive system optimized for low-level entrances and exits that enables eight motors to deliver evenly balanced traction torque to both rails. ZF developed the transmission for installation in very confined spaces, making the streetcar a highly energy-efficient, environmentally friendly form of urban transit.

Auman EST-A
TraXon automatic transmission system
ZF AIRTRAC

Following the development of a comprehensive range of applications for the Chinese market, ZF’s TraXon transmission system now shifts the gears in Foton’s new, heavy-duty Auman EST-A truck. Winner of the “Chinese Truck of the Year” award, the Auman EST-A also travels on ZF AIRTRAC, a rear-axle pneumatic suspension concept developed specifically for heavy goods vehicles. The air-sprung system protects road surfaces as well as cargo, and makes driving more comfortable.

BMW 5 Series
Active Kinematics Control (AKC)
8-speed automatic transmission
8-speed plug-in hybrid transmission
8-speed manual transmission
Damping systems
Brake, chassis and electronic components
Electric park brake
Electronic Stability Control (ESC)
Airbag systems
Seatbelt systems

The agility to segue through inner-city traffic, plus the power and stability to execute high-speed maneuvers on the freeway. Vehicles fitted with AKC rear-axle tracking alignment perfectly fulfill both of these very different chassis requirements. Thanks to the ZF-built system, the rear wheels play an intelligent role in steering the car, turning in the same direction as the front wheels at high speeds and in the opposite direction at lower speeds.

John Deere 6230R/6250R
ECCOM 2.9 continuously variable transmission (CVT)

Maximum performance, minimum weight: a perfect description of the two new models in John Deere’s 6R tractor series, each capable of delivering up to 290 horsepower. The ECCOM 2.9 CVT, customized by ZF for higher performance, meshes tightly with the tractor engines. The ECCOM 2.9 delivers engine power to the wheels with almost zero losses – yet despite a vastly improved power-to-weight ratio, its size remains unchanged.

Buick Enclave
Forward-facing camera
Airbags
Brake components
Anti-lock braking system (ABS)

Three rows of full-size seats and an impressive five-star rating in the NCAP crash test are among the many features that make the Buick Enclave luxury crossover SUV the ideal family car. ZF has also made a significant contribution to the new vehicle’s active safety systems, in the form of the forward-facing camera that identifies other road users, as well as road markings, signs and other vehicles.

Porsche Panamera
8-speed dual-clutch transmission
Plug-in hybrid module
Rear-axle drive
Active Kinematics Control (AKC)
Continuous Damping Control (CDC)
Brake, chassis and electronic components
Gearshift system
Airbag and seatbelt systems
Steering-wheel system

ZF’s first 8-speed dual-clutch transmission has gone into series production in the new Porsche Panamera. Gearshift styles range from fuel-efficient (favoring low engine speeds) through comfortably smooth to uncompromisingly dynamic, according to need. Fitted with the optional plug-in hybrid module, which has a peak output of 100 kilowatts, the new sports transmission for rear-wheel-drive or all-wheel-drive vehicles is capable of electrically boosting acceleration, and enables cars to run on all-electric power with zero local emissions.

MOVING PEOPLE AND FREIGHT

ZF takes care of mobility on roads, railways, fields and in factories. These are some of the latest vehicles and machines to feature ZF technology.
At the end of 2016, ZF received not one but two awards. First, the company was presented with the “Top 500 Award” by media group WeltN24 and international consulting firm Accenture. This award honors corporations that succeed in sustainably increasing sales and profits. According to the jury’s summary, ZF is an “impressive example of how a company with a 100-year history can manage to be extremely successful under constantly changing market conditions and despite fierce competition.”

The American Chamber of Commerce in Germany (AmCham Germany) honored ZF and four other German companies with the prestigious Transatlantic Partnership Award. In bestowing this award, the organization recognizes the success, adaptation and persistence of German companies investing in the U.S., holding up the award-winning companies as outstanding role models and examples of close German-American relations.

Two awards

Setting an impressive example

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Passenger airbags

Better in-car protection

To minimize injuries to vehicle occupants resulting from collisions, ZF is presenting new passenger airbag concepts, as well as curtain airbags with additional V-shaped or U-shaped design features. They can help protect front-seat passengers very effectively from serious injury, even in the event of a frontal oblique impact on the vehicle’s left-hand side at 55 mph. The National Highway Traffic Safety Administration (NHTSA) is considering whether to add this functional test to the U.S. New Car Assessment Program (U.S. NCAP) for assessing new cars starting in model year 2019.

New technologies

Joint venture with MTU for marine propulsion systems

In the future, ZF and Rolls-Royce Power Systems will work even more closely together on marine propulsion systems. For many years, perfectly matched combinations of MTU engines built by Rolls-Royce Power Systems and marine transmissions built by ZF have been installed in a wide variety of ships and yachts. In the future, both companies will share more closely in the development of new technologies and products as they aim to provide customers with optimized propulsion solutions.

The two partners also intend to collaborate on joint marketing, sales and service activities.

Race Engineering and Conkit

Smart use of synergies

At the start of 2017, ZF combined Race Engineering and Conkit to form a single business unit. Under the management of ZF Race Engineering, the new unit will develop and manufacture products capable of meeting special customer requirements. In terms of strategy, ZF will become a full-service provider, acting as a single source for motorsport technology, as well as products and services for low-volume production runs, engineering, consulting and test purposes. Norbert Odendahl, CEO of ZF Race Engineering, emphasizes that “for our long-term success, it is vital that we act as a single, powerful unit in all of these niche markets.”
NO NEED TO FEAR THE DIGITAL REVOLUTION

The onward march of digitalization affects us all—from individuals to globally active enterprises. While the resulting anxieties are understandable, history shows that technological disruption has always speeded up social development.

Text: Stefan Schrahe
Illustration: Dave Hänggi
o doubt about it – business is undergoing a radical transformation. The world’s largest media company doesn’t produce any of its own content (Facebook), the world’s largest taxi company doesn’t own a single car (Uber), the world’s largest provider of accommodation doesn’t offer a single hotel bed (Airbnb). And yet the market value of over-night accommodation exchange Airbnb is currently estimated at around 25.5 billion dollars – meaning that just eight years after it was launched, the online platform is worth 15 times more than the long-established Hyatt Group, which owns more than 600 hotels in 50 countries and employs around 45,000 people.

These examples show that today, new ideas can be implemented faster and more easily than ever before. Cloud computing, networked user groups and the blurring of once clearly defined boundaries between customers and suppliers are other factors that are helping this process along. New technologies are enabling entrepreneurs to enter new markets with relatively little start-up capital.

But this dawning new age is not just transforming companies and business models – on many a shop floor, the most strenuous and difficult jobs are now handled exclusively by robots. Robot vacuum cleaners are appearing in every consumer electronics store. And very soon, robots will be ready to take on more household chores, enabling individuals in an aging society to remain autonomous and self-determining for longer than ever before. At the same time, the networking of digital products and the use of “deep learning” algorithms are enabling digital devices to climb ever steeper learning curves – to the benefit of users everywhere. Using swarm intelligence, the new algorithms positively suck up knowledge and experience, and we’re already seeing the benefits – when a smartphone’s Cloud-based voice control software also understands dialects, for example, even though they were never explicitly included in the program code.

Change always causes anxiety
Modern consumers are permanently on the move, networked, with a perfectly transparent overview of everything. But the very changes that are supposed to make our everyday lives easier inevitably arouse anxiety – even fear. Back in 1843, well-known German poet Heinrich Heine reacted to the opening of the Paris-Orléans railway by feeling “a spine-chilling horror of the kind we always feel when the most alarming, the most unexpected things happen, with all their unforeseeable, incalculable consequences.” The poet’s strong reaction is understandable; at the time, doctors feared the human eardrum would rupture at speeds over 20 miles per hour. After all, in more than 200,000 years of human history, nobody had ever traveled at such extreme velocities.

Today, the sheer pace of change is once again causing anxiety and even fear – albeit with significant differences between one part of the world and another. Even in New York and London, people talk about “German angst,” because 50 percent of Germans perceive digital innovations as dangerous – and 60 percent of Germans believe the advance of digitalization will cost jobs. Fear of change is greatest where people have settled comfortably into long-standing habits. Societies that are already

4.6% is the digital economy’s value-added contribution to Germany’s trade activities. And that’s just the start.
in the midst of the digital transformation process see things very differently. According to a recent survey, 57 percent of Chinese are convinced that digitalization will create new jobs and opportunities, and 66 percent of respondents underlined the benefits of digitalization.

These anxieties are essentially identical to the fears aroused by processes of change in earlier times. Thus the Silesian weavers tried to destroy the newfangled mechanical looms when they first appeared in the 1840s. In a sense they were right, because their jobs soon disappeared in much the same way as typesetters’ jobs vanished during the 1980s. But over the last 150 years of industrialization, new jobs have always emerged – usually more than compensating for those that were lost. In anxious Germany, for example, the digital economy already accounts for more than 4.6 percent of the country’s commercial value added, embracing 92,000 companies and employing over one million workers – 10 times more than the steel industry, about the same as the automotive industry, and more than the mechanical engineering industry.

Not really new – just much faster Perhaps what’s really new is not so much the digital transformation itself as the suddenly accelerating pace of change associated with it. There’s plenty of evidence to show that mankind has been engaged in a continuous process of transformation since the start of the Industrial Revolution. Since the middle of the nineteenth century, not a single generation has lived in exactly the same way as the previous one – a radical shift from the conformity and urbanization that previously characterized society.

The steam engine was the first thing to transform – in a remarkably short time – ways of life that had hardly changed for centuries. The next major change was sparked by electricity in the early twentieth century. Then the microprocessor appeared in the 1970s, kicking off the evolutionary “ever smaller, ever more powerful” trend that has paved the way for today’s paradigm shift – digitalization.

Digitalization started with the internet, which began its triumphal march some 20 years ago. Since then, personal use of IT has reached saturation point, covering almost 85 percent of the population. Even so, data streams are still showing exponential growth. What first began with beeping modems and complicated web addresses has become an almost invisible part of our daily lives. Many of the things we do are already internet-based, before we even open our web browsers. Digital television, Voice-over-IP telephony and modern GPS systems are all typical examples.

Accompanying phenomena Digitalization represents a new chapter in the history of industrialization. But it is accompanied by two other phenomena that have also accelerated dramatically, and without which digitalization would be impossible to imagine: globalization and urbanization. Global connectivity is a prerequisite for the business models pursued by companies like Facebook, Airbnb, Amazon, Uber and eBay, all of which are building platforms that unite vendors and customers around the world.

Urbanization is the second prerequisite for digital success. Uber, Airbnb and grocery delivery services would find a very limited customer base outside urban environments. And urbanization will become even more important in the future. At the end of the nineteenth century, London was the only city in the world with more than five million inhabitants. Nowadays, some 12 percent of the world’s population lives in 29 megacities, each with more than 10 million inhabitants. Since 2008, more people have been living in towns and cities than in the countryside. And a study by UN-Habitat – the United Nations Human Settlements Programme – estimates that by 2050, more than 70 percent of the world’s population will be living in urban areas.
2000

The Nokia 7110 is the world’s first internet-enabled mobile phone. The Wireless Application Protocol (WAP) means that websites can now be accessed by users on the move.

2007

Apple-CEO Steve Jobs presents the first iPhone – and the smartphone’s multi-touch screen is a sensation. The app-based operating concept opens up new application opportunities for developers. At the same time, network operators establish the UMTS mobile radio standard. Now 3G networks are capable of transferring 100 times more data per second than ever before.

2010

At 120 million units, the production of digital cameras reaches its zenith. In subsequent years, entry-level camera models are increasingly replaced by smartphones.

2016

Interactive speakers such as Google Home and Amazon Echo are capable of controlling all household electronics by voice command. Roll up the blinds, switch on the lights, turn up the heating – a spoken instruction is all it takes. The various devices are interconnected by WLAN.

of all employees who responded to a worldwide survey by online job exchange Monster believe that within the next 10 years, their jobs will be done by artificial intelligence.

soaring city traffic levels, digital management systems are essential; by 2030, the number of cars on the world’s roads will nearly double. Without automation and networking, individual mobility in metropolitan areas will soon be inconceivable.

Nothing for it: change – or lose

Those who don’t play an active part in this process of change will, quite simply, lose. This is why automakers are no longer exclusively concerned with vehicle manufacturing as the main source of value. They are transforming themselves into mobility providers, setting up car-share fleets and developing apps for enabling users to find the fastest routes between two places by all means of transport available – not just cars. “The industry’s value added is shifting away from hardware toward software and services,” confirms Harald Krüger, CEO of BMW. The automotive industry already knows how to interpret the many examples of once-proud top dogs sinking into sudden obscurity. Those unfortunates miscalculated the dynamics of the transformation process – the sheer speed of the shift from analogue to digital photography, for instance, or the transition from daisy-wheel typewriter to PC printer.

The real challenge is knowing how to look outside the box – and that’s not just true of our current age of digitalization. But Nokia failed to keep up with the rapid trend away from keypad-equipped mobile phones to smartphones, and in the space of just five years, practically disappeared from the marketplace.

If they don’t want to suffer the same fate, automakers and their suppliers must constantly seek out new business models that will enable them to anticipate trends while at the same time benefiting from the experience and expertise embodied in their core competency: mobility. Joint ventures offer one of the most promising ways forward, through cooperative agreements that benefit both parties.

The varying pace of digitalization

Building digital expertise, optimizing processing power and investing in associated technologies don’t necessarily mean you have to make a complete break with the past. In certain parts of the world, industrialization has only just begun; in many of them, it will take years before the digital interconnectedness of all aspects of life (let alone electromobility or autonomous driving) will play the significant role it is set to play in the near future in the cities of the industrialized nations.

Nobody is in any doubt that digitalization is transforming our society. But over the last 150 years of industrialization, change has become a normal part of everyday life. Change demonstrates just how astonishingly adaptable our economic and labor systems really are. Companies are also capable of taking advantage of such change – indeed, they have no choice. To do so, they must actively seek to drive and guide change, rather than allowing unexpected change to overwhelm them. ■
SWELLING STREAM OF DATA

We aren’t always aware of the growing influence of the digital revolution on our daily lives. But the figures on this page quite clearly show how drastically our lives have already been changed by digitalization.

In the space of one hour, a LUXURY VEHICLE generates around 25 gigabytes of data. Its computing power is equivalent to that of 20 HOME COMPUTERS.

50% was the growth in the number of videos downloaded to TVs from the web in 2015. And the trend continues: experts expect this growth to reach 260 percent by 2020.

Between July 2008 and June 2016, 130 billion apps were downloaded from the Apple App Store.

100 BILLION NERVE CELLS work together in the human brain. To replicate just 1 percent of what the brain does in a single second, the world’s fastest supercomputer in 2011 needed a whole 40 minutes.

By 2030, computers are expected to be able to achieve performance similar to that of mankind’s “thinking organ.”

After some 40 YEARS, the era of the VHS video recorder came to an end in July 2016, when the world’s last remaining manufacturer – the Japanese Funai Group – finally ceased production.

According to forecasts, 2017 will see a worldwide average of 225,3 BILLION E-MAILS sent and received each day. In parallel with this development, the worldwide volume of traditional letters has fallen drastically. Since mid-2015 in New Zealand, mail carriers have only been on the road 3 days a week (instead of the customary 6 days a week).

Well-known DATING WEBSITE MATCH.COM has been online since 1995. Since then OVER ONE MILLION BABIES have been born to parents who first met each other on the dating portal.

700,000 lines of SOFTWARE CODE typically appear in a modern car’s advanced brake control system – just 12 years ago, the figure was still 20,000 lines.

Compared to the NAVIGATIONAL COMPUTER in the Apollo 11 spacecraft used for the 1969 moon landing, today’s high-end smartphones work around 2,300 times faster, have 1 million times more RAM (at 4 GB) and up to 8 million times more storage space (at 256 GB), while also being at least 210 times lighter.
While technologies have made our roads safer, more than 1,250,000 people are still killed in traffic accidents around the world every year. These deaths usually happen for one of two reasons: failure to pay attention, or lack of visibility. That’s where ZF’s X2Safe algorithm comes in, by warning road users of imminent collisions.

Text: Stefan Schrahe
Photos: Robert Guio

Every driver’s nightmare

Pedestrians suddenly walking into the road are EVERY DRIVER’S NIGHTMARE, because often there’s no time at all for evasive maneuvers or emergency braking.

 nybody who left the house and joined the road traffic back in 1970 was taking – from a modern perspective, at least – a major risk. In that year, Europe’s dismal accident statistics showed a record 85,000 road deaths. More than four decades later, the figure has fallen to just under 26,000, even though European traffic and transit volumes have nearly tripled over the same period: today, traveling from A to B is safer than ever before. But that’s no reason for complacency. Thanks to major advances in the development of passive and active safety systems, integrative, interconnected safety concepts such as ZF’s X2Safe algorithm promise to take accident avoidance to a whole new level.

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Technologies save lives

The reason our roads are so much safer is mainly due to the use of technology. Over the first decades of motorization, rising accident rates were accepted as an inevitable corollary of progress. But since the 1960s, auto developers have aimed to make each new generation of vehicles safer than the one before. U.S. attorney Ralph Nader played a key role in this realignment of priorities. In his book “Unsafe at Any Speed,” published in 1965, he detailed significant design flaws in many U.S. automobiles, kicking off an industry-wide debate that eventually resulted in congressional hearings and a string of new laws. Among other things, no more convertibles were built in the U.S. for a period of six years, because Nader had highlighted their lack of protection in the event of rollovers. Suddenly, public interest focused on developments like crumple zones and seatbelts. Further passive safety innovations soon followed, such as seatbelt pretensioners and airbags. Then “smart” driver-assistance systems started to proliferate, such as the anti-lock braking system (ABS) and electronic stability control (ESC). The idea behind these active safety systems was not to mitigate the consequences of an accident, but to prevent collisions in the first place by means of targeted interventions in the vehicle’s driving dynamics. These technical developments were backed up by legislation and statutory regulations setting speed limits and blood alcohol limits, compelling manufacturers to fit headrests, and obliging drivers to use seatbelts and child seats. Crash tests by automobile clubs and organizations such as NCAP also raised consumer awareness of safety issues and helped ensure that new cars without good safety ratings never made it off the dealer’s lot.
The Vision Zero challenge

Because even one road-accident victim is one too many, ZF and other companies have set themselves an ambitious target, christened “Vision Zero.” The aim is to make roads and other means of travel so safe that serious injuries and traffic fatalities cease to exist. The term “Vision Zero” has its origins in occupational health and safety, and was first used to refer to road traffic in Sweden in the late 1990s. Vision Zero is based on the realization that human beings make mistakes. This is why highly complex systems such as road traffic require technologies that prevent such mistakes from having life-threatening consequences.

Over the last 40 years, vehicle occupants in particular have benefited from all kinds of safety improvements. The risks to weaker road users, however, such as pedestrians and cyclists, remain or are unchanged. They account for such mistakes from having life-threatening consequences.

Always online: from risk to opportunity

“And that’s what we took as the starting point for our product concept. X2Safe collects motion data from mobile phone users and vehicles connected to the system, and uses it to attain a level of safety that couldn’t be achieved without networking,” says Dr. Malgorzata Wiklinska, head of ZF Denkfabrik, where X2Safe originated. In the Cloud, X2Safe uses these individual motion profiles to calculate whether a collision with another road user is imminent, and alerts all those involved even before they have made visual contact. This means that X2Safe detects hazardous situations faster than either camera or radar systems. The algorithm effectively anticipates collisions before they occur. “With X2Safe, the risk associated with being permanently online is turned into a safety advantage,” explains Wiklinska.

The artificial intelligence embedded in the self-learning system is used to analyze the behavior of every single road user – and based on this analysis, to decide on a suitable response. So if, for example, a pedestrian ignores red lights at a junction or decides to cross the road in a hazardous spot, X2Safe rates this behavior as particularly hazardous situations – like this one.

Protecting vehicle occupants

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1930</td>
<td>First windshield made out of laminated glass (BMW DA 3)</td>
</tr>
<tr>
<td>1945</td>
<td>First car with shock-absorbing steering wheel and two-point seatbelt (Tucker Torpedo, U.S.)</td>
</tr>
<tr>
<td>1955</td>
<td>First three-point seatbelt (Volvo PV 544)</td>
</tr>
<tr>
<td>1957</td>
<td>First car with collapsible steering column, non-deforming passenger compartment with crumple zone, and side-impact protection (Mercedes-Benz W 111)</td>
</tr>
<tr>
<td>1966</td>
<td>Owners of new cars in the U.S. required to wear seatbelts</td>
</tr>
<tr>
<td>1967</td>
<td>Headrests fitted as standard for first time (BMW 2500)</td>
</tr>
<tr>
<td>1972</td>
<td>Introduction of electronic anti-lock braking systems (ABS)</td>
</tr>
<tr>
<td>1980</td>
<td>First production car fitted with electronic stability control (Mercedes-Benz S 600)</td>
</tr>
<tr>
<td>1996</td>
<td>Electronic stability control becomes mandatory in all new cars in the European Union</td>
</tr>
<tr>
<td>2001</td>
<td>ABS becomes mandatory in all new cars in the European Union</td>
</tr>
<tr>
<td>2011</td>
<td>Electronic stability control becomes mandatory in all new cars in the United Kingdom</td>
</tr>
<tr>
<td>1978</td>
<td>Seatbelt (Tucker Torpedo, U.S.)</td>
</tr>
<tr>
<td>1966</td>
<td>First production vehicle with electronic anti-lock braking system (Mercedes-Benz W 111)</td>
</tr>
<tr>
<td>1980</td>
<td>Electronic stability control becomes mandatory in all new cars in the United Kingdom</td>
</tr>
</tbody>
</table>
addition to motion data, X2Safe can also process information on high risk factors such as invisible streetcars or blind spots near bus stops, and incorporate this information into its situation assessments.

For ZF, this Cloud-based algorithm represents another building block in the intelligent digitalization of mechanical components. Torsten Gollewski, head of Advanced Development at ZF, believes that “X2Safe underscores – as do other digital developments by ZF – our commitment to playing an important role in autonomous driving. As vehicles become increasingly connected, we’re starting to progress beyond simple warning functions to direct, automatic interventions – right through to evasive maneuvers or full emergency braking.”

From Wiklinska’s perspective, road users could already start to benefit from X2Safe today. “Our technology is easy to retrofit to any vehicle on the market today. By doing so, we could create an interactive safety network that would become increasingly effective as more and more people and vehicles are connected to it.”

Thus the revolutionary X2Safe algorithm marks a significant milestone along the road to achieving Vision Zero.
For gaming fans, the Nvidia brand has been synonymous with high-performance graphics ever since its products first appeared in 1999. The GeForce 256 was one of the first dedicated 3D graphics processors (GPU) for computer games. Since then, Nvidia has succeeded in doing what no other company apart from Intel has done: turn an innocuous piece of hardware tucked away in the innards of the system into a high-value brand item. Today’s PC desktop builders use the latest generation of GeForce processors as a major selling point for their systems.

Meanwhile GPUs have powered their way into new fields, far removed from the realm of gaming. Nvidia CEO Jen-Hsun Huang believes his technology will quite simply “reinvent our world.” That’s because the GPUs that Nvidia has developed for processor-intensive 3D gaming over the last 20 years are now playing a key role in what is probably the most important IT development since the invention of the internet: artificial intelligence, or AI.

Deep Learning: full speed ahead!

AI is already used in many applications, such as smartphone voice control software capable of adapting to user input. The very latest innovation is “Deep Learning,” a way of enabling AI systems based on manmade “neural networks” to learn without any human intervention at all – something for which conventional computer architectures simply aren’t fast enough. The calculations needed to train an AI system are not dissimilar to those required to generate 3D worlds in computer games, based on mathematical models that must be reiterated billions of times. And that’s where Nvidia comes in.

“Neural nets fitted with our GPUs can be trained orders of magnitude faster,” explains Jaap Zuiderveld, head of Nvidia’s European operations. This discovery is laying the foundations for an application that will transform all our lives: automated driving. In order to make correct decisions in a traffic, self-driving vehicles must process vast quantities of data in real time – data streaming from dozens of cameras, as well as lidar, ultrasound and radar sensors. At the same time, self-driving vehicles are constantly learning, with every mile teaching a new lesson. And finally, they’re sharing their new experiences with each other via the Cloud.

Value-adding synergies

Now ZF is working with Nvidia to develop a system that will make artificial intelligence available to the mobility industry. At the Consumer Electronics Show (CES) 2017, ZF unveiled the company’s first system for automated freeway driving, based on Nvidia’s A1. ZF ProAI enables vehicles to “understand” their surroundings by using deep learning technology to process and interpret data from sensors and cameras. The two partners are also working on solutions for highly automated and fully automated driving.

At the heart of ZF ProAI is a processor developed specifically for automotive applications – simply installing an ultrafast PC processor in a car isn’t an option, as Torsten Gollewski, head of ZF Advanced Development, explains. “Temperatures in automotive environments range from minus 30 to plus 80 degrees Celsius. Other stress factors include humidity, vibration and high G-forces – conditions which conventional PCs and games consoles aren’t designed to handle.”

“ZF supplies ZF ProAI as a system that can built into a vehicle, updated via the Cloud, and upgraded with additional functions throughout the lifetime of the vehicle. Series production of the new ZF ProAI system is scheduled for 2018. But the beneﬁts aren’t solely reserved for cars. The key concept here is "automated operations", based on the realization that an electronic component capable of handling the stresses and strains found in passenger cars is also ideal for use in products in other industries. “Working with Nvidia, we’re bringing the supercomputer standards of performance required for artificial intelligence not just to cars and commercial vehicles, but also to all kinds of industrial applications,” confirms Dr. Stefan Sommer, ZF CEO.

Just what Nvidia’s technology is really capable of was demonstrated by company founder Huang in April of last year in San José, California. He fed 20,000 images of paintings from the Romantic era into an AI-based computer. Once this had been done, the deep learning machine proved capable of creating an original piece on its own, albeit a picture that was clearly in the same style as those it had just "seen".

Although the source images were categorized, the computer was not given any information on the subject of each painting. It had to work that out for itself. Huang believes this development is the start of a new age. “We believe that deep learning represents a whole new computer model. The results are quite simply superhuman.” ZF developer Gollewski views the two companies’ collaboration as an opportunity to make a quantum leap forward: “Our joint venture with Nvidia gives us access to a world of digital possibilities in a totally new dimension!”

“We’re bringing supercomputer performance to vehicles and industrial applications.”

Dr. Stefan Sommer, CEO, ZF Friedrichshafen AG

First fruit of a joint venture between ZF and AI computing company Nvidia, the ZF ProAI processor also represents a major milestone on the road to automated driving.

Text: Stefan Schrahe

PHOTO: MMJ Studio, Sean Rodwell

Heavweight processing power squeezed into a compact, secure package. The ZF ProAI system was unveiled at the start of the year.
Digitalization is not only changing vehicles, but also the role of automotive suppliers. Chief Digital Officer Mamatha Chamarthi and Head of Advanced Engineering Torsten Gollewski are actively shaping these changes at ZF and building up a network of partners.

In the automotive industry, digitalization is a megatrend. What does this mean for ZF? Chamarthi: Digitalization at ZF will be a long and exciting journey. It is going to be massive cultural transformation, in addition to our products, services and technology transformation. The whole company needs to be engaged in this effort. Gollewski: Networked systems that extend far beyond vehicles are becoming increasingly widespread; for example, a market for autonomous transport systems has arisen as a result of the requirement to rapidly deliver orders placed online, while new mobility concepts envision robot taxis. And the question we’re asking is: could we not base both these types of vehicles on the same, standardized technology? The lines between our conventional market segments – cars on the one hand, commercial vehicles on the other – are becoming increasingly blurred.

In which areas will digital technologies first become fully established? Chamarthi: We will transform our business across all three horizons. First, by safeguarding our core to make our existing products and processes smarter and better. Then by enriching our core, by which I mean adding new features to existing products using digital technologies to, for example, create an uptime service offering based on predictive maintenance for wind turbine transmissions. And finally, by extending or redefining our core by creating a new product or service that is digitally enabled, such as the X2Safe safety algorithm.

We need to employ digital to innovate all aspects of our business – products and services, product development, workplaces, factories, and supply chains.

Gollewski: The X2Safe safety algorithm demonstrates the huge potential advantages of using networked systems in road traffic; these systems even enable us to protect road users who are not in their own vehicles, such as pedestrians and cyclists. The algorithm was developed by ZF’s in-house think tank, by the way.

Chamarthi: At the end of last year, there was a terrible accident on the Interstate 96 near where I live. A pile-up of more than 40 vehicles in snowy conditions caused three people to lose their lives. I am certain that these sorts of accidents can be prevented with intelligent, networked systems.

What does “intelligent” mean in this context? Gollewski: As a matter of fact, we’re talking more and more about “artificial intelligence.” Research has now progressed to such an extent that AI systems are becoming practicable and marketable.

Chamarthi: Soon we will be accompanied by digital assistants, such as Siri and Alexa, all the time.
Are’t these kinds of developments actually the automotive manufacturers’ job?

Gollewski: Increasingly, automotive manufacturers are showing a tendency to transform themselves into mobility service providers. This means that we, as a large supplier, have to assume more responsibilities in other areas. And yet there are nuances—not just between one manufacturer and another, but also between one vehicle and another—that present us with extremely exciting challenges and also make us a very attractive employer.

Does ZF already have the necessary software developers on board?

Chamartí: We are currently going through a massive expansion of our development capacity across the world. We are tapping into the Indian software engineering market to establish a capacity of 2,500 engineers by 2020 at our recently opened Tech Center in Hyderabad, India. We expect three-quarters of these engineers to work on developing new software capabilities for ZF.

Gollewski: It is also our job to continuously refine our own development methods. Think about functions based purely on software which could be retrospectively “uploaded” to vehicles. All technological innovations go hand in hand with process innovations.

Does digital networking also benefit ZF’s conventional products?

Gollewski: In the long term, it will benefit all of them; at the moment, quite a few. The Traxon commercial vehicle transmission, for example, with its GPS connection and navigation data interface, is capable of anticipating future maneuvers, thus greatly improving fuel efficiency. Its intelligent PreVision GPS shift strategy is able to recognize uphill and downhill inclines in advance, and considers these when selecting shifting points.

When will the Internet of Things make its way into ZF’s production plants?

Chamartí: We are already extensively testing “Industry 4.0” technologies. Our plant in Saarbrücken, where more than 1,200 types of passenger car transmissions are produced, offers a good impression of this. Digitalization is making a significant contribution there, by further increasing productivity and process quality. As an example, inventory visibility of every single component in real time helps us reduce the overall inventory levels we have to carry in the plant. This saves us money.

Can ZF do all this by itself?

Chamartí: We will certainly NOT do this all by our own. We have to orchestrate and streamline our portfolio of investments, helping us more from a disconnected portfolio to a streamlined portfolio. This will ultimately help us become a technology leader in automated driving, electrified drives and integrated safety.

How do you coordinate all these individual ideas?

Chamartí: Several successful activities have existed for a long time in the different divisions and business units. The ZF think tank is also constantly coming up with new ideas. As Chief Digital Officer, it is my task to orchestrate and streamline our portfolio of investments, helping us move from a disconnected portfolio to a streamlined portfolio. This will ultimately help us become a technology leader in automated driving, electrified drives and integrated safety.

Is there a comprehensive plan for ZF’s digital transformation?

Chamartí: We already have a great foundation and a number of initiatives underway. We need to create further success by building on the existing momentum. We are currently working on a long-term roadmap. But nevertheless, we have to prepare our organization to become more agile and prepared to respond to the rapidly changing environment and technology landscape of the digital world.

Gollewski: In today’s market environment, speed is a key factor. This is why it’s a good idea for us to work in flexible networks. Our task in Advanced Engineering is to go on integrating new ideas into an all-embracing system, so we can meet all our automotive customers’ expectations and requirements.
THE SILICON VALLEY FACTOR

How do you combine the long-term mindset of a well-established technology company with the creative spirit of a business start-up? ZF shows how: by setting up a new company, Zukunft Ventures GmbH, and entering into a joint venture with start-up accelerator Plug and Play.

Text: Andreas Neemann

The pace of change in the auto industry is accelerating. Face-lifted and brand-new vehicle models roll into car dealers’ showrooms and out to customers at ever shorter intervals. Nowadays, very few manufacturers wait for the usual eight years before bringing a new model to market. But the industry’s shortening development cycles, currently down to around five years, are still eternities compared to the ferociously quick product cycles in the electronics industry. Here, from the Cloud and automatically installed in their parked “hardware” overnight, ready for use the very next morning.

Updating cars via the Cloud
Software as a growing proportion of the product mix; shorter innovation cycles; new business models – all these developments are impacting technology suppliers like ZF. The company promises to deliver intelligent mechanical systems that enable vehicles to think, see and act. But to do so, ZF needs innovations and new ways of thinking – from inside and outside the company. One approach is embodied in ZF subsidiary Zukunft Ventures GmbH, set up in 2016 to enable the company to invest in other firms. “We offer start-ups in particular an opportunity to raise extra investment capital. In return, we gain improved access to viable, highly competitive technologies,” is how Torsten Gollewski describes the win-win concept. The fact that Gollewski is ZF’s head of Advanced Development as well as CEO of Zukunft Ventures GmbH shows how closely these functions are intertwined. The company has already made several investments, including a 40-percent interest in Hamburg-based Ibeo Automotive Systems. Together, ZF and Ibeo will develop a new generation of lidar sensors for the auto industry. Lidar (or rather, LiDAR, short for “Light Detection And Ranging”) is essential for autonomous driving. ZF has also taken a 40-percent stake in software specialist Doubleslash in Friedrichshafen. ZF has been working with close neighbor Doubleslash for several years, primarily in the field of vehicle networking.

A helping hand for start-ups
Another strategic step into the future is ZF’s joint venture with Plug and Play, a start-up accelerator based in Sunnyvale in California’s famed Silicon Valley. The collaborative venture with Plug and Play is ZF’s response to the challenge of finding and filtering the many business start-ups that could be relevant to the company’s multifaceted technology-focused activities. The Californian firm has been actively involved in start-up accelerator programs for years, all over the world. Plug and Play has helped more than 2,000 startups on their way over the past decade, and is already familiar with the auto industry; its German arm is working closely with auto manufacturer Daimler and the University of Stuttgart on the “Startup Autobahn” project. And now ZF has joined the party.

Once a potential partner has been identified and contacted, it’s often only a short step to an actual project. “ZF can benefit from working with start-ups in various ways,” says Torsten Gollewski. Over many years of working in the auto industry, he has built up extensive experience of collaborating with fledgling technology companies. In Gollewski’s view, key benefits include unconventional thinking, creative new processes and shorter, faster progress from initial idea to marketable product.

This is why it is important that collaboration with start-ups shouldn’t be restricted to the Advanced Development unit. ZF’s divisions are also embracing this stimulating opportunity; it is they, after all, who are responsible for series production at ZF – and ultimately, for the time it takes to bring finished products to market.
ONE PLATFORM – 1,000 POSSIBILITIES

ZF’s ready-to-drive Intelligent Rolling Chassis is the perfect starting point for cooking up tomorrow’s ultra-versatile mobility solutions – just add the right ingredients for a vehicle that’s entirely to the customer’s taste.

Is this what the future of mobility will look like? Every morning, your self-driving breakfast service delivers hot coffee, smoothies and fresh pastries. Then a driverless carsharing vehicle takes the kids to school while you’re being chauffeured to the office—in another self-driving rental car, natch. You ordered a vehicle equipped with two facing, fold-away bench seats and a table in the middle, so you and your coworker can hold a meeting while you’re both traveling to work. And thanks to the electric driveline, you’re not disturbed by any loud engine noise. As you get out, you tell the car to fold away the table and seats and head over to the furniture store to pick up your new lounge chair, then wait in front of your building with the purchase—where it can also be used as a mobile drop-box for any packages that might be delivered to your neighbors. The weather report forecasts glorious sunshine during the afternoon, so for your trip home, you once again book a car share. But this time you choose a convertible with a little more horsepower and classic manual steering, so you can drive yourself back on the highway. After all, why should the car always have all the fun?

One chassis – endless design options

Is this all just a fanciful vision of urban mobility? Although some of the details still need to be refined, this future may be approaching more rapidly than many of us would believe. After all, the Intelligent Rolling Chassis (IRC) developed independently by ZF is already an operational piece of technology. ZF’s ready-to-drive platform concept offers a decisive advantage to mobility providers of all stripes, from well-established automakers to scrappy new startups. They just need to add a few ingredients of their own—a battery system, a body and a customized interior, perhaps—and voilà! Their unique, all-electric transit medium is ready to roll. The Rinspeed Oasis, the first vehicle to be based on the IRC concept, has shown how quick and easy it is to build attractive, reliable, fully functional electric vehicles on the ZF platform. And if the resulting vehicle is expected to offer automated driving, an especially well integrated passenger protection system, and intelligent HMI features, ZF offers a full range of system solutions to make it all possible. Even so, the technology company is not planning to go head-to-head with OEM automakers—rather, ZF is aiming to become a stronger industry partner than ever before. This can only work to everybody’s advantage in an era which automotive
experts unanimously describe as “the greatest transformation since the invention of the motor car.”

Intelligent, connected mechanical systems

Speaking of change and the future, it’s worth mentioning that the basic idea, as well as the term “rolling chassis,” have deep roots. From the 1920s to the 1950s, both were popular and widespread in the automotive industry – and that’s still the case today for commercial vehicles such as trucks and buses. The more models and variants can be built on a given platform, the more attractive it becomes for vehicle manufacturers to order the whole interconnected complex of chassis, driveline and suspension, together with steering and braking systems, as a single unit – provided that the unit is supplied by proven specialists like ZF. What’s more, the technology company has infused the new, flexible IRC platform with something that sets it apart from earlier rolling chassis and will carry it forward into the future: intelligence. As the word “intelligent” in its name implies, the IRC incorporates all the latest advances in mobility technology.

Knowledgeable observers will swiftly appreciate the IRC’s many ingenious features. At the rear, the IRC is equipped with ZF’s Electric Twist Beam (eTB), a torsion-beam axle incorporating two powerful, clean-running, wheel-mounted electric motors. And at the front of the chassis, you’ll find an innovative independent suspension system that interacts with ZF’s electromechanical power steering system – in such a way that the vehicle has a steering angle of up to 80 degrees. That’s 50 percent more than the maximum steering angle offered by conventional front axles today. Thus the Intelligent Rolling Chassis gives every vehicle constructed on the platform – whether intended for transporting goods or passengers – a much higher degree of agility. Turning and parking in confined or congested spaces becomes child’s play.

The applied art of connectivity

When the wheels of a vehicle built on the IRC are turned to the limit – which in this case means almost perpendicular to the direction of travel – the steering axle at the front and the driven axle at the back must work together in clever ways to enable the vehicle to drive off from standstill. This is made possible by the torque vectoring function that distributes the power from the electric motors between the two rear wheels on an as-needed basis, so they can actively assist with the turning motion as the vehicle starts to accelerate. The function itself is located in the IRC’s electronic control unit or ECU – the electronic “brain” that connects together all the systems in the chassis. As a matter of fact, this ECU, designed and built by ZF, manages all aspects of the driving strategy, including all longitudinal and transverse dynamic functions and even energy recovery during deceleration. It also has all the interfaces necessary for advanced driver assistance systems, making the IRC into a very attractive plug-and-play platform for highly automated or driverless transporters.

Intelligence is the key factor defining the IRC’s chassis, which is more than just a mechanical connection between the innovative driveline and suspension on the front and rear axles. The floor of the IRC is flat as a pancake. For obvious reasons, this type of flat-floor design is also known as a skateboard chassis. And it means the IRC really can accommodate all the interior functions and vehicle concepts described above in our vision of the future – and more. It can be used as the starting point for trendy two-seaters like the Rinspeed Oasis, or for a convertible, a self-driving taxi, or even an automated electric transport container that can reliably deliver groceries or packages along the last mile of an urban delivery route.
More demanding customers and new technologies are changing the game in the logistics industry. We take a peek at what the future may bring.

The customer is king – even on the internet. Here, where consumers are no longer constrained by traditional brick-and-mortar store opening hours, they can place orders around the clock. And now they would also like to free the delivery process from traditional time constraints. No longer are we talking about delivery in two to three working days, or by overnight express – now we're looking at delivery on the same day, or in a matter of hours. Statistics clearly show the growing popularity of online shopping: in 2015, three billion packages were dispatched in Germany alone – that's one billion more than in 2005. This trend will continue for the foreseeable future as the flood of online orders keeps rising.

The challenges facing the booming parcel delivery market are especially visible on inner-city streets. Individual delivery preferences, environmental and noise restrictions, delivery traffic regulations and supply-chain safety standards are all coming together to reshape the playing field for logistics firms – who still face the same pressure to cut costs and innovate. How is the industry responding to these changes, and which trends are likely to become standards impacting the last few meters of the delivery chain? These questions are addressed by ZF in collaboration with the Fraunhofer Institute for Material Flow and Logistics (IML) in the latest ZF future study, "The Last Mile". The highlights of our findings are presented here.

DELIVERY 4.0

By land – or by air?

In the near future, could it be that packages will arrive at our homes by air, rather than by delivery van? Online retail giants such as Amazon, as well as parcel services like Deutsche Post DHL, are already testing airborne delivery by drone in selected areas. Even so, Professor Dr. Uwe Clausen at Fraunhofer IML, who served as the study’s scientific director, remains skeptical about the widespread use of such airborne solutions. "Drones will never be the standard delivery vehicle over the last mile," he says. "There are too many points against them, such as airspace safety risks and local residents’ desire for peace and privacy." It is more likely that companies will turn to driverless delivery robots, especially in rural areas. But this doesn’t mean that delivery drones have no future – they may be useful for making express deliveries in, for example, urban areas with overburdened infrastructures. Similarly, drones may be the ideal solution for making deliveries in isolated regions not yet served by more conventional methods of transportation.

Humans and robots making deliveries together

According to the ZF study, the “last mile” will undoubtedly become more automated. Solutions will range from driverless delivery robots to trucks that automatically steer themselves to warehouse loading docks. For direct deliveries, driverless vehicles represent an efficient solution that meets growing customer demand and higher delivery frequencies. It is increasingly difficult to find drivers willing to deliver to rural areas. In such cases, the use of automated package transporters will help make it possible to offer home deliveries at acceptable prices. Parcel delivery service Hermes is already testing the use of driverless delivery robots capable of carrying a payload of up to 15 kilograms over distances of up to five kilometers. But even in such futuristic scenarios, delivery drones won’t become obsolete. In urban areas, one can imagine delivery processes in which a self-driving vehicle automatically follows the delivery person while the latter focuses on handing over the parcels and interacting with recipients, for whole new levels of customer service.
3D printers shorten distances

The biggest changes in logistics will be driven in particular by technologies that not only impact methods of delivery, but make transportation itself unnecessary. ZF’s 2016 Future Study came to the conclusion that 3D printing could have the same game-changing effect on the entire logistics industry as the advent of e-mail once had on the postal service. Thanks to additive manufacturing, many products no longer have to be built in traditional production facilities, but instead can be manufactured much closer to their recipients. This will also bring about changes in city centers. Where once we used to find copy shops for photocopying or printing paper documents, we may well see 3D printing shops from which customers can pick up the goods they have ordered. However, even this futuristic scenario will not be entirely feasible without transportation. Although the finished product may not have to be transported over the last mile, the raw materials required for the 3D printing process will still need transportation.

**Consumer Behavior**

Short distances allow lightning-fast delivery

Houseplants, perishable items, cut flowers and foodstuffs all used to have one thing in common – they had to be collected from the store. Customers picked them out, paid for them and took them home themselves. While local pizza delivery services first whetted consumers’ appetites for (almost) instant gratification, e-commerce was the wild card that intensified this desire. Customers are starting to demand faster delivery of other things than just warm meals – often on the same day, and not infrequently within a few hours. This has placed hugely increased pressure on the logistics process, especially in the transportation of fresh produce. The only way to guarantee that an item arrives in good condition is to successfully deliver the order to the customer on the first attempt. Without customized delivery concepts and shorter driving distances, it is impossible to meet these demands – as a result, local distribution centers will have no choice but to move closer to their customers and become part of a more decentralized organizational structure.

**Emobility**

Target: zero emissions

In big cities in particular, the last mile of the logistics process represents a major challenge when delivery vans must share the road with other vehicles during rush hour. In the future, electrically powered vehicles will allow deliveries to be postponed until city streets quieten down for the night. Almost-silent electric drives won’t cause noise pollution, and will also reduce fuel consumption and exhaust emissions – an overall win for urban traffic. "Electric mobility will play a key role in logistics going forward, not just downtown, but also in the world’s megacities," asserts Fredrik Staedtler, who heads the Commercial Vehicle Technology division at ZF. In the future, electric commercial vehicles could replace competitors powered by combustion engines over the last mile of busy routes, as already demonstrated by a number of different pilot projects being conducted by parcel delivery services today. For example, Deutsche Post DHL has already successfully teamed up with business start-up Streetscooter, based in Aachen, Germany, to produce a functional, practical electric delivery van for use in urban areas.

**Digitalization**

New workflows

Increasingly, the logistics industry is responding to the trend toward ever more customized services by digitizing the delivery process itself. Connected systems make it possible to anticipate orders plus transportation demand curves before they are actually needed. Ideally, products should already be located in the immediate vicinity of customers even as they are placing their orders. Consignment tracking, data communications and proactive customer information are already helping to significantly improve existing workflows over the last mile. This applies in particular to timetable, itinerary and route planning, but also to the selection of suitable locations for distribution centers. For this to work, however, organizations and their employees must learn to handle the growing quantities of data required for making sound business decisions. Trust in integrity, security to prevent unauthorized access, and data protection all play an essential role.
Independent organizations like NCAP test the safety of new vehicles. Their work helps reduce the number of people injured or killed in traffic accidents – and also inspires automakers and their suppliers to produce even more impressive innovations.

As we enjoy watching Formula One races in our living rooms, we become almost subconsciously aware of the latest advances in automotive safety. Because nowadays, when an F1 race car is involved in a pile-up or careens off the track and into a pile of tires at a cool 200 mph, the driver usually walks away from the wreckage unscathed. Although enormous forces are acting on the race car’s structure, the fragile human body within is protected from injury by state-of-the-art automotive architecture. And yet just a few decades ago, such accidents would undoubtedly have been fatal.

So what’s happened? Well, the vehicle’s structure is optimized with the help of sophisticated computer simulations. Its body is made out of high-tensile materials capable of withstanding massive impacts. And the driver is fully integrated into the vehicle, wearing a helmet that is itself a marvel of high-tech engineering. How much of this has made its way from racetrack to road? Not the helmet or monocoque body, at any rate – in terms of design, a standard car has nothing in common with an F1 racer. But our understanding of the factors necessary for a driver’s survival, plus the enormous gains in computer processing power, have dramatically improved vehicle safety on the streets.

Big decline in traffic fatalities

Back in 1985, annual road traffic accidents resulted in some 10,000 fatalities in Germany alone. But by 2015, the number of traffic fatalities had fallen by almost two thirds to just under 3,500 – even though there were almost twice as many vehicles on the road. The U.S. saw a similar trend: over the same period, the number of motor vehicles in the country rose by around 100 million, whereas the number of road deaths fell by some 20 percent.

One of the institutions that made a significant contribution to this trend was the New Car Assessment Program, better known as NCAP. What may seem like a single consumer protection organization spanning the globe is actually made up of 10 independent rating agencies that specialize in assessing the safety-related features of new automobiles. The individual agencies were founded between 1978 (U.S. NCAP) and 2006 (China’s C-NCAP). They developed test protocols to standardize the crash properties of cars. Tests focus on vehicle occupants; the safer they are, the higher the number of points awarded.

Crash-test ratings take the form of stars, with a maximum score of five stars. And nowadays, vehicles with low ratings are almost impossible to sell.

Different country, different focus

However, test criteria are not identical in every country – and never have been. Each NCAP organization sets different priorities based on regional needs and the most common types of accidents there. Thus U.S. accident statistics show significantly more single-occupant accidents due to, for example, solo drivers becoming tired, accidentally veering off the endlessly long highways and rolling their vehicles. That’s why vehicle roll-overs are an important part of the U.S. NCAP test. In Europe, accidents involving other road...
Euro NCAP safety ratings cover four main areas: adult protection, child protection, pedestrian protection and safety assist technologies.

“...this will give further impetus to the development of driver-assist systems,” explains Thomas Herpich. As ZF’s Senior Manager Legislation and Regulatory Affairs System Engineering Airbags & Inflators in China, he is permanently engaged in dialog with lawmakers and the rating agencies. For years, the company has stayed in regular contact with consumer protection organizations and the relevant legislative bodies. Intelligently designed safety systems help improve road safety around the world. Consequently, engineers actually welcome the associated challenges. “It’s our job to make vehicles safer. We’re constantly having to ask ourselves new questions and find the right technical solutions. Our systems save lives,” says Herpich. And there’s still plenty to do, especially in view of foreseeable developments in automated driving.

Here, the big challenge surrounds the moment in which control of the vehicle is handed back to the driver – the moment when the system signals to the driver, “it’s time for you to take over again!” The usual visual or optical signals might not be enough for a safe transfer of command. “So in this case, the driver’s seatbelt could tighten slightly, to attract his or her attention,” says Herpich, as he describes one possible solution. In this scenario, the traditional seatbelt – originally developed as a passive safety feature – acquires an additional communication function that transforms it into an active safety device. An evolutionary step, the original developers of the seatbelt could never have imagined.

Using more realistic dummies

Passive safety also needs to take a step forward. In the U.S., one particular type of accident is very common, and the National Highway Traffic Safety Administration (NHTSA) – which is responsible for testing – has developed a suitable test protocol for this scenario, involving the simulation of a turning vehicle. A moving deformable barrier weighing almost 2.5 tons and traveling at 56 mph strikes a non-moving vehicle from the left, at an angle of 15 degrees and with a 35 percent overlap. These tests are carried out with the latest generation of crash-test dummies, christened THOR (Test Device for Human Occupant Restraint). Not only does THOR more closely resemble a human being than previous generations of dummies – it also collects much more data. In short, THOR registers loads and stresses that previously went undetected.

“...the NCAP criteria are giving further impetus to the development of driver-assist systems.”

Thomas Herpich, Legislation and Regulatory Affairs System Engineering Airbags & Inflators at ZF.

China shifts into high gear

So what’s happening in China? “The Chinese version of NCAP won’t simply follow European or U.S. standards. It will set its own priorities for the future by focusing on passive safety, pedestrian safety, active safety – including automatic emergency braking – and fuel efficiency, not to mention overvoltage protection in hybrid and all-electric e-vehicles,” says Chris Wu, Engineering Director Occupant Safety Systems at ZF China. In contrast to India and China, sophisticated safety technology has already reached the economy segment in Europe. The new Ford Fiesta, for example, contains 15 advanced driver-assist systems – features that just a few years ago were only found in luxury cars.

China NCAP

Protecting pedestrians

C-NCAP will focus more on its own priorities in the future. Starting in 2018, it plans to include pedestrian protection in the list of assessment criteria. At a later date, tests will also cover automatic emergency braking systems.

“...ZF is developing special airbags for drivers and their front-seat companions that have very little in common with simple “bags of air.” For the above-mentioned Oblique Moving Deformable Barrier (OMDB) crash test, ZF engineers developed a system of front and curtain airbags with special V-shaped and U-shaped chambers. “The special geometry covers the area around the A-pillar and instrument panel, preventing heads from hitting these components,” says Dirk Schultz. “And front-seat passengers are protected from extreme movements forward and left by our ‘parallel cell front seat passenger airbag’, which widens out toward the center of the vehicle. Both airbag systems are also designed to cushion the rolling motion of the head when it impacts,” adds Schultz, Vice President Global Engineering Airbags & Inflators at ZF.

But with autonomous driving on the horizon, engineers must think even further ahead. Whereas today’s vehicle occupants – especially drivers – sit in clearly defined positions at a certain distance from steering wheel and pedals, the variable design of future vehicle interiors means that in certain situations, drivers will move away from this “ideal” (i.e. predictable) position. If, in such a situation, a crash should happen, today’s airbag systems may no longer provide sufficient protection. To fully protect vehicle occupants in a wide variety of alternative situations, new or modified safety systems may be required. This is yet another very good reason for making efforts to further improve passive safety systems – and also introduce active safety systems that help prevent accidents from happening in the first place.

Whereas the safety standards in industrialized countries are continuously improving, many emerging nations are only just starting to establish basic safety standards. India is planning to become the world’s third-largest automotive market by 2020. And yet according to WHO statistics, more than 200,000 traffic fatalities occur in the country every year. Vehicle occupants account for up to 20 percent of these deaths. The major factor here is the relative scarcity of airbags or robust vehicle structures. Now Bharat NCAP, founded in 2011, is on the case. January 2015 saw the introduction of legislation governing head-on and side-impact collisions. The second stage involves the implementation of an NCAP test protocol.

Passive safety challenges

Front-seat passengers are also receiving more attention. ZF is developing special airbags for drivers and their front-seat companions that have very little in common with simple “bags of air.” For the above-mentioned Oblique Moving Deformable Barrier (OMDB) crash test, ZF engineers developed a system of front and curtain airbags with special V-shaped and U-shaped chambers. “The special geometry covers the area around the A-pillar and instrument panel, preventing heads from hitting these components,” says Dirk Schultz. “And front-seat passengers are protected from extreme movements forward and left by our ‘parallel cell front seat passenger airbag’, which widens out toward the center of the vehicle. Both airbag systems are also designed to cushion the rolling motion of the head when it impacts,” adds Schultz, Vice President Global Engineering Airbags & Inflators at ZF.

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China shifts into high gear

So what’s happening in China? “The Chinese version of NCAP won’t simply follow European or U.S. standards. It will set its own priorities for the future by focusing on passive safety, pedestrian safety, active safety – including automatic emergency braking – and fuel efficiency, not to mention overvoltage protection in hybrid and all-electric e-vehicles,” says Chris Wu, Engineering Director Occupant Safety Systems at ZF China. In contrast to India and China, sophisticated safety technology has already reached the economy segment in Europe. The new Ford Fiesta, for example, contains 15 advanced driver-assist systems – features that just a few years ago were only found in luxury cars. ■
COMPETENCIES AND CAREER OPPORTUNITIES

With the recent completion of the R&D center in Pilsen in the Czech Republic, ZF has strengthened a key Central European location.

Text: Ulrich Saff erling
Photos: Dominik Gigler

Dobrý den! Good morning!” Plant manager Dr. Mathias Eickhoff welcomes his Czech colleagues to the Tuesday morning management meeting. Although he has built up a solid basic vocabulary after 18 months of learning the language, the meeting will be held in English. "When we’re discussing technical stuff, it’s easier and faster for everybody just to use the main company language,” explains the engineer with a laugh. Heads of department make their reports; Mathias Eickhoff digs deeper, then makes decisions. “Our young engineers are highly motivated,” he says. “Because we focus on software development, experienced professionals as well as university graduates come to join us from Pilsen and Prague.”

ZF Engineering in Pilsen enjoys a strategically advantageous location on the university road, right next to various research institutes. Pilsen and the Czech Republic have many advantages, explains Eickhoff. “They’re near the German border, in a central European location, with technical universities that deliver a high standard of education. Last but not least, many young Czechs also speak German or English. “This makes it a very attractive place to be, and is a good reason for potential: “We’ve built up enormous expertise among our new recruits. We’re proud to be part of the larger ZF team.”

ZF acquired the Pilsen development center from an engineering services provider in 2007, along with some 50 employees, The new main building was added in 2015. Today, ZF employs around 300 people in Pilsen.

CAREER OPPORTUNITIES

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EYES ON EVERYTHING – ALWAYS

Many species have evolved special ways of perceiving their environments, from the raptor’s eagle-eyed vision to the ultrasonic echolocation that enables bats to navigate in the dark. Vehicle sensors use the same underlying principles to maintain precise positioning and orientation.

Musca domestica, or the common housefly, is not the animal that most immediately springs to mind when discussing spectacular performance evolved over millions of years. Yet it often appears to anyone wielding a fly swatter that these winged pests have added a seventh sense to the other six, enabling them to evade certain death by mere fractions of a second.

The housefly owes its superfast reactions to a highly evolved sensory system. A film comprising a series of images flashing by at 20 frames per second can fool the human eye into seeing continuous motion. But flies are capable of perceiving as many as 250 separate images in one second. They can watch the deadly fly swatter as it approaches in what, for them, is literally slow motion – a principle that is equally useful in road traffic. But a lidar sensor puts even a housefly’s awesome high-speed, high-resolution capabilities in the shade. On average, lidar sensors register several thousand signals every second.

Lidar: precise echolocation for cars

But the detector, a passive device for registering stimuli, makes up just half of a lidar sensor. The sensor as a whole is based on an echolocation principle similar to the biological sonar that allows dolphins and bats to find their way – and their prey – in the dark. To do so, they generate sound waves that are reflected back to them by obstacles and potential food sources. The time the sound takes to bounce back tells the animals where a given object is positioned in relation to themselves. Bats even...
Perfect all-round vision – guaranteed

Depending on vehicle speeds, front-facing radar systems are useful, for example, active cruise control systems have a range of up to 200 meters. They can detect the position and speed of the vehicle in front, as well as oncoming vehicles. For lane-change assistance purposes, ZF also supplies the AC2000 system as a side-mounted radar sensor with a field of vision of up to 150 degrees.

LiDAR systems are very costly, but their long range and high resolution beat other technologies hands down. They’re also capable of effortlessly detecting pedestrians and cyclists. However, rain and fog do have a significant impact on their visual acuity. Together with Ibco, ZF is currently developing a compact LiDAR sensor that doesn’t need wear-prone rotating mirrors.

As cost-effective, robust alternatives, cameras like ZF’s Tri-Cam system are already used in many driver-assist solutions such as lane-keeping assistants. With ranges of up to 250 meters, they are not the most “eagle-eyed” of technologies – but they are capable of detecting motion perpendicular to the direction of travel much more accurately than, say, radar sensors.

Working together, all these different sensor technologies ensure that the vehicle has full, all-round perception of the surrounding environment at all times. The benefits of the different systems are mutually complementary, giving vehicles the system redundancy that is so essential for the success of autonomous driving.

Processing power for driverless cars

If necessary, the multiplicity of sensor technologies could be extended even further. While ultrasonic sensors only have a comparatively limited range, they are a very cost-effective option for parking and lane-change assistance. And infrared devices could be helpful for reliably detecting obstacles obscured by the dazzle of oncoming headlights.

Of course not even the most comprehensive selection of sensor technologies is capable of powering a driver-assist system on its own, let alone enabling a car to drive by itself. For high-speed reaction times, you also need the right software, capable of processing and analyzing the incoming streams of data without delay. A bat’s brain, for example, is able to compute the exact position of its prey from the reflected echo of a sound wave. The chameleon’s bony features conceal a mind capable of processing two completely separate images of its surroundings and turning them into a single, coherent image. In the automotive world, the demand for processing power is growing in parallel with the swelling streams of data collected by ever more sophisticated sensors. Future electronic control units like the ZF ProAI developed in collaboration with Nvidia will become the vehicle’s brain. Only then will self-driving cars be able to react to the sudden appearance of a deer in the middle of the road with the same lightning speed as a housefly avoiding a potentially lethal flyswatter.

Sensor technology gives cars the same all-round vision as a chameleon with its exceptionally mobile, independently moving eyes. But vehicles can take advantage of multiple interlinked sensor technologies.
STEADY AS SHE GOES

ZF has been pointing vehicles in the right direction for more than 80 years. Originally a licensee of steering technology, the company now supplies a full range of innovative systems.

Transmission specialist ZF started to manufacture steering systems in 1932. A lack of expertise in this area drove the company to seek out a licensing partner in the form of U.S. firm Ross Gear and Tool Company. ZF produced Ross steering systems under license until the 1950s, then made an early switch to developing its own innovations with the spindle-type hydraulic steering system (1956). In 2003, the launch of the active steering system under the ZF Lenksysteme brand was another milestone.

Then

1932

ZF and now

Following the sale of ZF Lenksysteme GmbH to former partner Bosch in 2015, ZF has continued to develop steering systems that further enhance safety and comfort. Alongside existing front-wheel steering systems, one of ZF’s most recent innovations is the AKC rear-axle steering system. Depending on vehicle speed, the latter assists the front axle’s steering motion by adjusting rear-axle tracking a few degrees in the same or opposite direction as the front wheels, improving either high-speed stability or low-speed agility.

Mounted on the rear axle, AKC improves the driving dynamics of the Cadillac CT6. A ZF TRW dual-pinion EPS electric power steering system guides the movements of the front axle.

Wanderer was the first automaker to buy Ross steering systems built by ZF for cars like the 1929 W11 (above). The 1957 Ross steering unit shown here had already been discontinued.

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