



Gives Wings to the Automotive Industry

LITECOR® joins the fray as a rival to aluminum and carbon in car body construction

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DISCUSSION

Trend analyst Matthias Horx and Executive Board Member Dr. Heribert Fischer muse about innovations

TEAM

The new Sales leadership introduces itself

DETAIL

The hot-strip rolling mill explained

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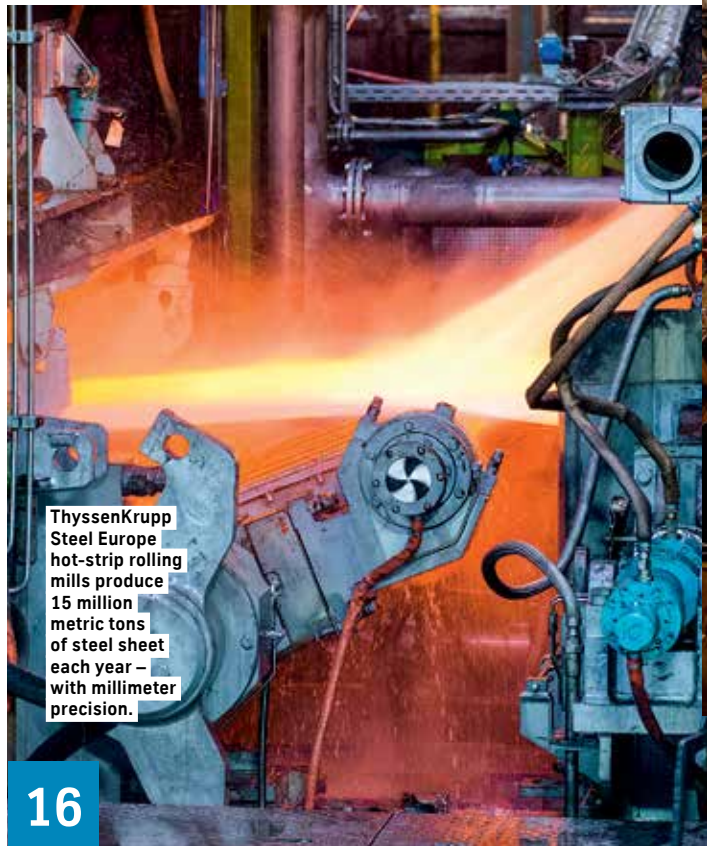
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Steel – For us it's a lightweight m

Booming market: Experts predict that market volumes for lightweight steels could quintuple by 2025. The automotive industry is in particular need of alternatives to aluminum and carbon. ThyssenKrupp Steel Europe has the answer: LITECOR®

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1,200 grams to victory: Find the tool that matches this weight – Is it the open end wrench, a shaggy broom head, or the waist-high poking stick?



ThyssenKrupp Steel Europe hot-strip rolling mills produce 15 million metric tons of steel sheet each year – with millimeter precision.

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S
atter



Built to impress: Luxury liners from Meyer Werft set standards for the cruise industry.

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Photos: Page 1: Volkswagen AG; Contents: Volkswagen AG, Carat/Oberhaeuser, ThyssenKrupp Steel Europe Fotografie, Laif; Illustration: KicherBurkhardt Infografik



Dear readers,

Innovations always take center stage in our compact^{steel} customer magazine. One of these innovations is that I am greeting you this time. ThyssenKrupp Steel Europe recently reorganized the responsibilities of the members of the Executive Board, and as a result the important 'Technology & Innovation' function has been assigned to my directorate alongside Sales. You see, we want to understand what you expect of us as a supplier and innovation partner even better. You already know the innovative power of ThyssenKrupp Steel Europe. We have been reporting on it regularly for 16 years through our compact^{steel} magazine. And this time the magazine itself is an innovation, featuring a fresh layout and new concepts. We have introduced informational graphics that illustrate complex facilities such as our modernized hot-strip rolling mill in an intuitive manner. Features, interviews, and portraits provide you with a vivid account of what is happening in the world of steel. And, as always, we present you with news and background information on our company. Quality remains a key priority, so substantial information takes precedence over sensationalism, and solid research supersedes tabloid-style journalism.

The new compact^{steel} will be published four times per year, and you can look forward to an online magazine launching in June to complement it. This aims at providing you with even more information, thus opening avenues for a more intensive exchange of ideas. I invite you to join the exchange and hope you will thoroughly enjoy this magazine.

Yours,
DR. HERIBERT R. FISCHER
Director of Sales & Innovation

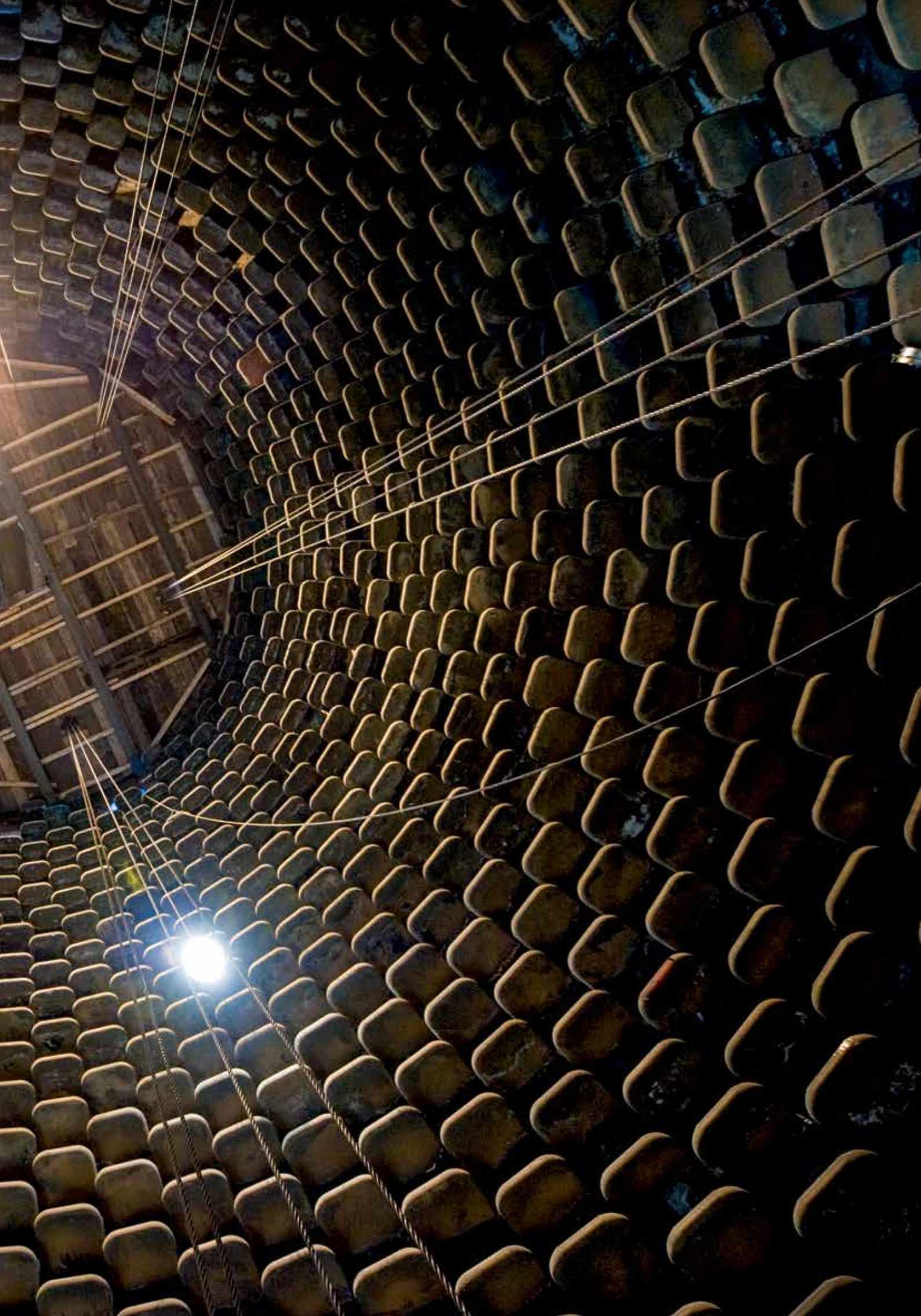
A low-angle, upward-looking photograph of the interior of a blast furnace. The walls are lined with dark, rectangular refractory bricks arranged in a regular grid pattern. Several thick, dark cables or pipes run diagonally across the frame from the upper left towards the center. On the right side, a wooden staircase with horizontal railings is visible, leading upwards. The lighting is dramatic, with a bright light source on the right creating a strong lens flare and illuminating the scene from the side, while the top of the frame is in shadow.

View

No Heat in the Furnace

It's a rare view indeed, considering that the central section of Blast Furnace 9 located in Duisburg-Hamborn is normally heated to a blistering 1,600 degrees Celsius. However, after 25 years of operation, the furnace had to be powered down for 180 days to replace the lining, which is two meters thick. The project involved the installation of 2,400 metric tons of refractory material: 1,900 metric tons for the hearth and 500 metric tons for the shaft section.

ThyssenKrupp Steel Europe invested 38 million euros in this modernization measure. If you want to take a peek into Blast Furnace 9, you will need a lot of patience. Now that it has been fired up again, it will be operating for several decades without interruption.



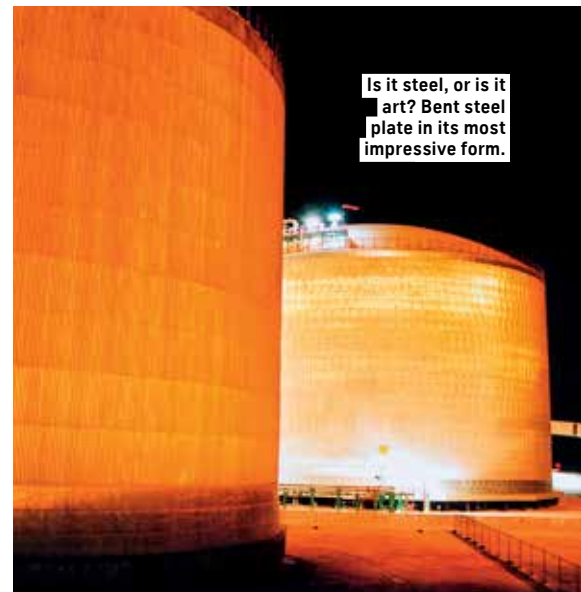


The sixth generation of the solar cruiser is energy-efficient and suitable for everyday use.

Steel Service Center Expands Range of Options

More services, all at one location:

The ThyssenKrupp Steel Service Center is now capable of offering its customers even more services – because ThyssenKrupp Stahlkontor has now relocated to the Krefeld site. That means a new cut-to-length system from FIMI is now available designed to handle even high-strength coils. The system can process the coils into sheets and blanks of suitable quality for laser cutting, at thicknesses up to 16 mm and lengths up to 12,000 mm. The infrastructure at the Krefeld facility enables flexible, just-in-time delivery to customers throughout Europe – by road, rail or ship. ■



Is it steel, or is it art? Bent steel plate in its most impressive form.

Heavy Plate Can Now Also Be Delivered Pre-bent

New prefabrication option: ThyssenKrupp Steel Europe is now in the position to offer heavy plate in prefabricated form. With this move the company is enhancing its product range, which has previously only comprised flat-rolled steel. The impetus was provided by a major contract within the Group – from ThyssenKrupp Industrial Solutions. A customer from Turkey had ordered ammonia tanks, which were needed for the production of fertilizers, from the plant engineers. For this, ThyssenKrupp Steel Europe produced a total of 1,500 metric tons of heavy plate, while Barlage, a specialist company, took responsibility for prefabrication and bending. ■

Soaking Up Australian Sunshine

A car produced by Bochum University and ThyssenKrupp has won second place in the World Solar Challenge for the first time ever.

This is an endurance test for any car: the sun beating down on you and 3,000 kilometers of asphalt ahead of you. A one-way trip across Australia, from Darwin in the north to Adelaide in the south – this is the coast-to-coast route of the World Solar Challenge, the global championship for solar-powered vehicles.

A German team has never made it to the winners' podium. But now a team from Bochum University and ThyssenKrupp Steel Europe has reasons to celebrate: Their jointly developed PowerCore SunCruiser bagged second place in the cruiser class, behind a team from the Netherlands. This class is reserved for vehicles that can be authorized for everyday street traffic. The PowerCore SunCruiser needed only 41 hours and 38 minutes to complete the 3,022-kilometer course. What made the victory possible was that the motor was now fitted with ThyssenKrupp electrical steel – a special, soft magnetic steel that transmits energy in motors especially efficiently. "The team is very proud of the fact that our solar car from Bochum sped down the Stuart Highway so safely and reliably," boasts Stefan Spychalski, responsible for the solar car project at the university. "And it achieved a maximum speed of 100 kilometers an hour!" But it wasn't just a question of speed. The scorers also took into account the car's suitability for everyday life, and its passenger-carrying capacity – the SunCruiser has three seats. Nine teams competed for the title of world champion in the cruiser class.

Bochum University has uploaded comprehensive data about the solar car line and the PowerCore SunCruiser: www.hochschule-bochum.de/solarcar.html. Further information about the World Solar Challenge can be found on the competition website: www.worldsolarchallenge.org.



The new Executive Director, Dr. Donatus Kaufmann.

New Executive Director for Compliance Appointed

Compliance is top priority: The ThyssenKrupp AG Supervisory Board has appointed Dr. Donatus Kaufmann to the Executive Board of the Group. Since 1 February, the 51-year-old has been in charge of the newly created Legal and Compliance directorate. Its work concentrates on the areas of antitrust law and anti-corruption measures. Kaufmann was formerly Chief Legal Counsel for Metro AG. "This appointment sends out a clear signal that compliance has the highest priority at ThyssenKrupp," says Dr. Ulrich Lehner, member of the Supervisory Board. Whenever regulations or laws are transgressed, the 'zero tolerance' principle will apply. ■

New Blog Tackles Topics Tough as Steel

Is steel on its way out in automobile construction? What effects is higher protectionism having on the industry? These and many other pressing concerns surrounding steel can now be debated with experts in the new blog (stahl-blog.de). This new platform is aimed at developers, designers, and anybody else interested in the topic of steel. Anybody can take part in the discussion and contribute comments. ThyssenKrupp Steel Europe is already represented, too – with specialist blog postings. The site is supported by inter-trade organization *Wirtschaftsvereinigung Stahl* (Federation of the German Steel Industry). ■

Photos: Imago, ThyssenKrupp Steel Europe Fotografie (4), Fotolia



LESS PARTICULATE MATTER

The ThyssenKrupp Steel Europe location at Duisburg now releases 350 metric tons less particulate matter into the atmosphere annually than in 2010. This has been made possible by new exhaust-gas filters. The plan is to make reductions of 700 metric tons annually by 2020.



ThyssenKrupp is investigating how CO₂ from steel production can be put to good use.

Greenhouse Gas Becomes Raw Material

Companies and researchers are developing processes to convert carbon dioxide into a synthesis gas with industrial uses.

The earth simply cannot become any warmer. For this reason, emissions of the greenhouse gas carbon dioxide must be reduced. But that's not so easy, because basically CO₂ is produced every time gasoline, oil, or natural gas is burned. Several companies, including ThyssenKrupp Steel Europe, and research institutes are therefore collaborating on a project to investigate how the gas might be used as raw material – with benefits for climate protection. They are developing a two-stage process. In the first stage, natural gas will be converted to hydrogen and carbon by means of a new, low-emission technology. This process takes place at extreme temperatures, but the waste heat produced can be put to direct use. In the second stage, this hydrogen can be used to convert large quantities of carbon dioxide into a synthesis gas. This gas mixture is an important product for the chemical industry, and moreover it can be used for fuel production. The project is being supported with nine million euros of funds from the Federal Research Ministry. Besides ThyssenKrupp, other participants include BASF, the Linde Group, Dortmund Technical University, and the VDeh Betriebsforschung Institut (BFI) in Düsseldorf. In this way, ThyssenKrupp Steel Europe and its subsidiary KBS Kokereibetriebsgesellschaft Schwelgern will be able to study how this process could be applied to the steel industry.

The German Federal Ministry of Education and Research can provide information on intersectoral cooperation and technology for sustainability and climate protection: www.fona.de/de/16610

200



MILLION METRICS TONS

That's how much steel Hot Strip Mill 2 in Duisburg-Beeckerwerth has produced since it started up 50 years ago. That's enough to build 27,400 Eiffel Towers!



Story

The Sandwich Effect

Lighter car bodies that are both high-quality and low-cost – it's the dream of many. ThyssenKrupp Steel Europe has developed LITECOR® and tested it under race conditions.

Text: Jochen Förster



Monte Carlo Rally:
Heading for
victory – with
4-wheel drive,
315 hp and 2-liter
4-cylinder engine.

The trend is clear, straightforward and based on a simple formula: 95 by 2021. New cars sold in Europe will only be able to burn a maximum average of 95 grams of CO₂ per kilometer by 2021. Right now, leading companies are still about 30 grams short of this target. That means we'll need many more low-emission drive systems, like electric or hybrid. And, of course, more lightweight construction. Which is where we at ThyssenKrupp Steel Europe come in.

Lightweight steels are perhaps the boom market in today's car industry. Experts predict that market volumes could virtually quadruple by 2025. Germany's biggest steel and technology company is consolidating its position in the automobile market with a unique innovation. You could also call it a 'third way' – one that's different from the conventional construction material options.

Until now, aluminum and carbon fiber-reinforced plastic (CFRP) have looked like the most likely future alternatives to the No. 1 construction material for decades, namely steel. But there's a problem. It's true both materials are considerably lighter than steel, but their energy-intensive production also makes them disproportionately expensive. And the costs of processing these materials fall to the carmaker. For small to mid-size cars with tight profit margins in particular – in other words, about 90% of the world market – aluminum and CFRP are hardly financially viable.

The 'third way' consists of the intelligent combination of various construction materials. To be more precise: steel and plastic. LITECOR® is ThyssenKrupp's answer to aluminum and CFRP – and the chances that this hybrid material will persuade many manufacturers are looking good. "This new material is a sandwich," explains Oliver

Kleinschmidt, as product coordinator responsible for steel sandwich materials in the steel division. The principle? A polymer core (0.3–1.0 mm thick) is layered between two steel face sheets (each 0.2–0.3 mm thick). The result? LITECOR® is considerably lighter than conventional sheet steel, easy to recycle, and displays good bending stiffness and dent resistance. And not least: very easy to process.

Minimum Need for New Machines

The layers of the steel sandwich don't come apart, even when subjected to complex forming operations. Producing hems and flanges, adding smooth design lines, mechanical joining or adhesive bonding – all are equally possible. "We are working hard to develop the spot-welding capability of LITECOR® with our colleagues from Systems Engineering. It already works in the lab," says Professor Hans Ferkel, Head of Technology and Innovation at ThyssenKrupp Steel Europe. Ultimately, the thermal expansion behaviors of LITECOR® and sheet steel are largely identical, which is why the hybrid material is particularly easy to integrate into steel bodywork. Electro-coating is equally possible. In other words, customers can process LITECOR® using their existing facilities, without added investment. Sometimes just a minor tweak by the head engineer is enough – for example, a little opening in the pre-hem steel makes it possible to maintain the existing folding process. ➔

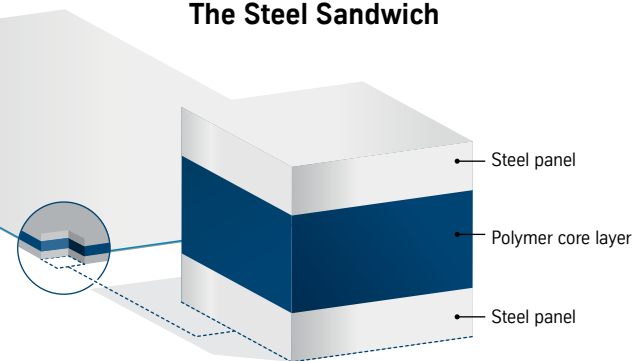
LITECOR® is the product of intensive, early predevelopment with carmakers

Oliver Kleinschmidt, Product Coordination, Steel Sandwich Materials

Photos: Pages 8-9: Volkswagen AG; Pages 10-11: Hermann Bredehorst/Polars/leif



The Steel Sandwich

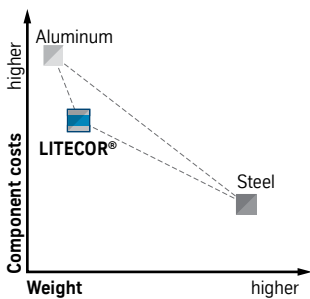


- ⊕ Extremely thin covering sheets (0.2–0.3 mm)
- ⊕ Core layer (0.3 - 1.0 mm) suitable for electro-coating
- ⊕ High bending stiffness and dent resistance
- ⊕ Modular construction system (individual adjustment of material thicknesses)
- ⊕ Thermal expansion analogous to monolithic steel
- ⊕ Structure-borne noise reducing properties

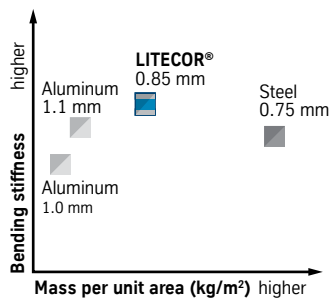
Steel/polymer composite LITECOR® unites the high rigidity of steel with the minimal weight of modern plastics. The resulting sandwich material is an emission-optimized, environmentally-friendly material.



Perfect fit:
Volkswagen
assembles
LITECOR® engine
hoods for the
Polo R WRC.



LITECOR® enables weight reduction combined with highly attractive lightweight construction costs.



Low mass per unit area and high bending stiffness: made possible by sandwich construction.

	Composition/ thickness	Mass per unit area	Bending stiffness
	mm	kg/m ²	%
Aluminum	1.10	2.97	105
Aluminum	1.00	2.70	79
Reference: steel	0.75	5.80	100
LITECOR®	0.2 + 0.4 + 0.2 = 0.80	3.50	106
LITECOR®	0.2 + 0.4 + 0.25 = 0.85	3.90	129
LITECOR®	0.2 + 0.7 + 0.2 = 1.10	3.80	234

“It’s in the Mix”

Why do Volkswagen and ThyssenKrupp Steel Europe cooperate so closely in the area of lightweight vehicle construction? And why is it so important, here in particular, to get the customer involved at an early stage? **An interview with Dr. Martin Goede, Head of Technology Planning and Development at Volkswagen.**

Interviewed by: Jochen Förster

Dr. Goede, the Polo R WRC – the standard street version of the rally car that Sébastien Ogier drove to the championship title – comes with a front hood made of the LITECOR® hybrid steel material. What made you take this step?

Martin Goede: We at Volkswagen view lightweight design as a means to achieving our goal of sustainably reducing the fleet’s consumption. Lightweight car body construction represents an excellent savings potential, second only to engine efficiency – meaning fewer emissions being produced by the car’s engine. As Europe’s leading carmaker, we produce cars in large numbers, in particular for the mid- and low-price segment. So reduced weight must always be affordable. Therefore, innovative solutions developed by the steel industry that offer good value are very attractive for Volkswagen. ThyssenKrupp Steel Europe’s LITECOR® product fully convinced us. This highly modern material combination provides the basis for significantly reducing a car’s weight. LITECOR® offers very good characteristics and can be processed economically using conventional facilities.

In other words, you’re saying it’s not necessary to build a new plant to include LITECOR® in the production process?

Precisely. The material is suitable for processing in plants used to shape and join monolithic steel sheets. We’ve been involved in the development of LITECOR® for three years now, helping get it ready for mass production. The front hood of the Polo R WRC is an example of what we’ve achieved so far. This model was the ideal candidate for a pilot project as only 2,500 units were produced. The pilot facility of ThyssenKrupp Steel Europe is capable of handling this kind of volume. However, we require real-life production conditions to test a material for use in the Golf, Polo, or Passat. This is why we are planning to wait until 2016 before we will use select LITECOR® components for large-scale production.

What makes LITECOR® stand out is that material specialists and the customer started to cooperate closely at a very early stage. What benefit do both sides derive from this?

The sooner we start cooperating, the more efficiently we can enable manufacturers to qualify their product for our intended application. This is an advantage for both parties. But material development is not the only area where we’re collaborating – we’re also working together to advance

joining technology and adapting our facilities to new materials. We have our own tool shop, so this allows us to provide manufacturers with helpful information on the specific products that the market requires. This goes a long way toward reducing development times greatly.

What part of an automobile is LITECOR® particularly suited for?

For lightweight construction of large body components demanding a high degree of rigidity, such as doors, tailgate, and engine hood, but also for interior parts such as the rear rack. For the time being, we are planning on using LITECOR® for hidden car body components and will, at a later point, expand its range of applications to the outer paneling.

What properties are required of future materials for automobile construction?

Less weight while maintaining the same features and providing increased strength plus improved elongation properties. The car body accounts for about one third of a car’s entire weight. This is why it makes a lot of sense to use lighter materials in this area. Materials of the future should be just as affordable, but at a fraction of the current weight.

Will all Volkswagen cars soon be made completely of LITECOR®?

This will never happen since a ‘sandwich’ material cannot satisfy all demands of the car body by itself. We will continue to use hot- and cold-formed steel sheets for parts that serve highly safety-relevant functions. I am expecting metal-based construction to continue to play the lead role at Volkswagen for many years to come. But the share of hybrids will rise. There’s a need for intelligent combinations: It’s all in the mix.

Dr. Martin Goede is a Volkswagen specialist for current and future car production processes and technologies.





Sébastien Ogier becomes world rally champion in a lightweight Polo

ThyssenKrupp experts know all about these 'tricks,' thanks to years of intensive predevelopment and collaboration with carmakers. This kind of close cooperation early on is particularly crucial for LITECOR®, even more than in other sectors. "With our products, we try to take the customer's needs into account as early in the game as possible," explains Erik Hilfrich, team leader of the Application Concepts team. These experts perform evaluations of potential with the aid of bodywork data, for example, right from the early stages. They simulate rigidity and crash performance, determine weight, cost and functional advantages develop and validate simulation models, accompany the material development process at every step, and give valuable tips on processing.

The ThyssenKrupp Steel Europe team works in close collaboration with all the big name manufacturers. The comprehensive R&D projects InCar® and ThyssenKrupp InCar® plus for application-oriented products in the automobile sector perform a crucial preparatory role here. "Basically we try to understand the demands on the cars just as well as the manufacturers themselves," says Erik Hilfrich.

Where LITECOR® is concerned, the current pilot project with R&D partner Volkswagen shows how profitable early cooperation can be for both sides. Engineers from both companies jointly developed a front hood using the innovative construction material for the road version of the Polo R WRC, the car with which Volkswagen won last year's World Rally Championship at its first attempt. They were able to reduce

the weight by almost two kilograms compared with the production engine hood. A limited quantity of LITECOR® was then produced for the special series at the Dortmund pilot facility for 2,500 front hoods. The new Polo R WRC arrived just at the right time for testing the lightweight material under real-life conditions. "We could put the potential of LITECOR® to the test during material development thanks to our intensive collaboration with Volkswagen at an early stage," points out Oliver Kleinschmidt. "Being able to use the material from our pilot facility brought us some important insights that we can now integrate into concrete concepts for manufacturing plants."

It's already clear that this modern sandwich material is ideally suited for lightweight construction of large body components demanding a high degree of rigidity, such as roof, door, tailgate and engine hood, and equally for interior parts such as the rear rack or vehicle floor. If construction of all these parts were switched to LITECOR®, ThyssenKrupp Steel Europe experts calculate that it would be possible to reduce vehicle weight by more than 30 kilograms. And that's with considerably lower additional costs (compared with steel) than in the case of aluminum.

The near-term plan is now to expand the LITECOR® pilot facility so that it can also supply vehicle series in larger quantities.

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We take customers' interests into account, even in the early stages of product development.

Erik Hilfrich, team leader in Application Concepts

Photos: ThyssenKrupp Steel Europe Fotografie (3), Volkswagen

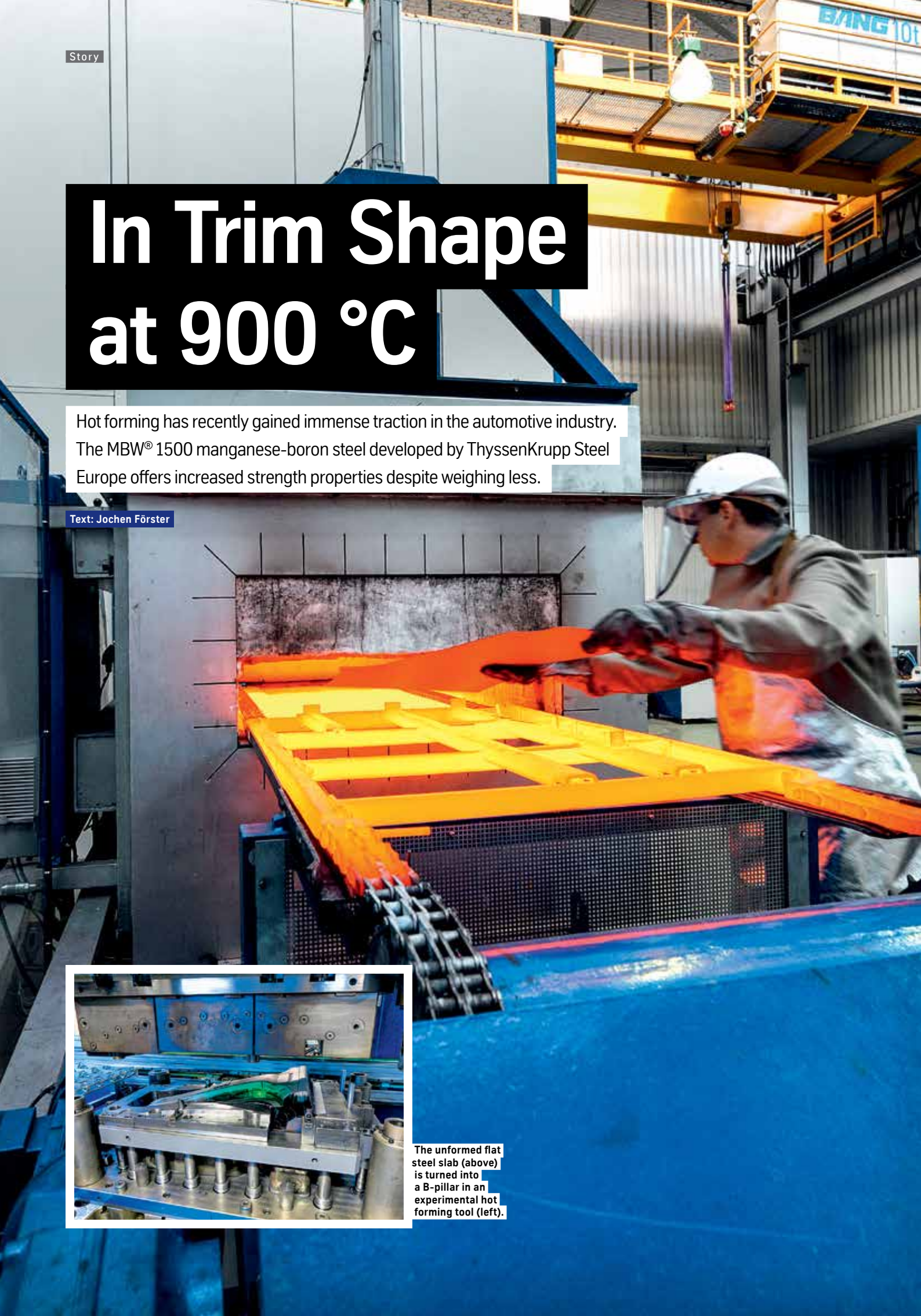
In Trim Shape at 900 °C

Hot forming has recently gained immense traction in the automotive industry. The MBW[®] 1500 manganese-boron steel developed by ThyssenKrupp Steel Europe offers increased strength properties despite weighing less.

Text: Jochen Förster



The unformed flat steel slab (above) is turned into a B-pillar in an experimental hot forming tool (left).



Steel has become, now more than ever, the raw material of choice when it comes to manufacturing components that are lightweight and readily formable while offering excellent strength and durability. This is also due to the fact that steel can be processed in a vast number of ways, including cold and hot forming, heat treatment, joining technology, and surface engineering. Amongst these, hot forming is the process that is growing the fastest. This process refers to all forming steps performed above a metal's austenitizing temperature, which means above 723 °C.

In recent years, the automotive industry has been increasingly applying this technology to manganese-boron steels, also known as press hardening or hot stamping. The material predominantly being used is MBW® 1500. The new MBW® 1900 manganese-boron steel developed by ThyssenKrupp Steel Europe is even stronger and has improved deformation-resistance properties. This makes it very well suited for use in bumpers or to reinforce components subjected to high stress in a crash. Volume production of this innovative high-end steel commenced in 2013. Alternatively, a hybrid component can be used, which is joined into a hot form blank by means of laser welding before hot forming. This further improves residual elongation and thus crash performance thanks to the softer joining component. This method also allows for combining various strength levels and thicknesses in a single component. ThyssenKrupp Steel Europe has been successfully mass producing and supplying the steel for these hot form blanks since 2005.

Hot forming can reduce the weight of car body parts by up to 35% compared to traditional cold-formed steel. The method for producing the same part can vary depending on the manufacturer. Volkswagen produces the B-pillar for its Golf series using a hot-formed blank that is rolled in three stages, reducing the weight by four kilograms. Sister company Audi uses a blank of uniform thickness for the A3; special temperature control during hot forming generates areas with varying strength properties. In other words, there are competing processing concepts. And this is a good thing, too, because it means that carmakers and steel suppliers are encour-

aging each other to come up with more efficient lightweight solutions. What gives the experts at ThyssenKrupp Steel Europe an edge are the state-of-the-art software and highly reliable material data at their disposal, allowing them to simulate with great accuracy how specific types of steel will behave at various thicknesses during a crash or when formed in a tool. And the software also keeps getting more and more refined. Recently, it has become possible for engineers to test their tools with virtual steel long before real-life production commences. Such simulations replace expensive and time-consuming trial and error strategies.

CONTACT



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The steel experts are intimately familiar with all production stages. This comprehensive know-how is all the more important as materials engineering and production processes affect one another in very complex ways, in particular in hot forming. In car manufacture all these advantages have led to a steady rise in the share of hot forming steel components with each new generation of models.

The current Golf limousine boasts a share of 28 percent (compared to only six percent in the previous model) according to Volkswagen. The new Volvo XC90 is said to have a share of 40 percent. The biggest increase is to be expected outside of Europe, in countries like the U.S. and China, where hot forming has started to become more firmly established. Experts believe that hot forming will also play an increasing role in the area of chassis production.

At present, only a fraction of the possibilities for combining and processing materials have been examined – yet the steel types available for lightweight construction of chassis, body, and drive alone number in the hundreds. Given this backdrop, further advances toward cost-efficient and sustainable mobility based on cars made of steel can be expected in the near future.

Hot forming can make car bodies up to 35 percent lighter.

— Dr. Franz-Josef Lenze, Product Coordinator

News-Ticker

Advancing Efficiency in 40 Areas

ThyssenKrupp InCar® plus provides automotive solutions that make powertrain, chassis, body, and steering system production more efficient. ThyssenKrupp is currently researching about 40 individual solutions as part of the InCar® plus project, which is aimed at making new cars even lighter and more fuel efficient, eco-friendly, and functional. Developments include more efficient powertrains based on optimized camshaft technology, electrical steering systems for safer and more comfortable driving, as well as lighter car bodies. The researchers also focus on seats and wheels: These parts greatly contribute to the weight of a car, yet they are essential when it comes to driving comfort, functionality, and design. The findings of InCar® plus will be presented to the public in the fall of 2014.



The Future of Engineering

At the 14th international automotive conference, Chairman of the Executive Board Dr. Heinrich Hiesinger unveiled the innovations on which ThyssenKrupp will focus to deliver materials, components, and engineering services that will drive the market. On 28 January, the opening day of the Bochum conference, he presented the future of engineering to the audience in a presentation entitled 'Materials, components, and engineering for more comfort, safety, and efficient use of resources.' A video of the presentation is available on the conference website at: www.car-symposium.de.

App Provides Quick Answers

How much damaging carbon dioxide does a car generate? ThyssenKrupp Steel Europe developed software for the iPad that helps carmakers answer this question. The 'Autobody LCA' app accounts for the entire lifecycle of a car, from production and operation through to material recycling. A graphical interface enables users



to enter eight key parameters such as weight saved with lightweight materials, energy expenditure and origin for production, or even reduced fuel consumption. An odometer

then indicates the break-even point – the mileage starting at which added emissions caused by, for instance, energy-intensive lightweight production is compensated. This provides manufacturers with valuable information on what materials and expenditures make economic and environmental sense.

Hot-rolled strip warms the heart

ThyssenKrupp Steel Europe is spending a quarter of a million euros on renovating its hot-strip rolling mill in Duisburg. Thanks to innovative technology, it will now be possible to develop new steel types there. That's good news for customers: They'll be getting even thinner strip with extremely high precision.

Text: Klaus Rathje

The hot strip races through the 493-meter-long obstacle course at 15 meters a second.

Video cameras together with the towering rollers in the Duisburg hot strip plant set the scene here. If you want to see the steel sheet production line for yourself with the naked eye, you'll need to negotiate a 600-meter-long obstacle course of catwalks, both down low and up high – past colossal steel giants, furnaces and measuring facilities. It also fluctuates between hot and noisy here. Yet, the whole time it is fascinating to think how fast the endless steel slabs have been racing through the machines for more than 55 years.

“The steel reaches a speed of roughly 15 meters a second,” says Heinz-Josef Engelskirchen, head of the newly modernized Hot Strip Mill 1. In the beginning, he too had to get used to the vibrating floor. And to the tons of steel sheet rolled up in coils that criss-cross the hall on remote-controlled cranes. Safety here is maintained by requirements to wear helmets and the correct health and safety gear. But the really important work takes place in the control center. Here, behind thick glass, the operators sit in front of an array of screens. All the data from the cameras and measuring instruments is monitored and analyzed. New software performs many of the necessary corrections instantly.

This is where they produce steel sheets to tolerances in the order of micro-millimeters.



If, for example, the first roller hasn't reached its target, the second is readjusted immediately. The team checks how accurately the plant is performing using the feed from the constantly flashing red and blue bars, which provide information on actual and target values. Engelskirchen explains, "The automation of this procedure raises us to an entirely new level of precision. It reduces both waste and subsequent corrections."

Of course, ThyssenKrupp Steel Europe has always met its customers' high demands for precision at 'WBW1,' as the mill is known by internal staff. "But now we can produce even thinner or higher-strength steel sheets to even narrower tolerances than previously (± 0.06 mm) – in the micromillimeter range," adds Engelskirchen. "This massively expands our capabilities in Duisburg at the hot strip plant." For example, if

CONTACT



As head of Hot Strip Mill 1, Heinz-Josef Engelskirchen is responsible for the production of hot-rolled flat steels in Bruckhausen. (+49-203) 5225393 karima.siba@thyssenkrupp.com

the automobile or canning industry should make even higher demands, which happens all the time, ThyssenKrupp Steel Europe is in an excellent position to meet them with the present modernization, which has cost 250 million euros.

The company hasn't just invested in new automation technologies. A lot of the money was also spent on energy-efficient furnaces, stronger roller supports and an optimized cooling section. "We've installed a strip cooling system. This is a real novelty, because these technical components make it possible for us to experiment," Engelskirchen points out.

"We can continue to develop our steels and optimize specific characteristics – and this means we're not just a production plant any longer, but a real innovation workshop."





PRE-PRESS STAGE

The edger sizes the steel blank to the correct width. The same housing also contains a rolling mill with two rollers.



LOW ON GAS

The new furnace has been working more efficiently, and therefore with greater savings, since the comprehensive modernization measures. Moreover, the total complement of four furnaces is also equipped with an optimized safety control system.

HIGH-PRESSURE CLEANING

The descaling plant cleanses the steel blanks (slabs) of oxidized carbon at high pressure (115 bar). This guarantees high levels of purity for the steel.

Weight Measured in Tons, Precision in Millimeters

In Duisburg, ThyssenKrupp Steel Europe has one of the most modern hot strip mills in the world. It operates to high-precision standards, and produces about three million metric tons of steel sheet annually.

CONTROL UNIT

Camera images and measurement reports are fed into the command center of Hot Strip Mill 1 in Duisburg. Here, modern software from Siemens carries out automatic corrections to the rolling and cooling processes, enabling strict tolerances in the micromillimeter range.



TEST SITE

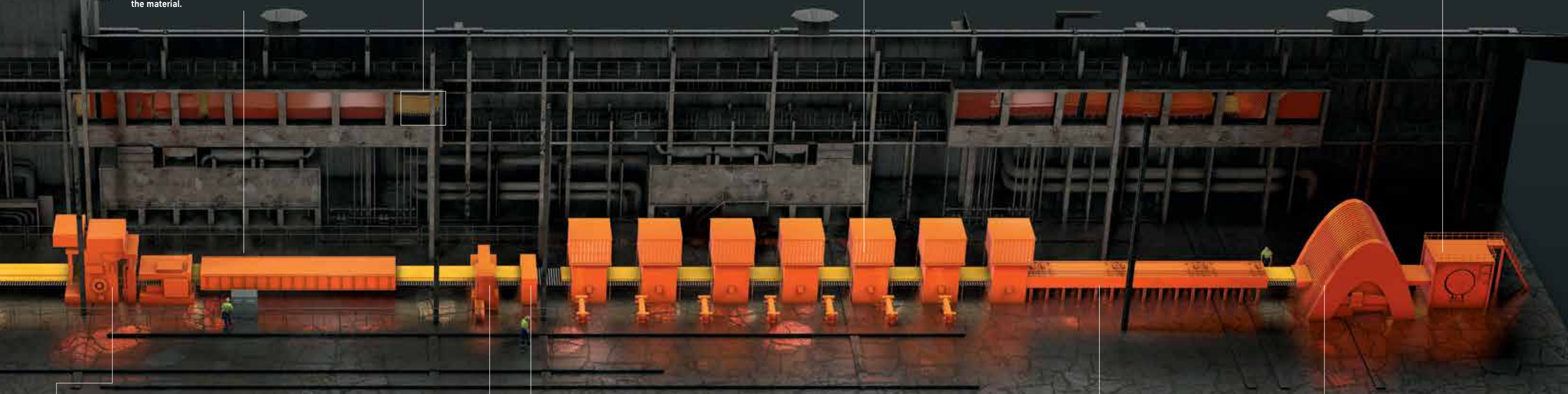
One of the most innovative developments has been the 'roughed strip cooling system' recently. It is possible to develop new steel microstructures, because the processing temperature has a major impact on the subsequent properties of the material.

FINE TUNING

Rolling gear that is seven times heavier is deployed in the finishing train, producing the desired steel sheet strength using computer software. The rearmost roller is equipped with a further measuring system for control purposes.

WOUND UP

Whatever gets 'uncoiled' tends to be in a bit of a mess. But a good coiling device knows how to wind steel sheet tidily. Watch out though: The sheet still hasn't quite cooled down. There's still enough heat left to fry an egg!



INITIAL CHECK

Two large back-up rollers drive two smaller working rollers, making it possible to exert even more pressure on the slab. The measuring system connected at this point checks the slab for temperature, thickness, width, and surface quality.

EDGE HEATING

Since the edges cool down first, they have to be reheated a little to ensure that the slab maintains a constant processing temperature. This is achieved by the edge heater.

CLEAN SLICE

The cropping shear slices the rough edge off to make sure the slab has a straight end before it proceeds to the finishing train at a speed of around 15 meters a second.

QUICK SHOWER

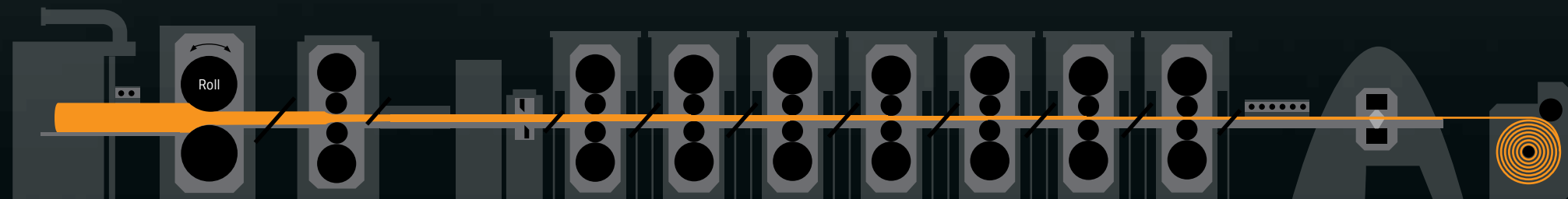
It now rains pretty regularly in the cooling section, which has been converted into a modern laminar cooling facility, so that the drop in temperature can be exactly regulated. This makes it possible to produce even higher strength steels than before.

FINAL CHECK

This measurement cabinet (visually modeled on the Thyssen arch) inspects the surface and width of the steel sheet as it slides past. Sensors relay the condition of the coil to the technicians in the control unit while it's being wound.

HOT STRIP PRODUCTION

Every year the hot strip mill processes about three million tons of steel in Duisburg. The core of the operation is a newly modernized finishing train.



MAKING AN IMPRESSION

The slab – in other words, the steel blank – emerges from the furnace at a temperature of 1,000 degrees Celsius. After descaling, it moves on to two coarse rolling mills in order to thin out the slab as much as possible.

ROLLING DOWN

The seven rollers now operate at a capacity of 3,500 metric tons (previously only 2,800) after the modernization measures. The smaller working rollers are relieved every two hours. For the changeover they are pulled outward, and then ground smooth again.

DELIVERING PRECISION

A multitude of sensors now supports the fully automated process. For Hot Strip Steel Mill 1, this means a tangible leap forward in quality. The new systems for regulating profile, contour, and flatness enable particularly uniform and precise measurements to be made throughout the entire length and width of the hot wide strip.



Market + Use Cases

220 years ago, the Meyer Werft shipyard built wooden vessels. Today, it launches spectacular luxury liners, 'swimming cities' that are ordered from all over the world.

Builder of Cruise Liners

Text: Mechthild Bausch

The stern of the 'Quantum of the Seas' rises up like a steel skyscraper, nearly touching the ceiling of Meyer's largest dry dock. There is activity everywhere on the 16-story section of the ship: Window panes are already being installed above the afterdeck, while showers of sparks indicate more basic tasks still being performed on other levels, such as welding walls and edging. At the edge of the dock, a forklift lowers one of 2,000 turnkey cabins to the ground, fully furnished with pictures, carpets, and furniture.

"We design and build swimming cities," says shipyard owner Bernard Meyer (65), "and as a full-service provider we do everything, from welding steel plates all the way to constructing restaurants and theaters, installing complex IT networks, and supplying everything else needed on board." Meyer started building cruise liners in the mid-1980's – and has gone a long way toward securing the existence of the shipyard and its 3,100 employees. The investments were worth every penny. The customer of ThyssenKrupp Steel Europe generates a yearly turnover of more than one billion euros, supplies all major cruise lines, and attracts luxury liner architects who are very eager to work for the global market leader.

The 'Quantum' was ordered by the U.S. Royal Caribbean line and is due for transfer in September. That is when its sister ship 'Anthem of the Seas' will be moved to dry dock II. These luxury ships will be the largest cruise liners ever to be built in Germany, with a gross tonnage of 167,000 and a capacity for about 4,200 passengers each. The furnishings are just as impressive. The 'Quantum,' for instance, has an extendible glass



CONTACT



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engine pod and other special features. "Such constructions really put our technological expertise and that of our suppliers to the test," says Ralf Sempf, head of Purchasing/Materials Management and member of the Board of Directors. "Building cruise liners is as challenging and multifaceted as shipbuilding gets."

And the shipyard's portfolio even includes further highlights. For example, the order books – which are filled to the brim until 2017 – not only include six luxury liners, but also 29 river cruise ships that will be built at the Rostock-based Neptunwerft shipyard. Preliminary tasks are performed for the affli-



In its sixth generation: Bernard Meyer's shipyard has specialized in building cruise liners.



High time to get things into motion: The azimuth thruster equipped with an electric motor is being attached to the hull.

Facts and Figures

20,000 metric tons

of heavy plate a year is delivered by ThyssenKrupp Steel Europe's Duisburg-Hüttenheim site to Meyer Werft, starting in 1986. Before that, the shipbuilding products came from Thyssen's Henrichshütte based in Hattingen.

1795

The year in which the former shipyard for wooden vessels was founded. Meyer Werft has remained a family-owned business ever since. Shipbuilding engineer Bernard Meyer took the helm of the company in 1982, representing the sixth generation. In May 2012, his son Jan Meyer became a Member of the Management Board.

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cruise liners of various sizes have been designed and built for customers around the globe by Meyer Werft since 1985. Seven alone for the German AIDA Cruises line. The most recently ordered luxury liner is the 'Norwegian Bliss' (Norwegian Cruise Line) with a gross tonnage of 163,000 metric tons. Launching: 2017.

ated company by Meyer's laser center located in Papenburg. This is where the steel plates are cut to size for both locations, with a total daily output of 200 metric tons. The plates move through the flame-cutting systems in glass cabins before being transported to the fully automated production lines. "In our production areas, we have replaced traditional shipyard practices with modern assembly line methods similar to the processes applied in the automotive industry," says Sempf with pride.

Roughly a third of the heavy plates processed in Papenburg originate from Duisburg-Hüttenheim. "ThyssenKrupp Steel Europe has been a key part-

ner of ours for many decades, both as a supplier and a co-developer," explains Sempf. "One of our joint projects involves developing even thinner plates in the required standard formats to save weight and thus energy."

"Aside from these activities, our product range for shipbuilding has remained constant over the past years," adds Mario Klatt, Sales Manager Germany of the Heavy Plate Business Unit at ThyssenKrupp Steel Europe. "We highly appreciate the Meyer Werft shipyard as a reliable customer." And Klatt readily admits that he is a big personal fan of the industry: "A cruise liner is about the most exciting and impressive thing you can build from heavy plate," says the 50-year-old manager, who has actually traveled on ships made in Papenburg. "More than once I sat on the balcony, sipping on a glass of wine while wondering whether we made the metal plates I was looking at."

Like many of the plates built into the 'Sonne' research ship: The shift has just ended in dry dock I, and workers are leaving the deck dotted with signal-red cranes. This new German high-tech research ship will start to explore the deep-sea regions of the Pacific Ocean in 2015. Meanwhile, Meyer is considering adding shuttle and maintenance ships for offshore systems to the product offering. "After all, European shipyards only stand a chance by combining expertise, top productivity, and the flexibility required to build complex specialized vessels," says Bernard Meyer with strong conviction, "a fact proven by the development of our own business." Given the increasingly stiff competition from Asia, he has decided to forge cooperations with other European shipyards. And his son Jan Meyer is getting ready to uphold the tradition of the nearly 220-year-old shipyard and secure its future for at least another generation.

For further information on Meyer Werft or a live-cam view of the dry docks, visit: www.meyerwerft.de/de/meyerwerft_de/werft/das_unternehmen/das_unternehmen.jsp

No matter how high the pressure, these plug connectors can handle it.

Perfect Connection

A revolutionary hose coupling from Austrian-based manufacturer HENN is successful across the globe. ThyssenKrupp Steel Europe supplies the materials for it.

Text: Klaus Rathje

Sporty roadsters and family station wagons alike need robust hose couplings to get into gear. These couplings hold the lines firmly together when gas, pressurized air, and cooling water speed through the engine. They must be absolutely spillproof, which is why “such a tube connector poses a considerable challenge to our materials suppliers,” says Martin Ohneberg, Managing Director of HENN GmbH & Co KG.

The small connection technology provider based in the Austrian state of Vorarlberg is a regular customer of ThyssenKrupp Steel Europe. “We may be a small customer, but we are a highly innovative one,” says Ohneberg with pride. “We

have jointly developed several products for the global market.”

The patented tube connectors are very easy to process. While traditional products from competitors require a lot of time when it comes to assembly, HENN connectors can be crimped with the hose material in a matter of seconds, saving both time and money. One feature of the innovation: wafer-thin steel sheet with a durable coating.

“The material from ThyssenKrupp Steel Europe is much more resilient than any other product we’ve seen in the market,” confirms Ohneberg. “We need this material to be able to guarantee our superior quality level.” After all, the component must handle pressures up to 6 bar, which corresponds to

the brewing pressure of a conventional espresso machine. Moreover, it must be corrosion-resistant and leakproof from a freezing minus 40 degrees Celsius up to a blistering 180+ degrees.

The secret to how the 0.35-mm thin steel plate can meet these extreme requirements rests with its special protective coating. An ultrathin 0.05-mm GALFAN® coating offers HENN products this extreme level of corrosion resistance.

HENN produced 30 million plug connectors for the global market in 2013. This success of the company and its 43 employees is also owing to the flexibility of its partners. “The partnership with ThyssenKrupp Steel Europe couldn’t be better,” concludes Ohneberg.

CONTACT



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Martin Ohneberg,
Managing Director
HENN GmbH.

Photos: Henn, Marcel Hagen, ThyssenKrupp Steel Europe Fotografie (9)

Realigned for Success

Better, faster, closer to the markets – in answer to the challenges posed by international markets, ThyssenKrupp Steel Europe has restructured key leadership functions. This has resulted in more streamlined workflows and consolidated responsibilities, speeding up the entire product cycle from research and development and innovation through to market introduction and sales.

ThyssenKrupp Electrical Steel

Dr. Peter Biele
Sales Manager Grain Oriented Electrical Steel

“Close cooperation with customers greatly stimulates development. The customer gains access to the entire ThyssenKrupp R&D infrastructure, including experts and extensive lab facilities.”

Hoesch Hohenlimburg

Michael Stausberg
Sales Medium-Wide Strip

“We expect to accelerate the market launch of our materials thanks to the reorganization. This means a competitive advantage for us and our customers.”

ThyssenKrupp Steel Europe Sales & Innovation

Jörg Paffrath
Sales Industry

“Combined expertise and jointly developed concepts enable our customers to address future trends faster than others, giving them a competitive edge.”

ThyssenKrupp Steel Europe Sales & Innovation

Prof. Dr. Hans Ferkel
Technology & Innovation

“The Sales & Innovation division allows us to better focus on our customers. Knowing their needs in detail greatly speeds up time to market for new products.”

ThyssenKrupp Steel Europe Sales & Innovation

Dr. Heike Denecke-Arnold
Sales Strategy/Planning

“Consolidating the Sales and Innovation activities has given rise to an organizational structure that enables us to align our sales and marketing strategy even more closely with the target industries.”

ThyssenKrupp Steel Europe Heavy Plate Unit

Dr. Jens Knöll
Sales Heavy Plate

“Product development has been speeded up, and our customers can now directly participate in the process: In the Heavy Plate area, this concerns premium and hardened/tempered products in particular.”

ThyssenKrupp Steel Europe Sales & Innovation

Bernhard Osburg
Sales Automotive

“Together with our customers and partners, we can turn innovations into products for the international automotive market more efficiently and at reduced risk.”

ThyssenKrupp Rasselstein

Dr. Ulrich Roeske
Sales Tinplate

“Now that Innovation and Sales are under the same roof, it has become so much easier to understand the needs and interests of our customers – and apply these insights to products, deliveries, and service.”



Agenda



Steel manager
meets futurologist:
Dr. Heribert R.
Fischer (l.) and
Matthias Horx

Who wouldn't like their own Gyro Gearloose?

In today's competitive world, only the innovative survive. But who can provide a company with the best conditions for this? A conversation between ThyssenKrupp Steel Europe Executive Director Dr. Heribert R. Fischer and trend analyst Matthias Horx.

Interviewed by: Anton Notz

Mr. Horx, how much innovative power is there in the German economy?

Matthias Horx: That varies from sector to sector. Generally speaking, Germany's tradition of gradual innovation is the envy of other countries. Its famous "Mittelstand", with its small and mid-sized businesses, has constantly been able to improve goods and processes to the point where they simply can't be copied. That's the decisive advantage in the global competitive market.

Mr. Fischer, how innovative is ThyssenKrupp Steel Europe?

Heribert R. Fischer: When I look at the materials we've developed lately, I'd say it's highly innovative. Our high-strength steels with their nanoparticles and sandwich products with polymer or carbon as the middle layer offer completely new solutions for lightweight construction. And with new simulation techniques, we can precisely predict the future behavior of our materials for the customer. This close collaboration with our customers is of tremendous importance for innovation today. You can see this in our InCar® plus initiative for the entire Group. This initiative will soon offer more than 40 solutions for the automobile industry that we've developed in close cooperation with our customers.

Matthias Horx: A process change is beginning to emerge in the industry. In the past you used to send a group of technicians down to the basement and tell them to tinker about for a couple of years. Today's innovation processes have a totally different architecture. This is something company leadership can't force – it just has to grow

organically. The result is collaborative innovation. Knowledge is no longer just fostered within the company, but also in advance, by exchanging ideas with customers.

Heribert R. Fischer: Not to mention, in collaboration with institutes and laboratories. We collaborate with 50 organizations worldwide, so that we can absorb promising ideas and develop them further.

Matthias Horx: The trend is heading toward modularization in the production environment, and for the customer, toward customization. The old value chain, where you pointed the cart forwards and drove it straight towards your destination, won't exist much longer. The cart will turn loops on the way, in order to supply new requirements. Products that interact with the materials cycle in quite different ways will be manufactured according to the 'cradle to cradle' principle, in which waste can also be nourishment.

Heribert R. Fischer: Steel can be recycled endlessly – we're already achieving recycling levels of almost 100% now. Modularization and the specific realization of customers' wishes, such as we already see in the car industry – these are the great challenges we have to meet.

What will the steel business look like in ten years' time?

Matthias Horx: Let's look even further into the future. By then a steel mill – or better still, a 'ferro basis' plant, because lots of molecules will be flying around inside it – will consist of a white hall with a variable, modular spatial configuration. ➔



“Knowledge is no longer just created within the company, but also in dialogue with customers.”

Matthias Horx

► The workers inside will be mainly technicians and inspectors. That’s already getting close to those utopias of the 1960s, with their completely unmanned factories.

Heribert R. Fischer: As far as we’re concerned, there’ll never be unmanned factories. But there will certainly be even fewer manual operations being performed in our plants. However, as always what we’ll need are well educated employees who’ll supervise and optimize the processes and ensure quality.

Perhaps, too, one brilliant idea might transform the steel industry?

Matthias Horx: Only very rarely in the history of innovation is there a ‘big bang.’ We should also bid farewell to Gyro Gearloose and his hopes of inventing a machine that turns metal into gold. At the end of the day, innovation is the interweaving of many fine strands. Plus, a company’s constant transparency not just toward society, but also toward other sectors with which, at first sight, it has nothing in common.

Heribert R. Fischer: Who isn’t looking for the next Gyro Gearloose? But the fact is, our innovations are developed and driven by teams. That’s why we involve all our employees, and implement the best ideas in the field. At the same time we need to quicken the pace and cut development times down – to three years before a product is marketable, down from five – so we can move more closely towards our customers’ development cycles.

What structures are needed to create a good climate for innovation?

Matthias Horx: Today, co-evolution and co-innovation are constantly on the increase, blurring the



“We promote curiosity, and also create free space to try things out.”

Dr. Heribert R. Fischer

Heads

Matthias Horx
Horx founded the Future Institute in 1996, and used to work as an editor for Die Zeit. As consultant and author, he deals with how social, technological, economic, and political trends interact.

Heribert R. Fischer
With a doctorate in engineering, Dr. Fischer is responsible for Sales and Innovation on the ThyssenKrupp Steel Europe Executive Board. Previously he also performed other senior management functions for the company, including four years in China.

boundaries of a company. Perhaps in 20 years ThyssenKrupp Steel Europe won’t be a steel company at all any longer, but rather a materials supplier – one that develops new solutions and processes with its customers in the most diverse areas. For this you need people who aren’t just curious about their own specific material, but also about how the world functions – and who are also able to communicate this. If you have enough of them, you get the right climate for innovation.

Heribert R. Fischer: For management, our No. 1 priority is to make the significance of innovation clear. Secondly, we need curiosity and free space to try things out. And thirdly, we rely on an intensive exchange between our Sales, R&D, and Production experts, because the most successful innovations arise across disciplinary boundaries.

How many people thinking outside the box does a company need?

Matthias Horx: It’s not enough just having people think outside the box. For every 100 employees, a company needs three or four ‘loyal mavericks’: know-it-alls, who get on everyone’s nerves, but who actually have lots of experience and identify closely with the company.

Heribert R. Fischer (chuckling): Whether we need mavericks right now or not, I really can’t say. But innovation needs employees with high levels of knowledge and experience, and who at the same time approach matters with open and curious minds, by asking simple questions that sometimes place things in an entirely new light. This kind of climate for innovation not only sharpens our competitive edge. It’s also a key factor in higher levels of customer orientation and attractiveness as an employer.

Photos: Andreas Teichmann (3), Constanze Tillmann, Cobis, ThyssenKrupp Steel Europe Fotografie, Jan Bitter, Gilles Cohen, Andreas Weise

Dates



Tube
7–11 April,
Düsseldorf,
Hall 3, Booth C28

The Düsseldorf 'Tube' is the world's foremost trade fair that offers insights into the latest trends and developments in and around pipe manufacture, treatment, and trading. ThyssenKrupp Steel Europe will be exhibiting innovative steels for pipe manufacture at the joint booth of ThyssenKrupp Materials International.

SCT
15–19 June,
Braunschweig

Manufacturers, suppliers, and steel producers get together for the international 'Steels in Cars and Trucks' (SCT) conference in Braunschweig. This year, ThyssenKrupp is exhibiting its InTruck® customer project, which offers tailor-made optimization solutions for utility vehicles, to a wide-ranging specialist audience for the first time. What these could look like are on display at the specially equipped ThyssenKrupp TechTruck, right in front of the city's Congress Center.



Eurosatory
16–20 June,
Paris, German Pavilion,
Hall 6

ThyssenKrupp will present solutions at the biggest international trade fair for defense and security in Paris. The Heavy Plate Business Unit will be providing information about its highly specialized SECURE steels in the German Pavilion in Hall 6 of the Paris Nord Villepinte Exhibition Center.



2014

April

METPACK
6–10 May, Essen,
Hall 3.0, Booth C15

Once every three years, the metal packaging industry meets in the German city of Essen for the METPACK trade fair. ThyssenKrupp Rasselstein will be there, too, presenting its latest innovations and seeking contact with customers old and new.



CONTACT



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May

Workshop
'Energy-Efficient Roofs and Facades'
14 May, Hamburg

How can we make industrial buildings that are energy efficient and economical? The workshop entitled Lightweight Steel Construction Systems for Roofs and Facades, organized by the Steel Information Center in Hamburg, promises to provide some answers. ThyssenKrupp Steel Europe will be participating, too, presenting its



coil-coated flat products from the **ReflectionsPearl®** color range. After the workshop, participants will be able to visit the Airbus factory free of charge. Registration can be made through the Steel Information Center.

June

JSAE
21–23 May, Yokohama, Japan

With its 20,000 square meters of floor space, the trade fair organized by the Society of Automotive Engineers of Japan (JSAE) offers around 70,000 visitors the chance to network with more than 400 exhibitors. At a joint booth shared with ThyssenKrupp Steel Europe and five other Group Companies, ThyssenKrupp Steel & Technologies Japan will be exhibiting innovative material solutions for carmakers using steel and lightweight construction technologies.

CWIEME
24–26 June, Berlin, Hall 4.2, Booth F70

More than 500 exhibitors from about 40 countries will be in attendance in Berlin at this year's CWIEME, the premier trade fair for coil winding, insulation, and electrical manufacturing. ThyssenKrupp Steel Europe will be participating as well, demonstrating its solutions for non-grain-oriented electrical steel.

July

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- A Open end wrench
- B Broom
- C Pipe wrench
- D Heatproof jacket
- E Adjusting ring
- F Broom head
- G Poking stick
- H Striking-face box wrench

Competition

Which of these weighs exactly 1,200 grams?

Eight possibilities, one right answer. If you think you know which of the items shown here is the right one, **let us know!**

We're giving away three vouchers for a driver safety course run by the DVW.

Send your answers to: ThyssenKrupp Steel Europe AG, Reference: compact^{steel} competition, 47161 Duisburg. E-mail: compact.tkse@thyssenkrupp.com
 Closing date for entries: 4 April 2014 (date of posting accepted). The winner will be chosen from all the correct entries. Employees of ThyssenKrupp Steel Europe and their dependants are not eligible. The judges' decision is final. Note: Your personal data will be used for the purposes of the competition only.