



Manufacturing Journal

magazine



Sixty Years

of Industrial Chemistry Innovation

page 35



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Dear Readers!

Manufacturing today is defined by acceleration. Product cycles are shorter, variants multiply, and technological shifts can redefine entire industries within a decade. In such an environment, automation is no longer just about speed or precision. It is about adaptability. It is about building systems that evolve alongside the products they assemble. IFSYS Integrated Feeding Systems GmbH has built its identity around this principle. Since its foundation in 2006, the company has focused on feeding technology not as a standalone component, but as a dynamic, integrated part of the production ecosystem. Read on page 17.

As D.N.P. celebrates its 40th anniversary, the company stands as a global leader in the design and production of high-pressure quick-release couplings. Founded in 1985 by Enzo De Isabella, whose pioneering vision transformed a small local enterprise into a brand recognized in more than 50 countries, D.N.P. has consistently combined Italian quality, innovation, and sustainability. Read on page 28.

In 2026, Haug Chemie celebrates its 60th anniversary—a milestone that symbolises not only the longevity of a family-led organisation, but also the extraordinary transformation of a company that has continuously reinvented itself alongside the global chemical industry. Founded in 1966 in Sinsheim, Germany, Haug Chemie began as a modest producer of solvent mixtures for local manufacturers. Today, it stands as an international supplier of advanced chemical technologies serving nearly every major industrial sector, from metalworking and plastics processing to woodworking, wastewater treatment, automotive supply and industrial maintenance. Read on page 35.

Making its debut at K 2025 under a new name, Syensqo marks a bold new chapter in its journey as a global leader in specialty polymers and advanced engineering materials. In this exclusive interview, Peter Browning, President of the Specialty Polymers business, discusses the strategic importance of the company's rebranding, the fast-growing technologies driving transformation across industries such as automotive, electronics, healthcare, and hydrogen mobility, and Syensqo's unwavering commitment to sustainability and circularity. Through continuous innovation and close collaboration with customers, Syensqo is redefining what performance and responsibility mean in the world of high-performance materials. Read on page 55.

Enjoy the magazine!

Editor:

A handwritten signature in black ink, appearing to read 'Peter Browning'.



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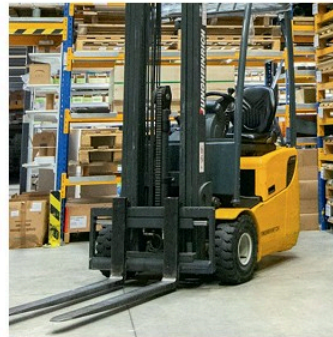
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ISSN2353-2793

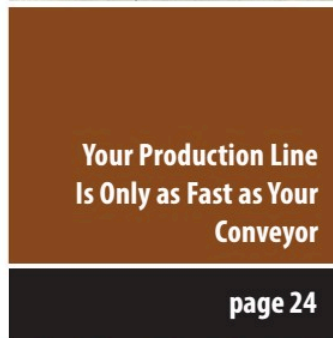


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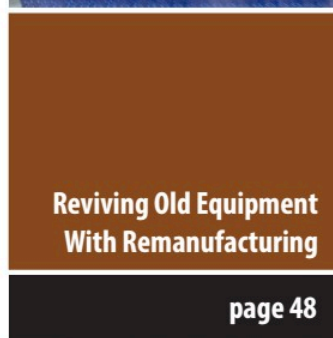
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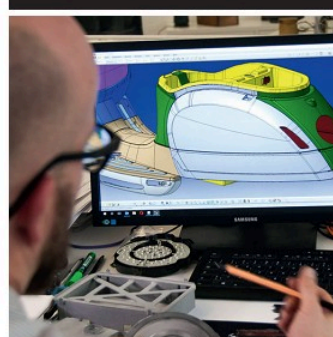
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Technology with a human face. Precise FAULHABER Drives for Humanoid Robots

They walk, grip, balance - and fascinate with their human-like appearance: Humanoid robots have impressive mobility and are even able to interpret facial expressions or understand language. What was still a futuristic vision just a few years ago is today taking concrete shape. Hidden behind the technological developments of humanoid robots is a complex interaction of artificial intelligence, precision mechanics and powerful drive technology. Miniaturization plays a decisive role here, as it enables compact designs with high functionality. The contribution of FAULHABER and the use of modern technologies are setting the course for the next stage in the evolution of robotics.

Walking on two legs is a complex matter that must be precisely controlled. Even humans need a good year before this apparently trivial sequence of movements is mastered and the interaction of approximately 200 muscles, numerous complicated joints and various specialized regions of the brain functions. Due to the unfavorable lever ratios for humanoid robots, a motor with minimal dimensions must produce the high-

est possible torque in order to be able to replicate a human-like movement. While classic robots are typically used in highly structured environments such as industrial manufacturing or logistics, humanoid robots enter a completely new terrain: daily life. They need to orient themselves in unstructured environments in which, e.g., no living room is like the other and every task is individual. When in direct contact with people, they operate less abstractly but are rather physically present - often within close proximity.

Humanoid robots form the interface between artificial intelligence and the real, physical world. They are able to process not only digital information but also transform this into concrete actions. If the sequences of movements function smoothly and safely, humanoid robots can perform a number of tasks that were previously reserved for humans - be it in hazardous environments, in direct contact with people or in repetitive processes. They assist in the household, support with rehabilitation, interact with older people or are used in retail business. Their strength is in their versatility and ability to adapt to human environments.

The role of drive systems

At the core of every movement performed by a humanoid robot is a precise

drive system. It decides how smoothly an arm is raised, how quickly a leg can respond or how gently a finger grips. Drive technology thereby has a significant impact on the performance, naturalness and safety of humanoid movements. The miniaturization, energy efficiency, dynamics and precision are central requirements here - an interaction that can be realized only with highly developed micromotors. These are all aspects that are decisive not only in robotics but also in prosthetics. The transition between humanoid robots and prosthetics is a seamless one. Modern prosthetics - especially arm or hand prosthetics - replicate the movements of the human body and use principles similar to those of humanoid robots to do this. Electromotors, sensors and precise control enable intuitive and forceful movements. Decisive in both cases is the perfect symbiosis of technology and biology - be it for the expansion of human capabilities or to replace lost functions.

More info: www.faulhaber.com

Anker SOLIX introduces single-phase parallel setup for its X1 home energy storage system

Double the power and storage capacity for single-phase home connections – up to 60 kWh storage and 12 kW output power

Anker SOLIX introduces a significant expansion for the UK market with the new single-phase parallel setup of its proven energy storage system, Anker SOLIX X1. The new model allows two single-phase systems to be operated in parallel for the first time, doubling power, storage capacity, and PV input power – ideal for larger households with extensive solar installations and dynamic electricity tariffs

The Anker SOLIX X1 was introduced last year and marks Anker SOLIX's entry into the market for permanently installed home storage solutions. Since its launch, the system has combined modern design, high performance, and certified safety





with maximum user-friendliness. Each X1 consists of a power module and up to six battery units, each with 5 kWh, resulting in a total capacity of up to 30 kWh per system. With a charging and discharging capacity of up to 6 kW and a PV input of up to 12 kW, the X1 covers the energy needs of typical single-family homes.

Store more solar power during the day, use less grid power in the evening

With the new parallel setup, the X1 can be expanded from a single system with 30 kWh capacity to a dual system with 60 kWh storage capacity. This allows users to store significantly more of the solar power they generate during the day for use in the evening hours and to operate their appliances, heating systems, or electric vehicles with their own solar energy instead of expensive grid power. By combining two 6 kW units, the X1 now offers up to 12 kW of charging and discharging power and up to 24 kW of PV input power. This allows batter-

ies to be recharged more quickly during periods of low tariffs or high solar radiation – and power-intensive devices can also be supplied with electricity in the evening.

High standards, optimized for the UK market

The single-phase system is fully designed for the UK grid structure and meets all relevant standards, including G100 CLS, Octopus, and RRCR. This makes the X1 ideal for UK households that want to take advantage of dynamic tariffs and maximize their own consumption of solar power. Installers also benefit: the system is easily scalable, can be set up via the Anker SOLIX Pro app, and monitored centrally via the O&M portal.

Like all models in the X1 series, the parallel setup stands for high reliability, TÜV-certified safety, and a clean design suitable for residential use. Thanks to the modular concept, the capacity can be adjusted to actual energy requirements at any time. The system offers proven IP66 protection, operates reliably at temperatures from $-25\text{ }^{\circ}\text{C}$ to $+55\text{ }^{\circ}\text{C}$, and is backed by a ten-year warranty.

Whether for a single-family home or a small business, the Anker SOLIX X1 in parallel operation offers a flexible solution for storing more energy, charging faster, and becoming more independent from the power grid. This strengthens Anker SOLIX's position as a provider of scalable energy storage systems that are driving the transition to a decentralized, sustainable energy supply.

More info: www.ankersolix.com





FPT Industrial continues to strengthen its position through a new partnership with Lindner, reaffirming the brand as the engine provider of choice in the agricultural segment

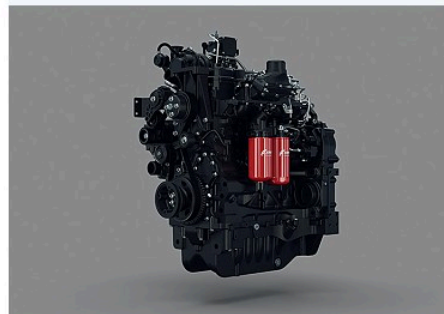
FPT Industrial, the Iveco Group brand dedicated to the design, production, and sale of powertrains and solutions for on- and off-road vehicles, as well as marine and power generation applications, has been chosen by the Lindner tractor company as the engine supplier for its new Lintrac 160 LDrive, the most powerful tractor in its history.

This is another major success for FPT Industrial: the Iveco Group brand thereby confirms itself as the preferred global partner for OEMs in the agricultural segment, thanks to its reliable products and innovative, technology-driven solutions.

Founded in 1948 and based in Tyrol, Austria, Lindner is a family-owned company specializing in the development and production of innovative tractors for Alpine and various other agricultural applications. Known for its high-quality engineering and sustainable solutions, Lindner is a trusted partner for profes-

sionals operating on challenging conditions. The Lintrac 160 LDrive was developed for farms that need plenty of power combined with maximum comfort and revolutionary maneuverability. Typical applications include work with combination balers, arable and row-crop farming, contract work, and maintenance tasks. In addition, the Lintrac 160 LDrive has been tailored for year-round municipal use. Four-wheel steering makes the Lintrac 160 LDrive the most maneuverable tractor in its hp class.

Lindner chose FPT Industrial's N45 engine because it is the perfect fit for the new Lintrac 160 LDrive, designed to operate in high-altitude environments and on steep terrain. Among the winning features of the engine which perfectly suit the missions of the new Lintrac 160 LDrive are its lean design and compact dimensions, paired with



impressive power and torque. Not to mention the engine's proven reliability, a key factor when it comes to demanding field operations.

The FPT Industrial NEF family, as market leader in the powertrain sector, is the best choice for the most demanding missions of agricultural equipment, and is testament to the brand's technological excellence. Since 2001, over two million of these engines have been manufactured for a range of applications: agriculture, construction equipment, on-road, marine and power generation. Celebrating 25 years of continuous improvement, FPT Industrial is proud to mark the anniversary of its powertrain family, a significant milestone that underscores the strength of its technology, its proven reliability, and the enduring trust earned from the market through consistent performance in the field.

"This new partnership further strengthens our position in the market. We are proud to be joining forces with Lindner, a company that shares our core values of innovation, customer focus, and reliability, making us ideal partners," said Sylvain Blaise, President of Iveco Group's Powertrain Business Unit. "Despite the headwinds, we are establishing new collaborations. Together, we look forward to delivering exceptional solutions for demanding off-road applications. The future holds great promise for our partnership."

"With our tractors, we empower customers across Europe to achieve exceptional results every day. Ensuring the highest quality is our foremost priority — both in our products and in our partnerships. The new Lintrac 160 LDrive represents a significant milestone for our company. We are pleased to collaborate with FPT Industrial, a strong and reliable partner who shares our commitment to excellence and meets the high standards we set for ourselves and our products", explained David Lindner, Lindner Managing Director.

More info: www.fptindustrial.com



BRB launches low carbon footprint viscosity modifiers for the lubricant industry

Viscotech® Upcycled solutions reducing carbon footprint by 60% using re-refined base oils, supporting circular economy.

BRB Lube oil Additives & Chemicals, a leading global supplier of lubricant oil additives and specialty chemicals, today

per kg final oil formulation, thereby supporting end-users in the value chain to reduce their carbon footprint (scope 3 reduction). Using re-refined raw materials support the shift from virgin fossil dependence towards a circular economy.

"We are very excited to share the new Viscotech® Upcycled series with the market. With high quality RRBO as a raw material in Viscotech® viscosity modifiers, we deliver innovative formulations

warming limited to 1.5°C, the most ambitious goal of the Paris Agreement. With the new Viscotech® Upcycled series, BRB is building on a sustainable specialty portfolio focusing on innovation and carbon reduction.

"Over the years, we've made continuous efforts and succeeded in specialty formulations with high-quality RRBO in our premium products, following a strategic shift towards solutions with lower



launched the new Viscotech® Upcycled series, a low carbon footprint viscosity modifier solution, dissolved in high quality re-refined base oils (RRBO), as alternative to virgin base oils.

Viscosity modifiers formulated using recycled base oils are ready for introduction into the value chain as high-value products, currently used in automotive and industrial lubricants. They are drop in alternatives for standard Viscotech, with the only difference being that they contain re-refined base oil, reducing the product carbon footprint by approximately 60% cradle to gate, compared to using virgin base oil. Furthermore, it reduces around 0.1 kg of CO2 emission

that meet stringent standards and exhibit performance in parity with modifier solutions based on virgin base oil," says Roger Dohmen, Vice President of BRB Lube oil Additives & Chemicals. "For us, RRBOs are no longer a compromise, but a strategic enabler for products that contribute to a reduced carbon footprint, both for BRB and the value chains."

As a subsidiary of Malaysia's PETRONAS Chemicals Group Berhad (PCG), BRB Lube oil Additives & Chemicals is now part of the Specialty Chemicals division of PCG. PCG Specialty Chemicals division has set ambitious targets to reduce greenhouse gas emissions in line with the reductions required to keep global

carbon footprint. We invite our customers to explore our product offerings with reduced climate impact and collaborate with BRB as business partners on the journey toward circular economy and products with lower carbon footprint," said Roger Dohmen, Vice President of BRB Lube oil Additives & Chemicals.

About Re-refined base oils (RRBO)

Rather than disposing waste oils, an increasing number of producers are collecting used oils and removing impurities through multi-step technological processes, thus extending their life cycle.

More info: www.brb-international.com



Clariant increases capacity in Daya Bay facility and expands Exolit™ OP portfolio for e-mobility

Clariant completes its CHF 100 million investment in the Daya Bay facility, with the second production line fully operational in November. This expanded capacity strengthens Clariant's ability to meet growing demand for more sustainable flame-retardant solutions in Asia and globally, particularly in the rapidly expanding e-mobility sector.

"Our continued investment in the Daya Bay facility underscores our commitment to supporting the significant growth of engineering plastics applications in e-mobility and electrical & electronic segments," said Angela Cackovich, Business President Adsorbents & Additives and EMEA and Member of the Executive Steering Committee. "With this world-class manufacturing plant, we strengthen our leading position in innovative and more sustainable fire safety solutions while improving our ability to serve customers across the Asia Pacific region with reduced delivery times and tailored solutions." In addition, Clariant announces the expansion of its Exolit OP flame retardant portfolio with two new high-perfor-

mance solutions specifically designed for polybutylene terephthalate (PBT) applications in e-mobility. The new products, Exolit OP 1242 (TP) and Exolit OP 1266 (TP) are featured at K 2025.

Meeting critical e-mobility challenges

The new Exolit OP flame retardants address two critical challenges in e-mobility applications. Exolit OP 1242 (TP) offers exceptional hydrolysis stability, while Exolit OP 1266 (TP) provides a stable comparative tracking index (CTI) of 600 V even after extended storage periods. Both products meet the UL 94 vertical test with V-0 classification down to a sample thickness of 0.4 mm at dosing levels of 15-20%.

These innovations are particularly significant as the e-mobility industry transitions to higher voltage systems of 800 V and above, requiring materials with superior electrical insulation properties and long-term stability under demanding conditions.

Sidestepping antimony market volatility

The new halogen-free flame retardants offer manufacturers an attractive alternative to traditional systems based on antimony trioxide (ATO), which has experienced dramatic price increases and

supply chain volatility in recent years.

"Our new Exolit OP solutions not only deliver superior technical performance for e-mobility applications but also help manufacturers reduce their exposure to antimony market fluctuations," explained Mariano Suarez, Head of Marketing Additives at Clariant. "By offering halogen-free and ATO-free alternatives that don't require fluorinated polymers like PTFE, we are enabling our customers to meet growing OEM environmental requirements while maintaining reliable supply chains."

Expanding the Exolit portfolio with melamine-free solutions

As part of Clariant's ambition to remove substances of very high concern (SVHC) from its portfolio, the company has also developed Exolit AP 422 A, which delivers exceptional fire protection for polyisocyanurate (PIR) insulation panels while offering manufacturers a melamine-free, SVHC-free solution that meets stringent fire safety standards.

In polyurethane foam applications, this versatile halogen-free ammonium polyphosphate serves as an effective replacement for TCPP (tris(chloropropyl) phosphate) and TEP (triethyl phosphate), providing robust flame retardancy without unwanted plasticizing effects. With improved powder flowability for more efficient production handling, Exolit AP 422 A enables customers to create safer, more sustainable building materials that align with evolving regulatory requirements.

More info: www.clariant.com

Introducing Rexelian: A New Era of High-Performance Recycled Compounds for the Mobility Industry

The plastics and mobility industries welcome a new player today with the official launch of Rexelian, a company born to reshape how high-performance recycled materials are developed, produced,



and brought to market. Headquartered in Sant Cugat del Vallés, near Barcelona, and strategically positioned at the heart of Europe's industrial corridor, Rexelian is dedicated to delivering advanced recycled polyolefin compounds for mobility, appliances, and electronics - with a laser focus on sustainability, quality, and performance. Rexelian is an independent company, but it emerges with a unique competitive edge: the backing of GCR Group's recycling and compounding infrastructure, one of Europe's largest with over 500KT/year of installed capacity. Structured as a standalone company, Rexelian benefits from its proximity and direct access to this industrial scale, using 10% of GCR's total capacity to serve its specialized portfolio - creating a value chain integration rarely seen among independent compounders. "Rexelian represents a new generation of companies - agile, technically driven, and fully aligned with the demands of the circular economy," said Antoni González, General Director of Rexelian. "We don't just make recycled compounds. We develop material solutions that help our customers meet their CO2 reduction targets without compromising technical performance."

A Strong Foundation, A Clear Focus

Rexelian was quietly founded in mid-2024 and has since laid the groundwork for long-term success - investing in product development, strategic part-

nerships, and regional coverage across Europe. The company enters the commercialization phase with:

- A dedicated team of direct sales managers and application development engineers covering Iberia, France, Italy, Germany, and Eastern Europe – each bringing extensive industry experience and a deep-rooted automotive DNA, ensuring a clear understanding of automotive-grade solutions.
- A product portfolio of high-performance recycled PP and PE compounds (PIR- and PCR-based), available in multiple talc-filled grades and custom colors
- Immediate access to certified, traceable feedstock through a dedicated sourcing team

Designed for the Mobility Sector's New Demands

Rexelian is purpose-built to support automotive OEMs and Tier 1/Tier 2 suppliers with materials that meet the demands of electrification, lightweighting, and regulatory pressures. Applications include:

- Interior, exterior, and under-the-hood components
- Large and small appliances
- Electronic casings and structural parts
- Its mission is to help clients reduce

CO2 footprints, meet 2030 circularity targets, and replace virgin materials without sacrificing performance.

R&D, Quality and Market Differentiation

Rexelian is investing heavily in innovation, application testing, and regulatory compliance. The company is on track to obtain an IATF 16949-certified Letter of Conformity by the end of 2025, with ISO certifications integrated into its operational standards from day one. Its integrated value chain - from feedstock to compound - ensures full traceability and consistent quality. Rexelian actively engages with OEMs, Tier suppliers, and technical centers to co-develop and validate new formulations.

Meeting Industry Momentum Head-On

Rexelian is not just built for today's market – it's designed for the decade ahead, supporting customers in meeting the early 2030s ELV regulations. Drawing on its expertise and state-of-the-art technology, the company is able to introduce End-of-Life Vehicles (ELV) materials as a viable source within the circular economy. This achievement is a direct result of its proven know-how. Positioned as a local partner for European industry, with efficient logistics and short supply chains enabled by proximity to Tarragona's petrochemical cluster and the Port of Barcelona.

With automotive and electronics industries under rising pressure to comply with EU mandates on recycled content, Rexelian offers immediate and scalable solutions to enable compliance without delay. The company is already engaging in pilot projects that demonstrate compliance with OEM specifications, while drastically improving eco-balance scores. "Our customers understand that sustainability is no longer optional," added Antoni Gonzalez, General Manager of Rexelian. "They need reliable partners with the capability, flexibility, and technical know-how to ensure consistent delivery and supply security- and that's exactly what Rexelian offers."

More info: www.gcrplasticsolutions.com



CYCOM® EP2190 now included in NCAMP database, enabling faster aerospace qualifications

Syensqo, a global leader in advanced materials, announces that its CYCOM® EP2190 epoxy prepreg has been added to the NCAMP (National Center for Advanced Materials Performance) database. This milestone provides customers with standardized, publicly available qualification data packages, lowering barriers for adoption and enabling faster timelines for aerospace programs. NCAMP qualification lowers barriers for adoption and shortens customer design timelines.

The NCAMP datasets cover EP2190 unidirectional tape on intermediate modulus (Teijin IMS65) fiber and plain-weave fabric on standard modulus (Syensqo Thorne!® T650) fiber. With NCAMP publication, OEMs (Original Equipment Manufacturers) and tier suppliers gain access not only to material property data, but also to comprehensive qualification reports, statistical analyses, material specifications, and process specifications. This full suite of documentation significantly reduces the time and cost of adoption for new aerospace programs.

CYCOM® EP2190 is a high-performance

thermoset material designed for demanding primary structures. It delivers enhanced toughness while maintaining excellent compression properties — a balance critical for commercial aerospace, defense, and AAM (Advanced Air Mobility) applications.

“Having CYCOM® EP2190 in the NCAMP database allows our customers to efficiently adopt this high-performance material and rapidly move into the design phase of their programs,” said Greg Kelly, Director of Product and Asset Management, Syensqo Composites. “This is particularly impactful for AAM and defense customers seeking proven, readily available material systems.”

Over the last several years, Syensqo has further broadened its EP2190 portfolio beyond its core UD tape and fabric forms to include AFP carbon tape, S2 glass tapes, and the required complementary glass fabrics. These expanded offerings provide engineers with greater versatility across both primary and secondary structures.

CYCOM® EP2190 is currently produced at Syensqo’s Wrexham, UK facility, with plans to expand production to North America as demand grows

More info: www.syensqo.com

SONGWON strengthens OPS leadership with major investment in KSA

- SONGWON expands global OPS footprint with new facility in KSA
- Local OPS plant to support KSA’s polyolefin market and the Saudi Vision 2030

Songwon Industrial Co., Ltd., one of the world’s largest manufacturers of polymer stabilizers, has announced a major new investment to establish a state-of-the-art OPS (One Pack Systems) production facility in the Kingdom of Saudi Arabia (KSA). This greenfield investment project underlines SONGWON’s global strategy to strengthen its position in the polyolefin industry and deliver high-quality, locally manufactured OPS products to its KSA customers with shorter lead times.

Due for completion in 2028, the new state-of-the-art facility will be wholly owned by SONGWON and produce a range of SONGNOX® OPS, high-performance additive blends to support efficient polyolefin resin production. By expanding local capacity and improving supply chain flexibility, the plant will position the organization to better serve the fast-growing polyolefin market across the Middle East.

Commenting on the greenfield investment, Jongho Park, Group CEO, said: “Following the success of our facilities in the UAE, Germany and the U.S., this investment represents a significant step forward in expanding SONGWON’s global OPS footprint and our dedication to this key polyolefin market and the Saudi Vision 2030. Furthermore, the new KSA plant will unlock new possibilities for growth and future expansion and enable us to provide reliable and responsive service to customers across the Middle East and beyond.”

“The new strategically-located facility will complement our existing production network and enhance our ability to serve KSA customers effectively. It highlights not only our commitment





to this important region but also our drive to lead in operational excellence and sustainability,” explains Christian Miglioli, Country Manager UAE & Leader Sales Polymer Stabilizers – Middle East, Africa & India. “By providing greater access to our high-performance SONGNOX OPS range, the KSA plant will open new opportunities for SONGWON to meet evolving market needs and, most importantly, to deliver real value to our customers.”

More info: www.songwon.com

Built on Experience, Driven by Innovation: POLYVANTIS Highlights Microfluidics Film Portfolio

Microfluidics is reshaping the future of healthcare and diagnostics—powering rapid point-of-care testing, lab-on-a-chip systems, and advanced biochemical analysis. However, the success of this fast-growing field depends on materials that combine optical precision, biocompatibility, and scalable manufacturability. At K 2025, POLYVANTIS will showcase how its PLEXIGLAS® polymethylmethacrylate (PMMA) and EUROPLEX® Cyclic Olefin Copolymer (COC) films meet these demands, delivering dependable, innovative solutions for device makers worldwide.

Microfluidic lab-on-a-chip technology integrates laboratory functions onto a single chip, enabling rapid, precise analysis of small fluid volumes. To perform reliably, these devices require exceptional optical clarity for accurate readouts, chemical and thermal resistance for stability, and straightforward processing for efficient production. POLYVANTIS’ portfolio of PLEXIGLAS® and EUROPLEX® films addresses these challenges head-on, offering complementary strengths that set a new standard for the industry.

Solving the industry’s toughest challenges with innovative film technology:

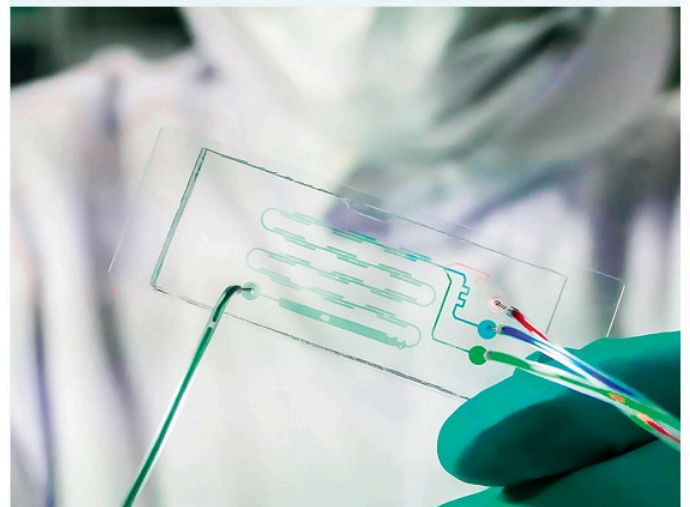
- **Optical precision:** PLEXIGLAS® PMMA films deliver exceptional brilliance and UV transparency (>90% at 315 nm for Film 0F301), while EUROPLEX® COC films provide excellent light transmission with very low autofluorescence.
- **Fluid control:** PLEXIGLAS® PMMA films feature the highest surface energy among polymers used in microfluidics, enabling laminar flow in microchannels.
- **Chemical and thermal resistance:** EUROPLEX® COC films withstand solvents, acids, and bases, and are available in two versions—0F304 (Tg 78 °C) and 0F305 (Tg 142 °C) - to meet diverse thermal demands.
- **Biocompatibility and sterilization:** Both film families are biocompatible; EUROPLEX® COC films comply with the European Pharmacopoeia, Monograph 3.1.3 “Polyolefins.”
- **Processing versatility:** Both films are easily processed by laser cutting and suitable for thermal, solvent, ultrasonic, and laser bonding.

Built on experience. Driven by innovation

With decades of expertise in acrylic chemistry and film engineering, POLYVANTIS delivers reliable products and services on a global scale. Cleanroom manufacturing, in-house customization, and tailored formats—from thickness and lamination to precision cutting—make POLYVANTIS uniquely positioned to support customers from prototype to commercialization.

“Microfluidics is transforming how the world approaches diagnostics and healthcare, and our role is to make that transformation possible at scale,” said Ravi Menon, EVP Commercial – Specialties at POLYVANTIS. “Built on experience and driven by innovation, POLYVANTIS is uniquely positioned to support our customers with dependable solutions and global reach, helping them bring breakthrough technologies to market faster and with greater confidence.”

More info: www.polyvantis.com



Emily Newton ▾



Emily Newton is an industrial journalist with over five years experience covering the manufacturing sector. As Editor-in-Chief of Revolutionized, she also covers trends in other industrial sectors, like logistics and engineering. Subscribe to her newsletter to read more.

Ellie Gabel ▾



Ellie Gabel is a science writer specializing in astronomy and environmental science and is the Associate Editor of Revolutionized. Ellie's love of science stems from reading Richard Dawkins books and her favorite science magazines as a child, where she fell in love with the experiments included in each edition.

Beyond the Price-Per-Pound: A Guide to Strategic Material Selection

By: Ellie Gabel

Material choice sets performance, build speed and profit. Price-per-pound is misleading since cycle time, scrap and reliability play a large role in cost-effectiveness. Teams that convert requirements into clear properties and pair them with processes they can run every day hit first-pass yield and keep schedules honest.

Frame Selection Around Outcomes

Material choice should protect function, speed production and lower total landed cost. Treat cost as a result of good selection, not a starting point. When a cheaper alloy increases cycle time, scrap or warranty exposure, it stops being cost-effective.

Turn Requirements Into Properties

Start by quantifying requirements. For load-bearing parts, set yield strength and stiffness targets for worst-case scenarios.

For cycling or impact-prone parts, specify fatigue strength and notch toughness, not just static strength. If heat or chemicals are in play, define continuous service temperature and resistant media to narrow materials early.

Design for Capable Manufacturing

Material candidates must suit forming, machining, molding or additive routes. Confirm the chosen material's bend radii, wall thickness rules, springback behavior and tool life — improper values can cause cracking or excessive thinning during forming. Lock the process route early, then check fixturing and tool wear plans to maintain high yield during ramp-up.

Control Tolerance Risk Early

Tight drawings are useless if stack-ups are unachievable. Tolerances have a cumulative impact, and even one out-of-tolerance feature can cascade, wasting time, material and money. This risk increases for stamped, cast or molded parts that move through multiple operations. Use process capability data for material selection and set gauge plans for the most critical features. In February 2024, Boeing disclosed that about 50 undelivered 737 MAX jets needed rework due to misdrilled holes in fuselages. A small alignment error triggered inspections, repairs and schedule changes. The fix slowed deliveries, tied up cash and strained production plans.

Plan for Sustainability and Product Data

The EU's Ecodesign for Sustainable Products Regulation lays the groundwork for rules that improve durability and reparability and require clear product information across the supply chain. It introduces a Digital Product Passport that travels with each product and carries verified data on materials, performance and compliance.



Suppliers upload the data once, then downstream teams read it during design, purchasing and service. Companies outside the EU still feel the effects because shared suppliers and global programs adopt the same rules.

Material route choices also influence footprint and compliance. Using higher scrap content, EAF-sourced steels or coatings with simpler chemistries or designing for disassembly can lower risk when new disclosure rules arrive. Engineering, procurement, and Environment, Health and Safety should set targets together at kickoff, not at the production part approval process.

Price and Supply Move Faster Than Drawings

Battery mineral prices swung hard in 2023. The International Energy Agency (IEA) reported that lithium spot prices fell about 75%, while cobalt, nickel and graphite dropped 30%-45%. Such swings rewrite bill of materials (BOM) costs mid-program and force new hedging plans or alternate materials.

Concentration also adds risk. In 2024, the IEA noted that top producers and refiners control a large share of key materials like lithium, cobalt, graphite and rare earths, raising exposure to logistics shocks and trade actions. Teams should price this risk as a landed cost.

Helpful Tools That Speed Material Choices

These lightweight tools help teams see trade-offs faster without heavy software.

- Choice architecture: Offer three to five material-process options per gate, with a “why it could win” note for each so the team can see trade-offs. Research shows that better option sets improve decisions when analytics surface strong candidates.
- Screening matrix: Quickly score options on performance, manufacturability, supply risk and sustainability. Then stress-test the two most uncertain weights to see if the winner changes.
- Supplier capability snapshot: Ask suppliers for recent process performance data, default stack-up rules and typical tool wear curves for the material. Choose the option comfortably within that capability window.
- Short capability trial: Run a small batch to check hole position, flatness and finish before buying hard tooling. Use the results to refine fixturing, tolerances and yield targets.
- Regulatory watchlist: Track Ecodesign for Sustainable Products Regulation delegated acts and the fields required for the Digital Product Passport. Add those data tags to drawings and BOMs early.



Seismic Considerations for Warehouse Rack Design

By: Emily Newton



In potential earthquake-affected regions, engineered racking systems in warehouse storage can prevent disastrous failures that result in severe safety hazards for employees, inventory loss and operating downtime. With global seismic activity becoming a growing concern, engineers and facility managers proactively incorporate warehouse racking seismic design to protect staff and assets while ensuring business continuity and regulatory compliance. What are some of the seismic considerations for warehouse rack design?

Understanding Seismic Risk in Warehousing

Risk assessment is paramount for facilities located in high seismic areas to safeguard warehouse operations. As identified by the U.S. Geological Survey's seismic hazard maps, facilities in high seismic zones must evaluate, analyze and identify any weak points in existing structures relative to factors including site-specific response spectra like soil liquefaction and ground acceleration.

Factors like rack load distribution, height-to-depth ratios and using the proper method for pallet racking frame bracing are pivotal in a racking system's seismic undertaking. Mezzanines and automated storage and retrieval systems, combined with weighty pallet loads, further intensify seismic demands on racking structures.

Industrial designers who understand these risk factors and incorporate anti-earthquake design principles into early planning significantly reduce the chances of catastrophic losses during a seismic event.

Seismic Design Standards and Codes

Complying with seismic design standards ensures safe and resilient warehouse racking systems. Provisions within the IBC and the IEBC establish seismic standards for how structural design and construction best resist forces during earthquakes. The IBC applies to practically any new building. At

the same time, the IEBC includes new editions published by the ICC — the primary global model code, standard and building safety source — on a three-yearly basis.

These codes consider seismic force calculations, drift limits and load combinations for storage rack structures. Along with RMI specifications, the IBC offers thorough guidance on pallet rack system seismic qualification — covering base plate sizing, anchor bolt selection and bracing needs. Engineers must assess SDC categories, site classes and other priorities when defining racking components and layouts.

While RMI and IBC were once zonally classified, they are now more detailed and location-specific — warehouses in the same state could have different regulatory requirements.

Regional amendments, especially in high-risk seismic zones, may impose additional detailing requirements, with non-compliance with set standards leading to potential regulatory penalties, increased liability and higher risks of rack failures during earthquakes. Warehouse managers and engineers must stay updated with evolving codes and engage with structural engineers to mitigate these risks.

Design Rack Considerations for Seismic Resiliency

A holistic approach to integrating sound structural engineering principles with operational actualities can achieve seismic resiliency in warehouse racking systems. A primary consideration is rack configuration.

Height-to-Depth (HTD) Ratios

Height-to-depth (HTD) ratios play an essential role in secure racking. Tall, narrow, rigid racks with high center-of-gravity loads will likely topple more easily during seismic events, so load distribution and geometry are essential in rack design. If the HTD ratio is equivalent to or less than six to one, securing floor base plates using standard anchoring provides sufficient stability. However, if the HTD ratio is greater, you should apply further safety measures — anchors and base plates that resist 350-pound overturning forces — to the highest beam level.

If your HTD ratio exceeds eight to one, employ overhead cross-aisle ties as an extra stabilizing safeguard. Extending these overhead ties across the aisle to connect two rack frames provides additional support to minimize overturning and prevent a load impact when placing or removing a top-level pallet. A certified engineer should authorize anchoring designs for these high-level racks.

Semi-rigid connections account for the precise stiffness of rack frames and considerably dissipate seismic energy, reducing the base shear a structure undergoes. Engineers must also account for the seismic storage weight of materials, with



heavier pallet loads increasing the inertial forces transmitted to the racking system.

Racking Material Selection

Choosing racking material is another critical factor in rack configuration. High-strength steel components, robust welds and reinforced bracing systems improve rack structures' energy dissipation and ductility. Anchoring and base plate design are also imperative — large base plates, high-capability anchor bolts, and seismic-rated fasteners assist in safely transferring seismic loads into the warehouse slab. Longitudinal and cross-aisle bracing, coupled with ductile frames, further enhance lateral stability to prevent potential frame collapse.

Using highly ductile materials in rack manufacture allows racks to move and change shape without losing strength or breaking. Steel and wood are the most common and best earthquake-resistant materials. Masonry and concrete, common in pre-1950s construction, offer the lowest ductility. Any warehouses with old, permanent shelving solutions from these materials should consider replacement or, at worst, reinforcement or wrapping.

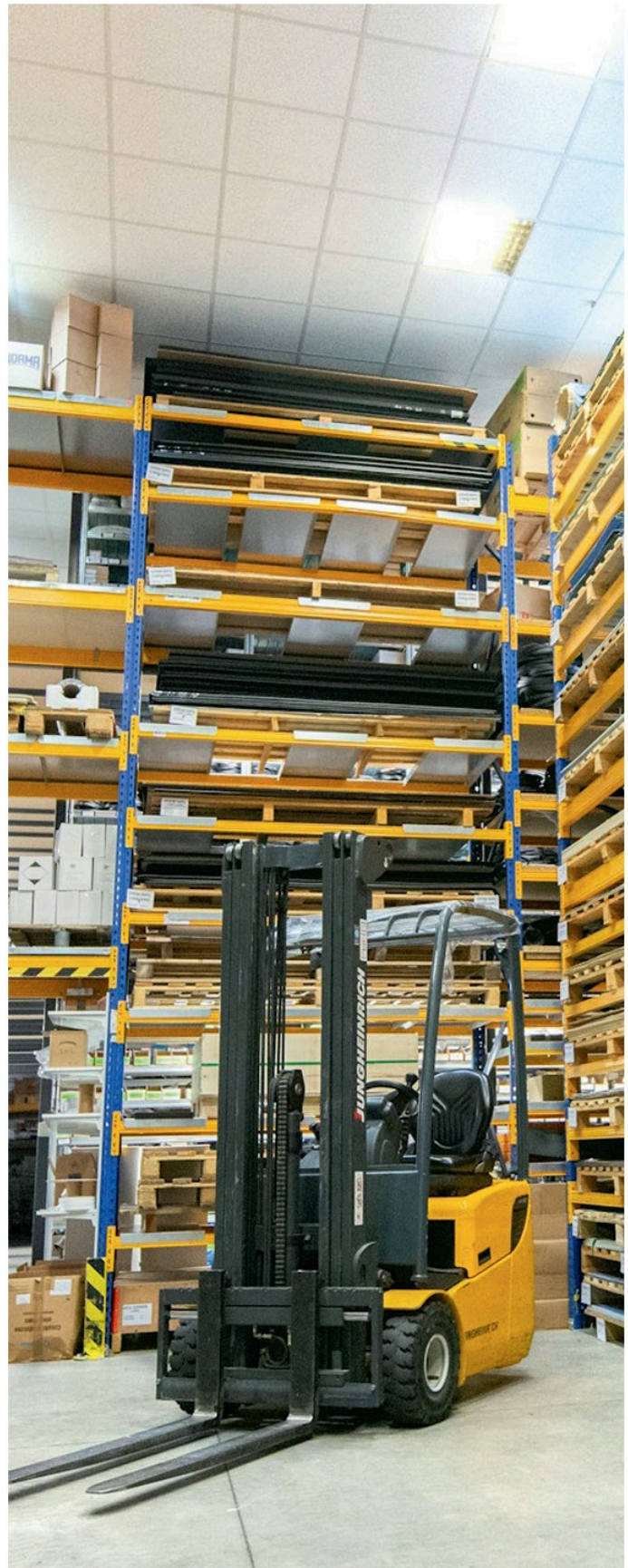
Real World Assessment

Specialized engineering assessments like computerized finite element analysis (FEA) simulate real-world conditions, like the dynamic behavior of racking systems under seismic conditions, without the time, expense or risk of physical prototype testing. Site-specific response spectrum analysis requires individual site development referencing specific earthquake data, referenced by the magnitude-distance combination of regional seismic hazard, soil response and soil conditions analyses. While these site-specific response spectra are accurate, using this analysis is time-consuming and requires operational insights that are more scarce.

FEA and spectrum analysis assist in identifying potential failures — chances of column buckling, connection shear and others — and contribute to selecting appropriate seismic material detailing. Ultimately, their integration, along with incorporating IoT Disaster Management for early warnings, ensures warehouse racking seismic design meets code requirements and delivers enduring operational asset and safety protection.

Warehouse Rack Design for Seismic Regions

These seismic considerations afford warehouse managers and engineers starting points when designing racking systems that withstand earthquake activity. Abiding by seismic standards and regulations is crucial for rack designing that utilizes the best HTD ratios, spacing and rack widths to construct seismic systems best suited to your region.



WSM's mould tool solution enhances torque testing device



When industrial torque tool specialist Gedore Torque required a high-quality injection-moulded product at short notice, they turned to WSM INDUSTRIES for a custom-designed solution.

Gedore was in the process of launching a new premium torque testing device and had planned to 3D print the main housing. However, during initial product testing it became clear that 3D printing the housing would not deliver the quality and consistency required to meet Gedore's high product standards.

Needing an alternative solution, Gedore's R&D team approached Operations Manager Gavin Bridger for support.

Having considerable experience working within the plastics sector, Mr Bridger had collaborated with WSM for tool making, injection moulding and parts assembly services over a number of years and didn't hesitate to call on them for help.

"I worked with WSM for a number of years in my previous role and when a challenge arose in my new role there was only one company I knew I could reach out to."

Gavin Bridger, Operations Manager, Gedore Torque

A tight deadline meant that time was of the essence, so within 24 hours of Mr Bridger's call, a WSM representative visited site to assess the project before taking Gedore's drawings away to work on a solution.

Working in partnership with Gedore's R&D team and communicating throughout the process, WSM created a bespoke injection mould tool to the precise specification, ensuring that the torque testing device housing could be produced to the same exceptional standard time and again.

Mr Bridger was delighted with WSM's cost-effective solution and dedicated service: "WSM communicated consistently through the whole project, delivering the product on time to a very high quality. The team at Gedore were extremely impressed and we will be using WSM for our future plastic projects."

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GLOBAL TOOL MAKER AND INJECTION MOULDER



When feeding technology becomes a strategic advantage

FACT BOX

IFSYS

FULL NAME:

IFSYS GmbH – Integrated Feeding Systems

GENERAL DIRECTOR:

Rigobert Zehner, Sebastian Demar

INDUSTRY:

Special Mechanical Engineering

ESTABLISHED:

2006

EMPLOYEES: 230 worldwide (215 based at its headquarters in Großbardorf, Bavaria)

TURNOVER:

27 Mio Euro

www.ifsys.com

Manufacturing today is defined by acceleration. Product cycles are shorter, variants multiply, and technological shifts can redefine entire industries within a decade. In such an environment, automation is no longer just about speed or precision. It is about adaptability. It is about building systems that evolve alongside the products they assemble. IFSYS Integrated Feeding Systems GmbH has built its identity around this principle. Since its foundation in 2006, the company has focused on feeding technology not as a standalone component, but as a dynamic, integrated part of the production ecosystem. Nearly two decades later, that early vision of flexibility has become a defining competitive advantage.

As part of the JOPP Group since 2010, IFSYS has expanded both technologically and geographically. With operations in Germany and branches established in the United States and China since 2013, the company combines the agility of a specialized engineering house with the stability and international reach of a larger industrial group.

Within the JOPP structure, IFSYS represents the feeding technology segment while complementing the broader expertise in special-purpose machinery. The exchange of knowledge across the group strengthens development without diluting specialization. The result is

a focused yet globally connected engineering culture.

Automation built around real production challenges

Reliable automation remains the trademark of IFSYS. The company's portfolio includes feeding and palletizing systems, screwdriving and joining technology, as well as measurement and testing systems designed for quality-critical processes. These solutions are primarily deployed in the automotive industry and advanced automation environments where precision and repeatability are essential.



However, what distinguishes IFSYS is not simply the range of technologies offered. It is the philosophy behind them.

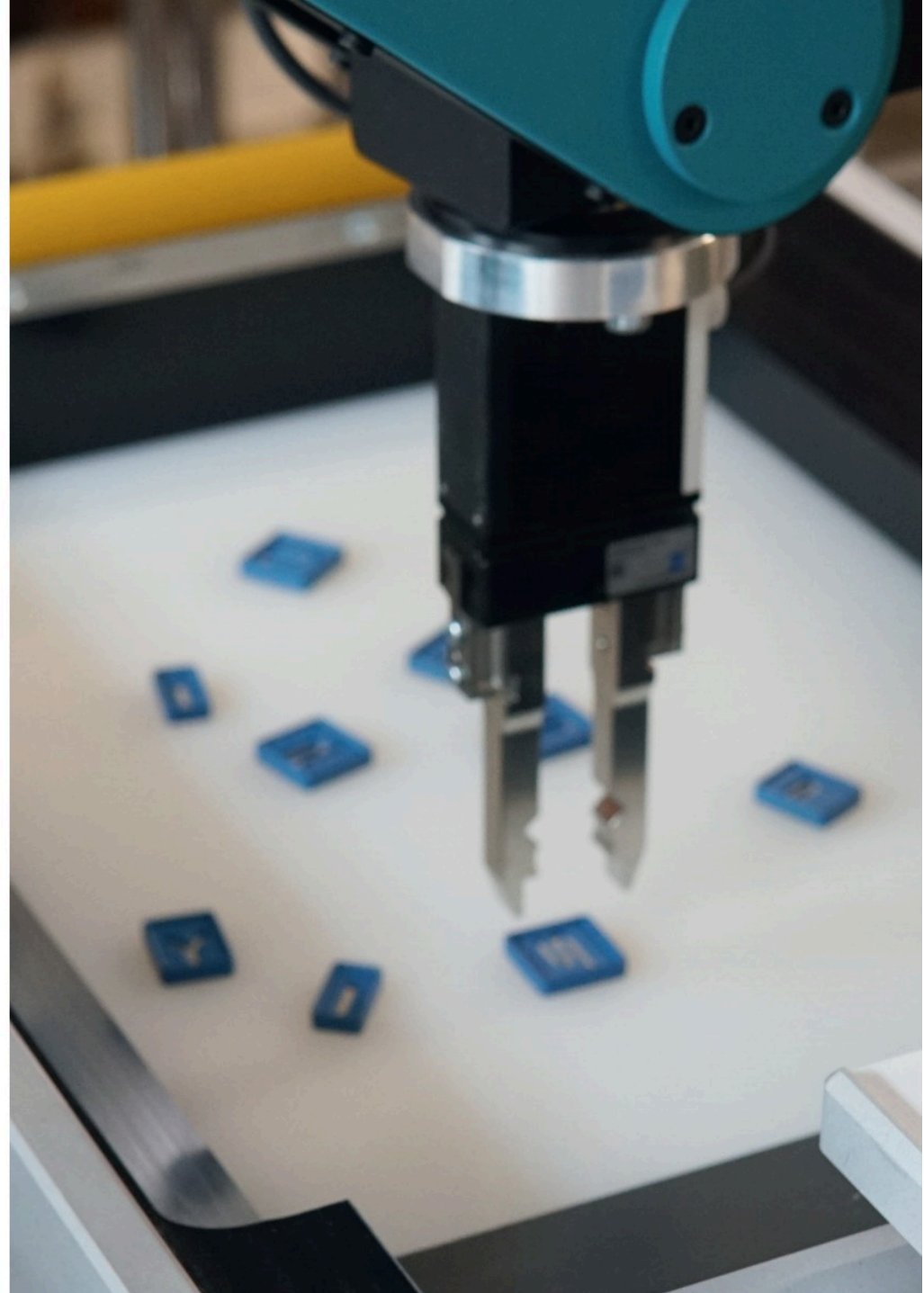
The company describes its systems as process-agile rather than rigid assemblies of components. This distinction becomes especially meaningful in periods of transformation such as the ongoing transition from combustion engines to electric mobility. When entire drivetrain concepts change, feeding systems must adapt to new geometries, materials and assembly sequences. Flexibility ceases to be optional. At IFSYS, flexibility is engineered into the system architecture itself.

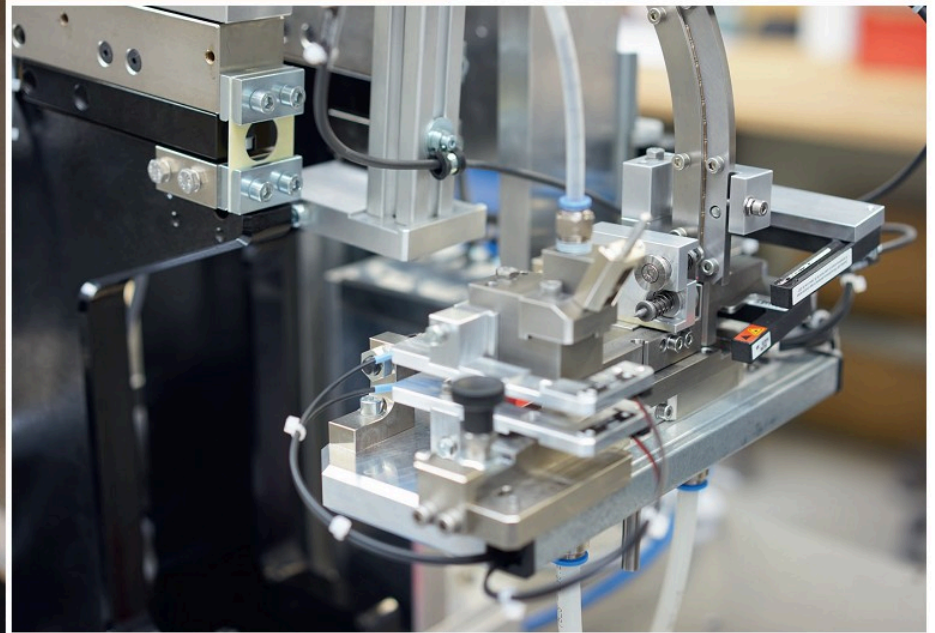
Vertical integration as a foundation of quality

One of the defining characteristics of IFSYS is its high level of vertical integration. Design, precision machining and assembly are carried out in-house. This structure allows short communication paths, rapid iteration cycles and tight quality control.

The interaction between engineering and production is deliberately close. Concepts move quickly from design models to machined components. Feedback from the shop floor flows directly back into development. This proximity reduces friction and increases responsiveness.

Digital intelligence plays a central role, but the company maintains a clear position: software alone cannot compensate for mechanical rigidity. Only





when adaptable mechanics and intelligent control systems are developed together can automation reach its full productive potential. This conviction shapes every project.

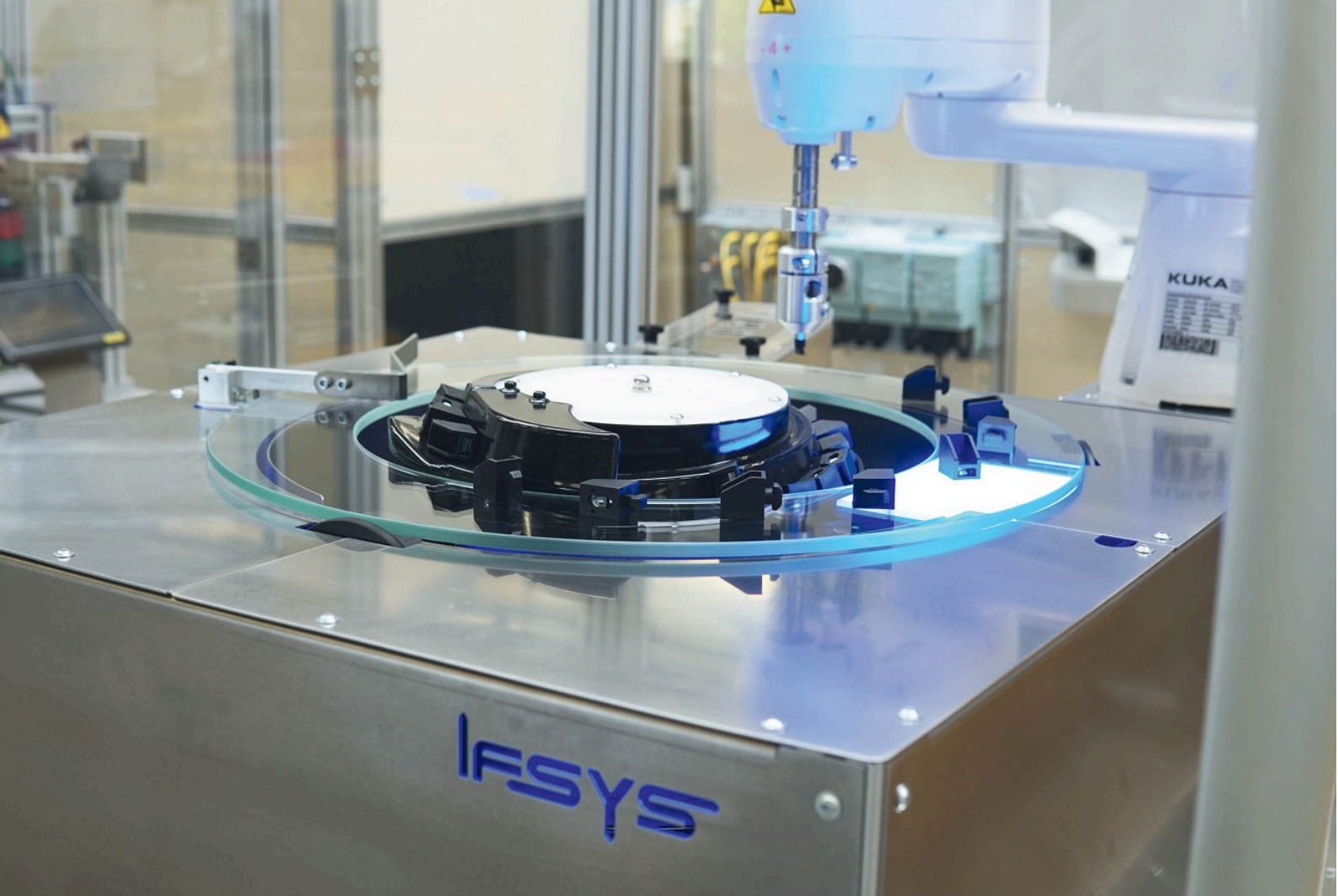
Innovation driven by practical efficiency

Innovation at IFSYS does not focus on spectacle. It focuses on measurable improvement. In flexible feeding technology and testing systems, the company continuously refines solutions such as free-fall testing, gentle material handling and feeding concepts that eliminate compressed air in order to improve energy balance. These developments respond directly to customer demands for reduced energy consumption and lower operating costs.

The integration of robotics and image processing further enhances system versatility. Feeding units can be combined with vision systems to accommodate product variation without mechanical reconfiguration. This approach supports manufacturers facing growing SKU diversity and shorter product lifecycles. Rather than introducing isolated innovations, IFSYS integrates mechanical agility, digital intelligence and resource efficiency into cohesive systems.

Quality tailored to application

Quality assurance at IFSYS is embedded in the entire process chain. From initial design to final assembly, integrated workflows and digital transparency ensure consistency.



Each solution begins with a specific application. Standardized quality processes provide a foundation, but customization remains central. This balance allows systems to meet industry standards while remaining precisely aligned with individual customer requirements.

The automotive sector represents a key field of activity, and over many years IFSYS has delivered systems for singulat-

ing and feeding bulk materials such as screws, nuts and other fasteners. The company has also contributed to battery production systems within the e-mobility segment, an area where precision and reliability are critical.

A decisive factor behind this breadth of application is technology transfer. Experience gained in one industry is applied to emerging production requirements

in another. Proven principles migrate across sectors, accelerating adaptation to new market realities.

Sustainability as a design parameter

Energy efficiency and sustainability are not treated as external add-ons. They are integrated into system design and internal operations alike.

Feeding systems are engineered for long service life, reduced energy consumption and optimized material usage. In production, process efficiency is continuously refined to reduce environmental impact.

The elimination of compressed air in certain feeding applications exemplifies this mindset. What may appear as a technical adjustment has significant implications for energy balance over the lifetime of a production line. Sustainability is therefore approached not as a marketing claim, but as an engineering objective.

Strategic investments and European expansion

Currently, IFSYS is investing in digital feeding technologies to further increase



efficiency and adaptability. These investments reflect the broader industry trend toward data-driven production and modular system architecture.

At the same time, the company is strengthening its European presence. Plans to build partnerships with foreign representatives aim to expand market reach and increase visibility across the continent. Internationalization remains a long-term priority, with Europe and North America representing key focus regions.

New growth opportunities in additional regions are under evaluation, reflecting the global demand for flexible automation solutions.

People as the core of performance

Technology defines output, but people define capability. IFSYS employs approximately 230 people worldwide, with around 215 based at its headquarters in Großbardorf, Bavaria. Training and continuous professional development form an integral part of the company's strategy. Maintaining expertise in mechanical engineering, digital systems and inte-

gration technologies requires ongoing investment in skills.

An open and team-oriented workplace culture encourages collaboration and innovation. In complex automation projects, interdisciplinary communication becomes essential. The internal structure at IFSYS is designed to support precisely this exchange.

Collaboration within the JOPP Group

As part of the JOPP Group, IFSYS benefits from shared R&D experience, pooled resources and global networking. Technologies and best practices circulate within the group, accelerating development cycles and strengthening competitive positioning.

At the same time, each entity retains its focus. Feeding technology remains the dedicated domain of IFSYS, allowing depth of expertise while leveraging group synergies.

Looking ahead

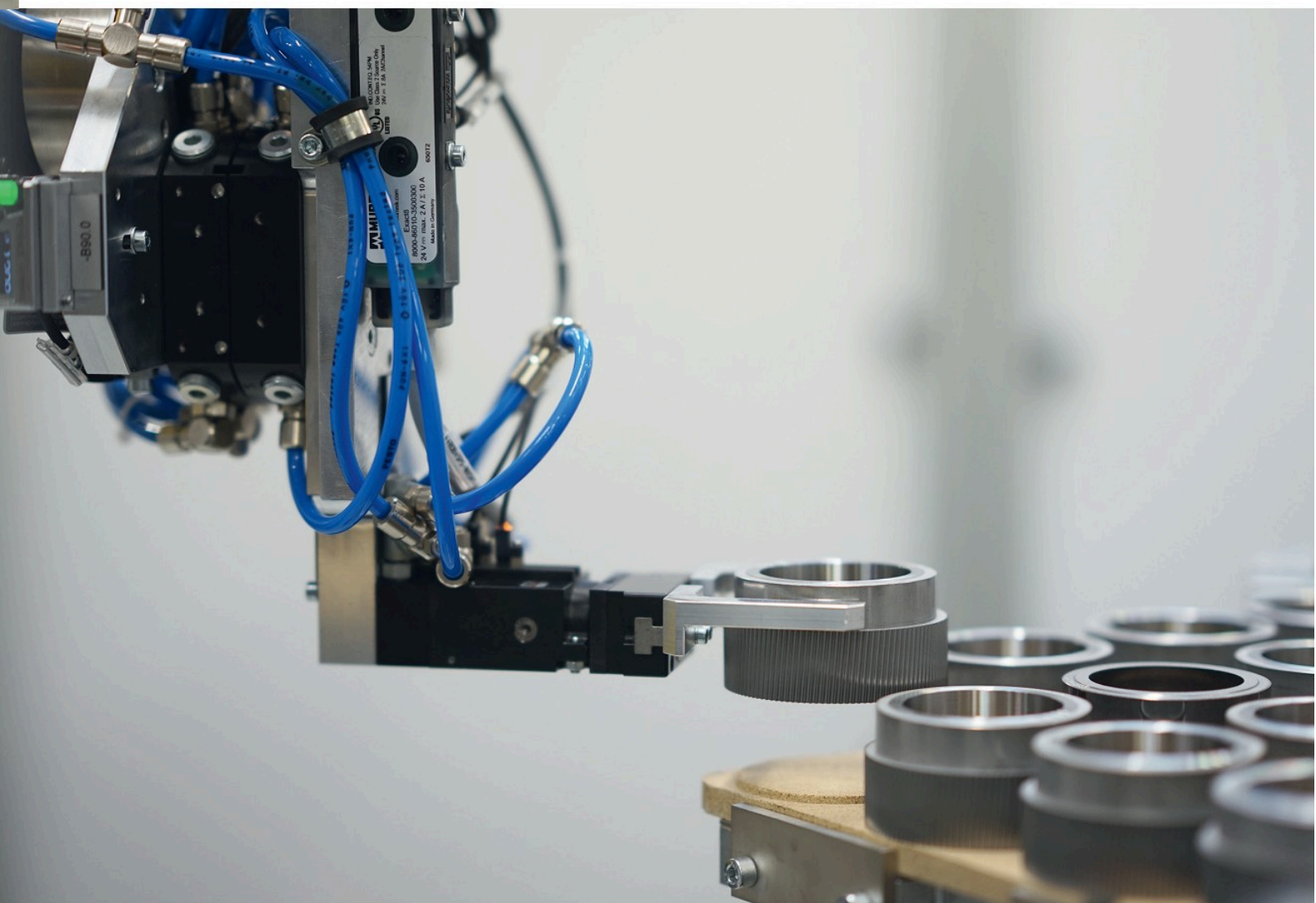
The trends shaping special-purpose machine construction are clear. Modular-

ity, digitalization and increasing product variety are redefining expectations. Customers demand systems capable of rapid adaptation to new variants and shifting market conditions.

IFSYS responds with modular, process-agile feeding systems that combine mechanical precision with digital intelligence. The objective is straightforward yet ambitious: to design systems that adapt to customer needs rather than forcing customers to adapt to the system.

In the medium and long term, flexible feeding technology will remain at the core of development. Through innovation, quality and international expansion, IFSYS aims to further strengthen its position as a provider of customized, future-ready automation solutions.

In an industrial landscape where rigidity quickly becomes obsolescence, adaptability is more than an advantage. It is survival. IFSYS has chosen to engineer precisely that.



AI-Driven Precision Manufacturing for Next-Generation Industrial Components

By: Emily Newton

Industries such as aerospace, automotive and health care need precision parts to keep essential equipment functional. These components traditionally required highly skilled workers to craft them, but artificial intelligence has changed things. AI-driven manufacturing gets excellent results for clients in tightly regulated sectors while offering many other benefits. How have companies applied it so far, and what opportunities exist for improving your work?

Overcoming Labor Shortages

Retirements, the time required to train new workers and job seekers' unfavorable perceptions of production roles are among the primary factors causing persistent challenges in many facilities. No universal solutions exist, but some decision-makers have tackled workforce gaps with AI-driven manufacturing.

The leaders of MSP Manufacturing, an Indiana business making aviation parts according to submillimeter precision requirements, embraced that option after facing a shortage of programmers for computer numerical control equipment. The company's CEO says it took employees from 90 minutes to an entire day to instruct a CNC machine to create a single part. The time-consuming nature became especially problematic when the facility experienced bottlenecks due to only having about three workers with the necessary skills.

After learning about an AI programming tool during a trade show visit, executives believed it could be a game-changer. They purchased and installed it, discovering the solution shortened 90-minute jobs to seven minutes. Workers needed another quarter hour to refine the AI's work, but this new process still saved significant time. The CEO also clarified that the average duration shrank further as people got accustomed to the software.

This example shows how producers can maintain high quality and boost productivity. Those gains could keep costs down, letting brands pass savings onto purchasers. Parts requiring unusual tolerances, such as flatness exceeding .005 total indicator reading per inch, are more expensive than their less precise counterparts. When AI makes programming the machines that make these components easier, some manufacturers may continue giving loyal customers competitive prices, knowing they have already saved money through better internal processes.

Tightening Quality Control

Precision parts undergo stringent inspections to verify that they meet or exceed all stated parameters. Employees must then rework or discard those with shortcomings, depending on the extent of the flaws. Pinpointing root causes also becomes essential, especially if machine-related problems are the culprits. Not addressing the issues soon enough





could cause substantial profit losses and decrease customer confidence.

AI excels at detecting deviations from baselines, and this characteristic makes it a good option for tool performance analyzers. These systems include high-tech sensors integrated into CNC milling machines. Even minor amounts of wear can cause dimension-related discrepancies in small-diameter parts. Algorithms perceive tiny changes in how tools affect surfaces, warning operators of potential issues much earlier.

These tools can also monitor overall tool condition and recommend when to perform maintenance, replace a worn instrument with a new one or take other steps to maintain high quality throughout production. Ongoing assessments use real-time data and historical patterns to recognize unusual aspects and prompt operators to investigate.

Quality-enhancing AI applications also target organizations' sustainability initiatives, turning more production attempts into usable products that satisfy customers rather than ending up in dumpsters as scrap material. Solid waste generation exceeds 2 billion metric tons annually, highlighting the improvement potential.

Once machine operators understand why precision parts fail inspections, they can examine each process step to find issues. AI-driven manufacturing solutions can help by ingesting and analyzing vast amounts of data to reveal trends.

Bringing AI-Driven Manufacturing to Microfactories

Long lead times and supply chain shortages could encourage some buyers of precision components to source them from nearby entities rather than distant factories when possible. Most people think of production facilities as sprawling sites, but a Canadian-based business called Watch Out upends that perception.

Its model brings manufacturing to container-sized cells that run with minimal human oversight. The company's leaders think this option can facilitate domestic production and tackle critical labor shortages. Executives developed the first microfactory to make precision-tuned parts, including aerospace fasteners. Three process modules handle, create and inspect the components.

The system performs numerous autonomous checks, including some to verify geometries and part positions align with relevant model data. All these microfactories connect to an AI communication tower that tells workers which tools to take to individual cells, and tags detect if employees load instruments into them. Internal optical cameras show tool and component orientations in real time, triggering the fabrication module to update its movements when necessary.

Your Production Line Is Only as Fast as Your Conveyor

By: Ellie Gabel

High-speed production separates many manufacturers from their competition. It allows them to fulfill more process orders and earn higher profits but requires strict maintenance protocols. The material handling system, often overlooked, is the foundation for quality control and reliable speeds. Without proper attention, organizations risk running into bottlenecks that require time and money to solve.

Inadequate Accumulation Capacity

Output-focused machinery at the beginning of the conveyor may create more speed than downstream mechanisms can handle. The dumping grounds for finished products or items needing to be transported to other work zones must be larger or have supplementary handling systems to deal with heavy loads. Buffer zones or adaptable accumulation machinery can prevent shutdowns and traffic buildup.

Installing one or more of these safeguards allows throughput to remain consistent. It also maximizes the value of upstream technologies, allowing them to run without disruption. Eventually, organizations will see fewer collisions and quality upsets due to poor material handling.

Insufficient Sortation and Divert Capabilities

Preventing downtime requires fewer planned stops. Reprogramming machinery or replacing materials to accommodate a recent order takes time and resources. Adaptable production lines should become more common to reduce turnover frequency and improve the versatility of manufacturing infrastructure. It is why researchers are trying to find ways to use aids like barcodes to help programmable logic controllers sort on high-speed conveyors.

As valuable as product variability and adaptability can be, they could lead to categorization concerns. Conveyors may inaccurately divert materials to the proper handling locations, which could lead to mispackaging or noncompliant labeling if items are in the wrong place.

Mixed product streams and excessive waste production are avoidable by embracing automated sorting equipment. They lower instances of human error while quickening processing times. These are controllable with software solutions, which provide real-time insights. Some options include, but are not limited to:

- Pushers
- Tilt-tray sorters
- Chutes
- Balance wheel sorters
- Sliding shoes
- Diverters
- Activated roller belts

Poorly Designed Transfers

Unfinished assemblies spend significant time between machines and processes, and these transfer points are vulnerable. They can lead to defects, unplanned stops and safety issues for several reasons.

First, many technicians are focused on active machinery or the front and end of the line. Intermediary locations can have less intervention because businesses rely on automation. However, even slight changes to conveyor speeds and transfer angles can cause items to topple over, fall off or collide. Operators may also miss if products are landing in the orientation, which can cause misfeeds.

Instead of manually clearing conveyors, technicians can install extra oversight in these zones. Sensors and cameras can connect to remote panels and variable-speed controllers, allowing workers to adjust settings anywhere on the production line. Workers may also use simulation and modeling software to see how new process orders function in high-speed environments before turnover occurs.





Inadequate Maintenance and Preventive Measures

Centralized control systems and sensors are several assets helping technicians refine their maintenance schedules. Other helpful tools include supervisory control, data acquisition systems and artificial intelligence-enabled computer vision. They allow repair schedules to be more informed by analytics. Then, staff can proactively tackle conveyor belts and material handling systems based on bottleneck frequency instead of guesswork.

Regular inspections of critical parts, including robotic arms or conveyor rollers can reduce issues. For example, if components like rollers show frame wear or demand constant maintenance, repairs could cost less and extend the system's lifespan. Manipulating and transporting products more carefully will also reduce issues at the material-handling stage.

Lack of Real-Time Monitoring and Control

Designing targeted maintenance schedules becomes even simpler with real-time monitoring. Every part — from belts to

sensors — must have a staff member or technology reviewing its performance and health. A miscalibrated laser or a malfunctioning camera could initially cause hard-to-detect problems, especially in high-speed environments.

Consider how printing or sealing issues exacerbate as conveyors and material-handling robots carry them to the following production stages — the quality concerns gradually worsen. Faulty and poorly assembled products can become more prevalent unless companies use predictive maintenance protocols that catch problems before they arise.

Some techniques include vibration analysis or environmental metric observations, like temperature and pressure. Real-time monitoring combined with data acquisition can perfect these processes. It could improve even the most sensitive industries attempting to undergo automation, like pharmaceuticals. One organization used smart systems and data to revise modular assembly solutions, resulting in a 40% reduction in application footprint.



A Manufacturer's Guide to Operator Training and Safety Standards

By: Ellie Gabel

Manufacturing leaders who maintain safe workplaces enjoy numerous benefits, including increased productivity, lower turnover rates and fewer accidents. Companies can operate without attracting adverse regulatory attention when their work environments align with the relevant safety standards.

Operator education is a central part of safe facilities because it ensures employees can use heavy equipment, work at risky heights and engage in other potentially dangerous activities relevant to their roles. What should decision-makers do to improve safety and training outcomes?

Review Requirements From Relevant Organizations

Studying what regulators mandate is a good starting point, especially because some are highly specific. Requirements can vary by country and are extremely comprehensive. The standards below apply to many manufacturers in the United States.

The Occupational Safety and Health Administration (OSHA)

OSHA is a federal agency that sets and enforces worker safety requirements, provides training, and issues relevant recommendations. This entity publishes nearly 1,000 standards within four main categories. Some of the most relevant to manufacturing professionals include:

1910.212 — Machine Guarding

These standards relate to safeguards protecting workers from moving parts. They apply to all equipment that could injure operators or others nearby during usage or through accidental contact.

Manufacturers should assess individual circumstances and take proactive steps to eliminate or reduce identified hazards, including requiring ongoing operator training and warning against removing or turning off protective features. Solutions that create barriers without obstructing machine views can increase employee compliance.

1910.147 — Control of Hazardous Energy

This group of standards concerns the lockout/tagout (LOTO) procedures operators should follow if servicing machines that could unexpectedly start or otherwise release dangerous amounts of energy. LOTO processes contain several steps, beginning with helping workers understand potential hazards and concluding with verifying equipment de-energization and isolation. Regular training sessions reinforce these necessities, ensuring people follow them in every appropriate case.

1910.28 — Duty to Have Fall Protection and Falling Object Protection





This two-part standard covers employees whose tasks require working at least 4 feet off the ground and workers at risk of objects from above striking them.

Machines like aerial lifts have built-in fall protections, including harness anchor points and guardrails. Many also feature emergency-stop buttons for colleagues to activate in emergencies. Training ensures all involved parties understand how to engage those functions.

Hard hats provide protection from falling items, making them essential workplace accessories. If manufacturers issue them, they should document distribution dates and provide replacements at manufacturer-recommended intervals

1910.178 — Powered Industrial Trucks

Many manufacturers use forklift trucks, tractors and other motorized equipment to efficiently move bulk items. This standards category covers eleven designations of those vehicles and stipulates details about designs, safety features, operating procedures and similar topics.

American National Standards Institute (ANSI)

The ANSI is a private, nonprofit organization that oversees, develops and enforces over 13,000 voluntary standards across numerous industries, including manufacturing. Although decision-makers should familiarize themselves with relevant ANSI mandates, some apply to most production settings.

B11 — Safety of Machinery

This standard recognizes that eliminating machine-related risks is impossible. Instead, it aims to reach an acceptable threat level with proactive mitigation techniques.

Additionally, this standards group applies an A-B-C format to differentiate between types. A standards include basic safety and design decisions applicable to all machines, while B standards deal with individual safeguards across machine ranges. C standards have the narrowest focus, stipulating guidelines for a single machine or group.

R15.06-2012 — Industrial Robots and Robot Systems

ANSI representatives collaborated with regulators from the Robotic Industries Association to develop these standards about robotic equipment in industrial environments. They span best practices for safe designs, operating practices and hazard recognition.

International Organization for Standardization (ISO)

ISO is a worldwide group of experts who collaborate on numerous best practices for manufacturing principles, process management and more.

ISO 45001:2018 — Occupational Health and Safety Management Systems

This framework manages work-related risks, identifies ways to enhance employee physical and mental well-being, and highlights continuous improvement opportunities. It is broader than the other standards mentioned, applying to all organizations and requiring participants to recognize risks and become accountable for minimizing them.

Develop Operator Training Programs

Once manufacturing leaders confirm their organization meets the relevant standards, they should create detailed plans to give workers foundational knowledge and update their understanding as the industry evolves.

Accommodate Workers Without Offices or Desks

Many assembly line personnel and other manufacturing employees do not have private, dedicated workspaces for training. Education managers should account for this by offering flexible access to the required information.

That may mean allowing employees to complete the content at home for their usual pay. Some companies have addressed this need by publishing educational modules via mobile apps. One recently released app from an industrial robot manufacturer complements the material distributed to more than 25,000 individuals who learn at the brand's physical training centers.

Tailor the Material to Individual Operators

Many manufacturers have diverse workforces, with people working their first jobs alongside those with decades of experience. This can make it challenging to design applicable training content. However, education directors should consider personalizing it to learners' roles, backgrounds and other particulars.

Some course vendors offer platforms capable of assessing participants' knowledge and adapting the content based on their scores on initial questions. That straightforward approach raises engagement and introduces material encompassing new concepts or weak areas rather than things workers already know well.

Experts suggest customizing educational materials according to equipment, company purpose and the environment to satisfy standards. Authorities should also consider implementing virtual reality and gamification systems to address varied learning styles and increase motivation.

Safety Standards Are Essential for Manufacturing Success

Complying with relevant regulations to maintain a safe workplace connects to other, overarching production environment goals. Similarly, operator training encourages employees to gain and develop skills that enable productivity and lower risks.



40 Years of Excellence in Quick Coupling Technology



Mr. Michele De Isabella
CEO

As D.N.P. celebrates its 40th anniversary, the company stands as a global leader in the design and production of high-pressure quick-release couplings. Founded in 1985 by Enzo De Isabella, whose pioneering vision transformed a small local enterprise into a brand recognized in more than 50 countries, D.N.P. has consistently combined Italian quality, innovation, and sustainability. Today, the company offers over 4,000 types of couplings across 70 product series, serving industries from agriculture and construction to automotive, energy, and oil & gas.

In this exclusive interview for Manufacturing Journal, Luna El Maataoui, Marketing manager, shares the key milestones of the company's journey, its technological innovations, commitment to sustainability, and strategic vision for the future.

This year D.N.P. celebrates its 40th anniversary. In your view, what have been the most significant milestones in the company's history and growth?

The story of D.N.P. began in 1985 with the pioneering vision of Enzo De Isabella, the founder who transformed a small local business into a global leader.

The most significant milestone was undoubtedly the very beginning: the decision to specialize in the production of quick-release couplings for high-pressure fluids, foreseeing the potential of this emerging sector.

Another key moment came in 1998 with the achievement of ISO 9001 certification, a formal recognition of the company's commitment to quality excellence. This certification opened the doors to international markets and enabled the company to reach one of its defining goals: exporting 95% of production to more than 50 countries worldwide.

The transition to the second generation, led by Michele De Isabella, also represents a fundamental moment. Ensuring continuity of the entrepreneurial vision while evolving to meet modern challenges is the task the company faces today. Today D.N.P. produces more than 4,000 different types of quick couplings organized into 70 series, with a growing focus on optimizing processes by integrating traditional company values with digital tools. The main challenges have been those linked to globalization and

FACT BOX



FULL NAME:

D.N.P. Industriale S.r.l. a socio unico

GENERAL DIRECTOR:

Pamela Bellamacina

INDUSTRY:

Hydraulic components

ESTABLISHED:

1985

EMPLOYEES:

60

TURNOVER:

25 000 000 euro

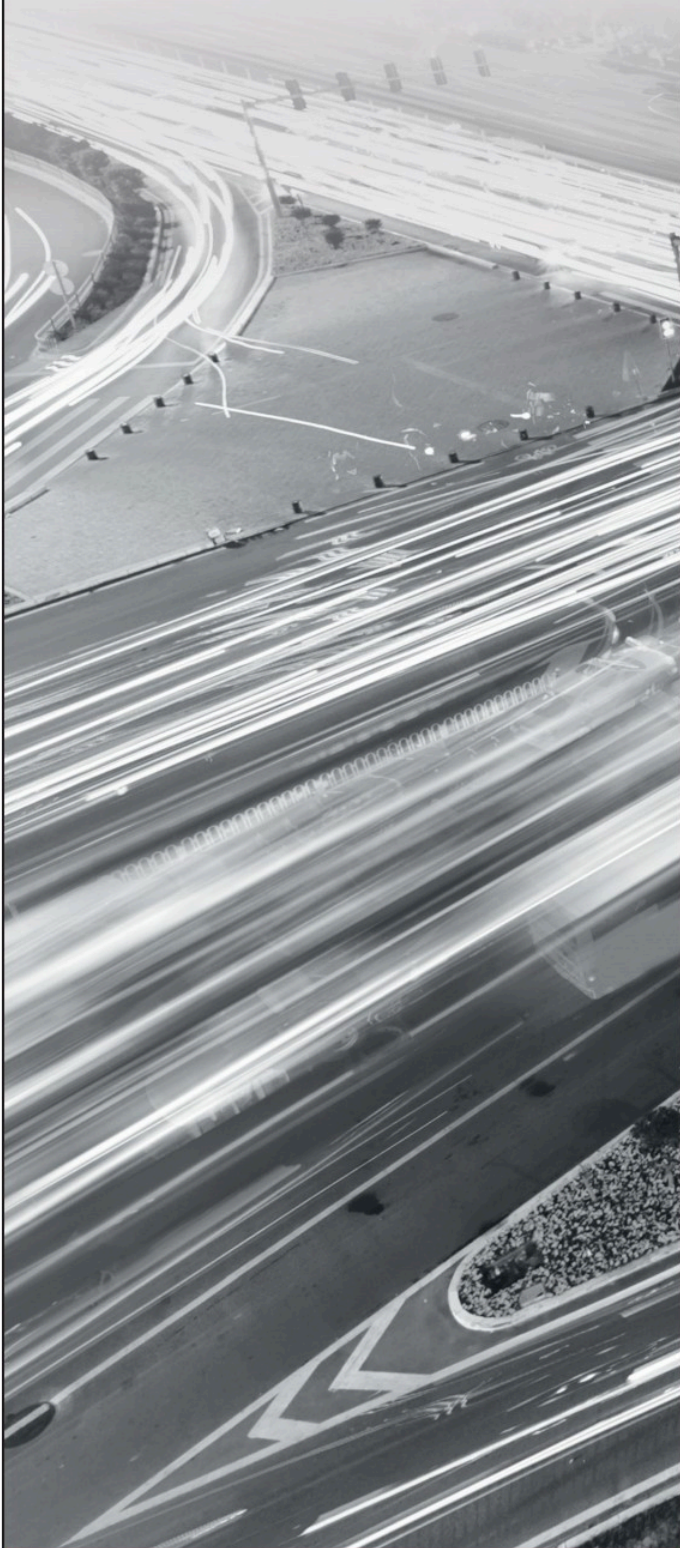
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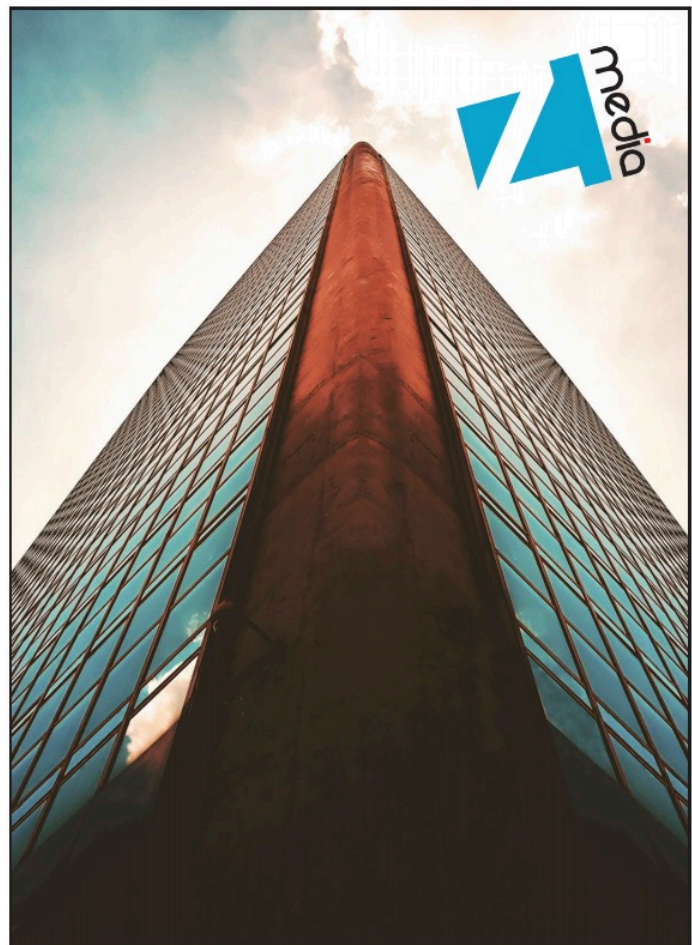
Our company produces springs in band and in wire with a diameter from 0.10 mm to 24 mm made with the best materials.

We can produce items with the following materials:

- ✓ Carbon steel
- ✓ Stainless steel
- ✓ Pre-hardened Cr.Si. steel
- ✓ Superalloys (Inconel - Nimonic etc...)
- ✓ Bronze
- ✓ Titanium

The modern technology united with a long experience, permits us to produce small or big series of articles with low prices and meeting customers' requirements. Our systems, equipped with electronic control and automatic selection, are another guarantee of quality.

Via Paradiso, 3 - 23864 Malgrate (Lecco) Italia
☎ 0341/582631 | ✉ info@mollificiocodega.it





the need to remain competitive while staying true to Italian quality standards.

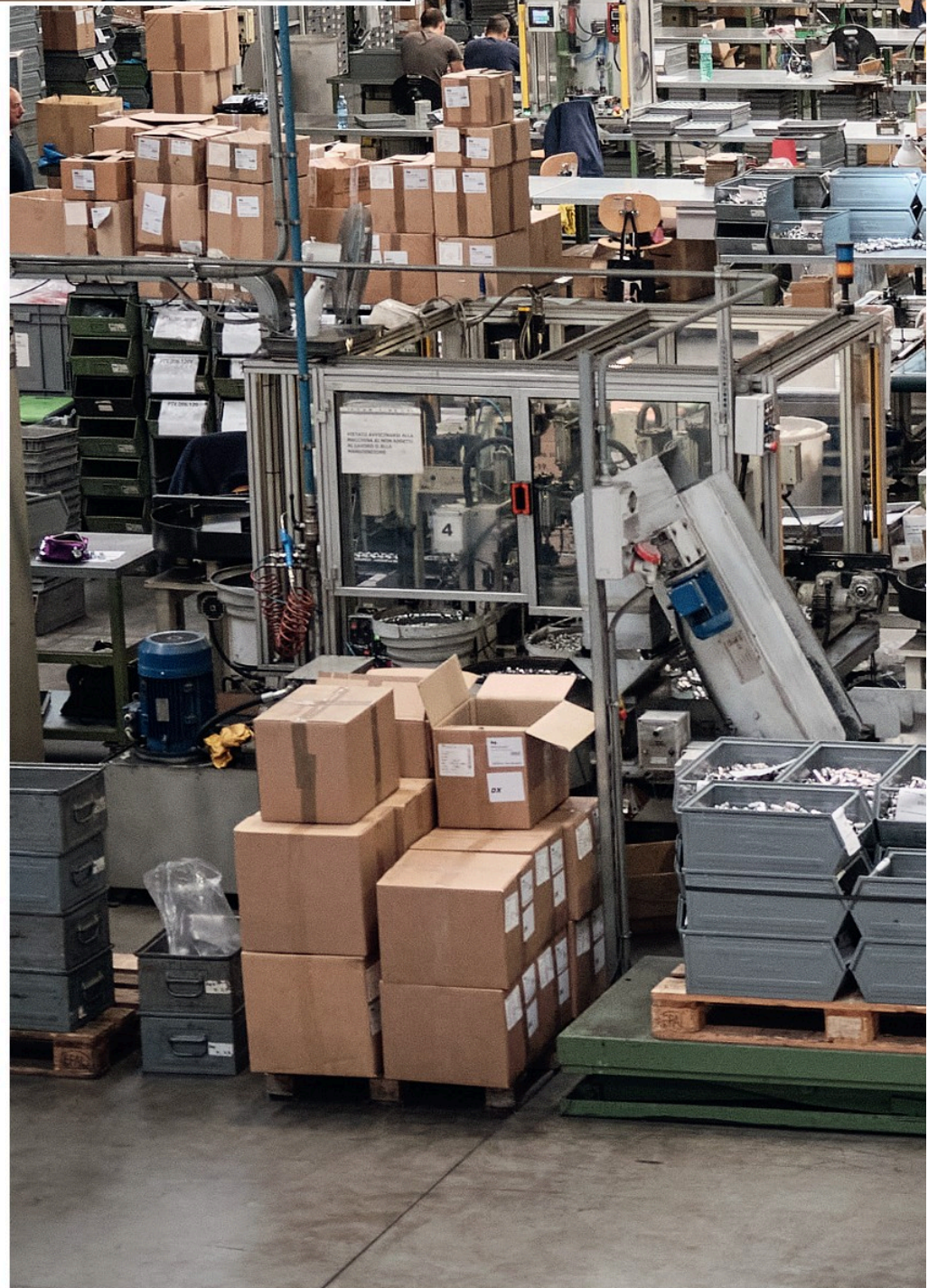
How has D.N.P.'s product portfolio evolved over the years, and what are the most representative product lines today?

D.N.P.'s product portfolio has grown from a limited range of basic couplings to one of the most comprehensive offerings on the global market. Today, the company produces more than 4,000 types of quick couplings, organized into 70 series, covering a wide range of hydraulic applications.

The most representative product lines include:

- Push-Pull couplings for high-pressure quick connections
- Screw-to-connect couplings for applications subject to strong vibrations and requiring maximum sealing
- Flat-face couplings to minimize fluid loss
- Multi-coupling plates, ideal for reducing downtime and ensuring greater operator safety

Product evolution has closely followed industry trends, including the development of couplings compatible with pressures up to 1,500 bar, extreme temperatures (from -50°C to +300°C), and special fluids. Special attention has been dedicated to sustainable agriculture solutions, particularly flat-face couplings that significantly reduce oil loss and extend machine life.





What are the main industrial sectors you serve, and how has your customer base diversified over time?

D.N.P. serves an extremely diversified global customer base, reflecting the versatility of quick couplings in modern applications. Key sectors include:

- Agriculture: advanced solutions for agricultural machinery, including color-coded systems for quick identification of hydraulic lines
- Construction and earthmoving: couplings for excavators, bulldozers, and heavy equipment
- Manufacturing industry: applications in production plants and automation systems
- Automotive: specialized hydraulic systems
- Oil & Gas and energy sector: high-pressure applications in extreme environments

Geographical diversification is equally impressive: 95% of production is exported worldwide, with consolidated presence in Europe, Asia, and emerging markets. This global reach has made the company resilient to fluctuations in individual markets and sectors.

Innovation and technological development are key elements for competitiveness. How does D.N.P. integrate new technologies into its production processes, and how important are partnerships with technology partners in this regard?

Today the company focuses on technological integration at multiple levels:



- Product innovation: continuous development of new coupling series for specific applications, such as quick couplings that allow connection under residual pressure, eliminating the need for potentially dangerous pressure relief operations
- Process innovation: implementation of constant quality monitoring systems throughout production stages, ensuring that each product meets the highest standards

Strategic collaborations are also essential, exemplified by the decades-long partnership with Hi-Flex Italia, exclusive distributor for the Italian market. Such alliances

standard quick couplings, ISO 14540 for high-pressure couplings.

An in-house laboratory performs rigorous tests on every product: burst pressure tests, impulse tests, flow tests, pressure drop tests, and corrosion resistance tests. Compatibility with different fluids is ensured through certified seals (NBR, FKM, EPDM, PTFE, HNBR) for specific applications. Recently, D.N.P. also initiated procedures to obtain ISO 14001 certification.

The 40th anniversary is also an opportunity to look ahead. What recent or ongoing investments do you con-

ditional partnerships to strengthen presence in emerging markets and investing in employee training to maintain updated technical know-how.

These initiatives reflect a strategy of sustainable growth driven by passion, commitment, and innovation, always focused on delivering superior quality solutions to customers worldwide.

What product or process innovations have you recently introduced, and what is currently under development?

Recent innovations at D.N.P. focus on sustainability, safety, and operational



combine Italian manufacturing excellence with specialized distribution networks, ensuring consistent support for end users.

D.N.P. is recognized for the high quality of its products. What certifications or standards do you adopt to constantly guarantee this level of excellence?

Quality is the cornerstone of D.N.P.'s identity. The company has held ISO 9001:2015 certification since 1998, demonstrating a long-term commitment to quality excellence.

All products are designed and tested in compliance with international standards, including: ISO 18869 for flow and pressure testing, ISO 7241 A and B for

sider most important for consolidating and expanding the company?

On the occasion of its 40th anniversary, D.N.P. has undertaken significant strategic investments for the future. The most important is the installation of a photovoltaic system and an advanced heating/cooling system. This innovation has eliminated methane gas usage, achieving a more sustainable environmental footprint while ensuring optimal working conditions year-round.

Other key investments include: Expanding production capacity to meet growing global demand, upgrading quality control systems with advanced digital technologies, developing new interna-

efficiency. Product innovations already implemented:

- Color Code system for hydraulic plants with multiple lines, enabling visual identification of each connection and reducing errors and downtime
- Couplings designed for connection under residual pressure, eliminating dangerous operations and increasing efficiency
- Flat-face couplings for sustainable agriculture, reducing oil leakage, extending filter life, and contributing to more sustainable practices
- Multi-coupling plates designed to optimize machine downtime

Sustainability is an increasingly central theme in industry. What actions is D.N.P. taking to reduce the environmental impact of its activities?

D.N.P. has adopted a holistic approach to sustainability, starting with respect for people and the conscious use of internal, environmental, and social resources.

Concrete actions include:

- Energy self-sufficiency: photovoltaic system eliminating methane usage
- Energy efficiency: optimized heating and cooling system to reduce consumption
- Waste reduction: flat-face couplings minimizing hydraulic fluid leakage during use
- Circular economy: developing long-lasting products with less frequent replacement needs

Environmental benefits of products:

- Up to 80% reduction in oil leakage with flat-face technology
- Extended filter life in hydraulic systems
- Lower emissions thanks to improved system efficiency

These initiatives demonstrate how sustainability and competitiveness can go hand in hand.

Corporate Social Responsibility (CSR) plays a growing role in modern companies. What initiatives do you carry out in this area?

D.N.P. has implemented a comprehensive CSR framework based on transparency, ethics, and stakeholder engagement.

- Governance & transparency: introduction of a whistleblowing system compliant with Legislative Decree 24/2023, allowing employees, partners, and stakeholders to report violations in total confidentiality, with protection against retaliation
- Strict Code of Ethics: guided by five pillars – integrity, honesty, fairness, transparency, and accountability – shaping daily interactions with clients, suppliers, and within the company
- Employee well-being: Optimized work environment, supported by new climate control systems; Con-

tinuous professional training programs; Strict workplace safety protocols with ongoing updates

- Positive social impact: through its products, D.N.P. helps create safer working environments in customer industries, reducing accidents and improving operational efficiency

With its long-standing experience, D.N.P. has built strong relationships of trust with suppliers and strategic partners. How important are these relationships in ensuring quality, innovation, and production continuity?

Strategic relationships form the foundation of D.N.P.'s international success. Over 40 years, the company has built a global network of reliable partners based on transparency and mutual benefit.

Benefits of consolidated partnerships: Consistent quality of supply from trusted partners, shared innovation through technical collaboration, optimized processes thanks to mutual knowledge and flexibility in responding quickly to market changes

Impact on quality: Strict supplier selection and continuous performance monitoring ensure that every component meets D.N.P.'s standards. This approach allows the company to maintain complete quality control even in a highly globalized supply chain. Partnerships built on trust and transparency have created an ecosystem of excellence that translates into customer satisfaction and market leadership.

Looking to the future, what are D.N.P.'s priorities and main goals for the next ten years?

D.N.P.'s 2035 vision is guided by three strategic pillars: sustainability, digital innovation, and global leadership. Strategic priorities:

- Technological innovation: Digitalization of production processes (Industry 4.0), development of smart couplings with monitoring capabilities.
- Geographic expansion: Strengthening presence in emerging markets (Africa, Southeast Asia, Latin America), building strategic partnerships in new sectors (renewable energy, industrial applications), consolidating leadership in mature markets through continuous distribution support.
- Key objectives: Evolving product range toward high-specialization applications, expanding non-European markets by 30%, ongoing R&D investments.
- Value continuity: All future goals will be pursued with integrity, honesty, fairness, transparency, and accountability as guiding principles, ensuring growth that is always sustainable and respectful of people and the environment. The challenge is to grow while preserving identity: maintaining family values and Italian manufacturing excellence that have made D.N.P. unique in the global industrial landscape.



Poka-Yoke by Design: How Ergonomic Lifts and Fixtures Can Mistake-Proof Your Assembly Process

By: Ellie Gabel

Even though the assembly line is supposed to be foolproof in theory, human error has a funny way of showing up when it's least expected. What if there was a way to truly mistake-proof the process? With Poka-Yoke by design, that just might be possible.

What Does Poka-Yoke by Design Mean?

Poka-Yoke originated in Japan. In English, the term means “mistake-proofing” or “error-proofing.” It originated as Baka-Yoke, meaning “idiot-proofing,” before the Toyota Production System adopted and formalized the concept.

To make something Poka-Yoke by design is to create a built-in error prevention mechanism, designing out the possibility of human error in manufacturing. Facilities can accomplish this by preventing, correcting or drawing attention to mistakes as soon as they occur.

It's not about catching defects after the fact, but about designing processes where they are impossible in the first place. The expenses associated with substandard product quality make up a substantial portion of an organization's overall costs, so mitigating mistakes entirely is a strategic business decision.

The Three Primary Types of Poka-Yoke

While the concept of Poka-Yoke is loosely defined in the context of manufacturing, it is generally accepted that there are three primary types. The first is control, which involves physically preventing errors from occurring. For example, a device can prevent a worker from orienting a workpiece incorrectly before it is processed.

Warning systems alert operators to potential issues before they become problems — like when a passenger car chimes until the driver's seat belt is fastened. Common solutions include light curtains and warning lights.

The third and final type is guidance, which leverages instructions and visual aids to help assembly line workers complete tasks correctly. Color-coded wires, weighing systems and locator pins are some examples.

The Start of Mistake-Proofing Assembly

Despite how it may seem, Poka-Yoke is not an isolated activity on the assembly line. Viewing it that way completely overlooks its crucial connection to inventory organization and material handling. This concept's place extends to warehousing as it relates to the principle of lean manufacturing.

Upstream issues can translate into downstream defects, as manufacturers source assembly line elements directly from storage facilities. Improper storage can increase the likelihood of defects before an operator ever touches a part. Proper organization and material flow are foundational for an error-proof system.

Warehouses often require multiple racking solutions to store and access inventory. Proper selection can increase facility productivity and help prevent errors later on. For instance, a double-deep racking system increases capacity by 30% since it allows facilities to store items two pallets deep. However, it requires a specialized forklift with a double-reach mechanism for picking.

Ensuring materials are effectively stored, organized and delivered to the line helps keep parts from going missing or being damaged, preventing the warehouse from becoming the common source of errors.

The Role of Ergonomic Lifts and Fixtures

Manufacturing professionals can deploy ergonomic lifts and fixtures to help mitigate human error. Workers at the assembly station perform repetitive, tedious work day in and day out, which may eventually lead to inattentiveness or strain. Ergonomic equipment serves a dual purpose, helping enhance both operator safety and quality control.

For instance, facilities can integrate sensors or programmable logic controllers into smart lifts to ensure they only raise a part to the correct height for the next step. This virtually eliminates the possibility of human error.

Engineers can also design custom fixtures to support or locate workpieces. For example, they can create a jig with built-in sensors that confirm all components are present before proceeding. Alternatively, they can build a fixture with asymmetrical pins to ensure parts can only be loaded in the correct orientation.

Modern technology like three-dimensional printing enables manufacturers to create custom, cost-effective lifts, fixtures and jigs rapidly, so even smaller, less-resourced facilities can incorporate Poka-Yoke principles into the assembly line.





Sixty Years of Innovation, Resilience and Sustainable Transformation in Industrial Chemistry



Dr Andreas Stumpe
CEO

In 2026, Haug Chemie celebrates its 60th anniversary – a milestone that symbolises not only the longevity of a family-led organisation, but also the extraordinary transformation of a company that has continuously reinvented itself alongside the global chemical industry. Founded in 1966 in Sinsheim, Germany, Haug Chemie began as a modest producer of solvent mixtures for local manufacturers. Today, it stands as an international supplier of advanced chemical technologies serving nearly every major industrial sector, from metalworking and plastics processing to woodworking, wastewater treatment, automotive supply and industrial maintenance.

Over six decades, the company has expanded its portfolio, upgraded its production infrastructure, built strong R&D capabilities, entered new markets and embraced sustainability as a core strategic principle. What distinguishes Haug Chemie, however, is not only its technical expertise, but its ability to combine industrial-scale innovation with the personal, service-driven culture of a mid-sized, family-owned business.

As CEO Dr Andreas Stumpe explains, “Haug Chemie is a company with deep roots and strong traditions, yet we view ourselves as a modern, forward-looking organisation. Our anniversary is a moment to reflect on our heritage, but above all, to demonstrate how we are preparing for the next sixty years.”

The following profile examines how Haug Chemie has evolved, how it is reshaping its business around sustainability and circularity and how its long-term strategy positions the company as a future-ready leader in industrial chemistry.

Six Decades of Development: From Solvent Producer to Technology Partner

The story of Haug Chemie is intertwined with the evolution of European industry. When the company first entered the market in 1966, its primary focus was the blending of solvents for use as thinners, cold cleaners and paint removers. Early success in this niche reflected the needs of the time: German manufacturers sought reliable suppliers capable of producing stable formulations tailored to increasingly specific applications.

FACT BOX



Substanz. Partnerschaftlich. Erleben.

FULL NAME:

Haug Chemie GmbH

GENERAL DIRECTOR:

Dr. Andreas Stumpe

INDUSTRY:

Chemical Industry

ESTABLISHED:

1966

EMPLOYEES:

100

TURNOVER:

23 Mio.€

www.haugchemie.de



The 1970s marked the company's first major expansion. As industries demanded more sophisticated cleaning and surface treatment solutions, Haug Chemie introduced a wide range of spray and dip cleaners, ultrasonic cleaning fluids, iron phosphating systems and high-performance passivation technologies. These products enabled customers to adopt modernised production lines, and the company's reputation for technical reliability began to spread beyond its local region.

The late 1980s brought another turning point with the construction of a modern tank farm – a project that significantly expanded the company's storage and blending capacity. This facility laid the foundation for scaling operations and enabled more complex formulation work. In the 1990s, the company expanded into water-based technologies, aligning its development strategy with both environmental expectations and the changing chemistry landscape.

A major milestone came in 2006, when Haug Chemie Poland was established. This strategic move strengthened the company's international presence, improved service capabilities in Eastern Europe and established a platform for further market expansion. "Poland has become a central part of our organisation," remarks Dr Stumpe. "It has helped us operate internationally while remaining fast and flexible."

Today, Haug Chemie operates as a full system supplier with interconnected product families covering nearly every stage of industrial production. Its offerings include: water-miscible coolants and lubricants, wastewater treatment chemicals (such as defoamers and paint detackification systems), corrosion protection technologies, industrial cleaning and maintenance chemicals, surface treatment formulations, process additives and customised speciality solutions. This evolution from a solvent producer to an integrated technology partner has reshaped the company's identity and strengthened its position in the industrial chemical market.

A Modern and Diversified Product Portfolio

Although solvents and water-based cleaners continue to represent a large portion of the company's revenue – roughly 80 percent combined – Haug





Chemie's portfolio has undergone a significant transformation in recent years. Beginning in 2020, the company initiated a comprehensive modernisation programme aimed at improving ecological performance, energy efficiency and process stability across all product groups.

The result is a new generation of chemical systems designed to support manufacturers facing rising energy costs, stricter environmental regulations and increased expectations around sustainable production. Among the company's most impactful innovations are:

- low-temperature industrial cleaners, enabling significant reductions in energy consumption
- high-stability coolant lubricants, engineered for demanding metal-working environments

- innovative corrosion inhibitors, compatible with modern alloys and coating technologies
- water-based paint removers, replacing more hazardous solvent-heavy formulations

However, the most transformative innovation has emerged in the automotive coatings sector. Haug Chemie's new paint detackification series has dramatically improved separation stability, helping customers reduce wastewater volumes and extend bath lifetimes. "Our new detackification technologies are exceptionally stable," says Dr Stumpe. "They allow customers to operate more efficiently while reducing waste and lowering operational costs by 20 to 40 percent. That is real value creation."





This portfolio transformation not only strengthens the company's competitive position but also demonstrates its ability to anticipate market trends and deliver solutions ahead of industry expectations.

Innovation at the Core: The Strength of In-House R&D

At the heart of Haug Chemie's success is its research and development department. Located at the company's headquarters, the R&D team works closely with technical sales specialists, laboratory staff and regulatory experts to develop, test and optimise new formulations. This in-house capability enables fast response times, customised solutions and a deep understanding of customer processes. The R&D team focuses on several strategic areas: environmentally compatible formulations, reduced energy consumption, improved system performance and stability, extended bath life cycles, compatibility across multi-product systems, regulatory compliance and future-proof chemistry, customised solutions for niche industrial applications.

"Our R&D team allows us to think beyond single products," notes Dr Stumpe. "We analyse the entire process, under-

stand where value can be created or saved and develop solutions that fit seamlessly into our customers' production environments."

This holistic approach is particularly valuable as industries face tighter environmental legislation, stricter occupational safety standards and increased pressure to reduce chemical consumption and wastewater volumes.

The Changing Landscape of Industrial Chemistry

The industrial chemical sector has undergone profound transformation over the past two decades, influenced by several converging forces:

- stricter environmental regulations across Europe
- the European Green Deal and national sustainability frameworks
- rising energy and raw material costs
- increased digitalisation requirements
- demographic shifts within the workforce
- global supply chain volatility
- customer expectations for sustainable and circular solutions

Manufacturers increasingly seek chemical systems that are energy-efficient, safe, regulatory-compliant and economically optimised for the entire product lifecycle. This shift has created new opportunities for mid-sized players like Haug Chemie, whose agility allows them to respond faster than large corporations.

"Sustainability, efficiency and responsible chemistry are no longer optional," says Dr Stumpe. "They define competitiveness. Companies that anticipate these developments will shape the future of the industry."

Golden Circle: A Breakthrough in Circular Industrial Chemistry

One of the company's most future-oriented initiatives is Golden Circle, a closed-loop resource management system developed together with Zimmermann Group. Set to launch in 2026, Golden Circle represents a transformative step toward circular industrial chemistry. Under this programme, customers will be able to return: emptied packaging, solvent residues, paint sludge, used chemicals and process by-products and other waste streams from industrial operations.

Zimmermann Group will treat, recycle or responsibly dispose of these materials, recovering valuable raw materials wherever possible. The recovered components will be reintegrated into the production cycle, establishing a closed loop that reduces environmental impact and improves resource efficiency.

“Golden Circle is more than a waste concept,” explains Dr Stumpe. “It is a new philosophy of how chemicals should be produced, used and recovered. It is our contribution to a sustainable and circular future.”

This initiative positions Haug Chemie as a pioneer among mid-sized chemical manufacturers, bridging the gap between sustainability ambitions and real-world industrial practice.

Certified Quality, Compliance and Responsible Care

Haug Chemie’s strong operational discipline is supported by internationally recognised certifications. The company holds ISO 9001 for quality management and ISO 14001 for environmental management. It is also preparing to meet ISO 45001 for occupational health and safety. In addition, the company participates in Baden-Württemberg’s Klimafit programme and adheres to the Responsible Care principles of the German chemical industry.

These certifications ensure not only high product quality but also transparent, responsible and regulatory-aligned operations. They also reinforce customer trust – a critical factor in industries



where chemical safety and compliance are paramount.

Major Investments: Expanding Capacity for a Sustainable Future

To support its long-term growth and sustainability goals, Haug Chemie has initiated one of the largest investment programmes in its history. Over the next three years, the company will invest 17 million euros in modernising the Sinsheim production site. The redevelopment includes: redesigned production areas with optimised process flows, expanded tank storage and raw material handling systems, new energy-efficient technologies, enhanced safety and environmental protection systems, expanded laboratory and R&D infrastructure, modernised logistics and warehouse capacities.

These investments follow recent upgrades that included nearly 6 million euros for tank farm expansion, new reactor systems and expanded solvent storage infrastructure capable of handling up to 1000 cubic metres.

“Our investments reflect our long-term commitment to innovation, safety and sustainability,” says Dr Stumpe. “We are designing our operations for the next generation.”

An Expanding Market Presence

While Germany and Poland represent roughly 80 percent of the company’s sales, Haug Chemie’s presence in Europe and beyond is steadily expanding. The company maintains long-term partnerships in Austria, Belgium, the Czech Republic, the Netherlands and Switzerland, and in the past two years has entered new markets including Sweden, Thailand and Turkey.

Further expansion is planned in Hungary, India and the United Kingdom – markets with strong industrial sectors and increasing demand for specialised chemical solutions.

“Internationalisation is a strategic priority for us,” says Dr Stumpe. “We welcome new partners and are prepared to support global customers with the same level of service and expertise we provide in our core markets.”

Customer Relationships Built on Trust and Technical Expertise

Haug Chemie’s customer base includes around 3500 companies, ranging from



small and medium enterprises to multinational corporations. The company's strongest sectors include woodworking, metalworking, plastics processing, industrial maintenance and automotive supply. Regardless of industry, customers consistently value: high service level, solution-oriented cooperation, direct personal contact, technical reliability and long-term partnership.

These values remain central to Haug Chemie's identity. "Business is still made between people," emphasises Dr Stumpe. "Our customers appreciate that we support them personally, directly and consistently."

A Partnership-Oriented Technical Service Model

The company's service model is designed around direct collaboration. It begins with a technical assessment at

contractors, preferring mid-sized companies that offer flexibility and fast response times. The company prioritises European suppliers to ensure supply chain resilience, reduce environmental impact and strengthen regional industrial independence.

Organisational Renewal and Cultural Evolution

Over the past five years, Haug Chemie has undergone significant internal renewal. As long-serving employees retired, the company recruited skilled specialists with experience in large corporations, enriching expertise in R&D, health and safety and technical sales.

This infusion of knowledge transformed company culture, strengthening collaboration, accelerating innovation and supporting a solutions-oriented mindset. "The new generation of staff brings

A key part of this strategy is the collaboration with Zimmermann Group and RCN Chemie in implementing closed-loop chemistry and resource recovery based on the principles of circular economy.

Leadership Transition: Passing the Torch

In 2026, a symbolic alignment takes place: Haug Chemie and its CEO both turn 60. As part of a long-planned succession strategy, Dr Andreas Stumpe will hand over the role of CEO to Tobias Möller at the end of the year. After seven years of transformative leadership, Dr Stumpe will assume the role of Head of the Chemical Division at Zimmermann Group from 2027 onward.

Reflecting on his tenure, he says, "Leading Haug Chemie has been one of the most rewarding chapters of my career. The transformation we achieved together has strengthened the company for the future. I am confident that Haug Chemie is well prepared for the challenges and opportunities of the coming decades."

Conclusion: A Company Prepared for the Future

As Haug Chemie enters its seventh decade, it exemplifies the qualities that define successful mid-sized industrial companies in Europe: adaptability, innovation, technical expertise, customer proximity and long-term strategic thinking.

From its beginnings as a solvent producer, the company has evolved into an international system supplier and a pioneer of sustainable industrial chemistry. With major investments underway, a renewed organisational structure, a modernised product portfolio and the ambitious Golden Circle initiative, Haug Chemie is entering its next chapter stronger, more resilient and more future-ready than ever.

Its 60th anniversary is not merely a celebration of the past but a launching point for the company's next era – one shaped by sustainable innovation, circular processes and a deep commitment to supporting industrial customers worldwide



the customer's site, followed by laboratory analysis and tailored product recommendations. Implementation is supported by on-site engineers who optimise processes and ensure correct application.

Customer service teams support logistics, documentation, safety protocols, regulatory compliance and product instructions. This comprehensive approach enables long-term efficiency and strengthens trust.

Supplier Partnerships and European Resilience

Haug Chemie values long-term relationships with its suppliers and sub-

ideas, energy and perspectives that complement our long-standing traditions," says Dr Stumpe.

Strategy 2035: A Roadmap for Long-Term Transformation

To guide its future development, Haug Chemie has developed Strategy 2035, a comprehensive plan addressing all areas of the company. The strategy focuses on: digitalisation of processes, expansion of R&D capabilities, increased logistics and operational efficiency, sustainability integration throughout the product lifecycle, implementation of circular material flows, enhanced international presence, talent development and organisational alignment.



Pioneering the Future of Thermal Processing and Industrial Innovation



Karsten Seehafer
Business Owner & Managing Director

For nearly four decades, Hanomag Heat Treatment Group has stood as a benchmark of precision, reliability, and innovation in industrial heat treatment. From its origins as a spin-off from the renowned Hanomag Maschinenbau AG in Hannover, the Group has grown into one of Europe's leading independent providers of advanced thermal and thermochemical processing services. Today, under the leadership of Karsten Seehafer, Business Owner and Managing Director, Hanomag continues to combine deep metallurgical expertise with cutting-edge technology, sustainability, and a forward-looking business philosophy.

Interview with Karsten Seehafer, Business Owner and Managing Director, Hanomag Heat Treatment Group.

A Legacy Forged in Excellence

Could you briefly present the history of Hanomag Heat Treatment Group and the key milestones that have shaped its development?

The Hanomag Heat Treatment Group (Hanomag Lohnhärtereier Gruppe) was founded in 1986 as a spin-off from Hanomag Maschinenbau AG in Hannover, Germany. Initially focusing on high-quality heat treatment services, the Group steadily developed into one of Germany's foremost independent specialists in this field.

Over the years, we achieved several defining milestones. Our geographical expansion began with the establishment of additional facilities in Berlin,

Wernigerode, Gevelsberg, Gommern, and other cities, giving us strong national coverage. In 2015, we expanded beyond Germany by opening our first facility in Poland, followed by Austria in 2019, extending our footprint across Central Europe.

The Group diversified further in 2021 with the founding of Hanomag Aluminium Solutions GmbH in Kassel and Bunnatal, created to serve the increasing demand for aluminium heat treatment and precision processing. Two years later, in 2023, we strengthened our position through the strategic acquisition of HTU Härtetechnik GmbH, expanding our capacity and expertise.

These developments, along with nearly four decades of continuous innovation, have defined Hanomag as a trusted partner for industries demanding both technological depth and production reliability.

FACT BOX



FULL NAME:

Hanomag Heat Treatment Group

GENERAL DIRECTOR:

Karsten Seehafer

INDUSTRY:

Heat Treatment and Mechanical Treatment

ESTABLISHED:

1986

EMPLOYEES:

872 Employees

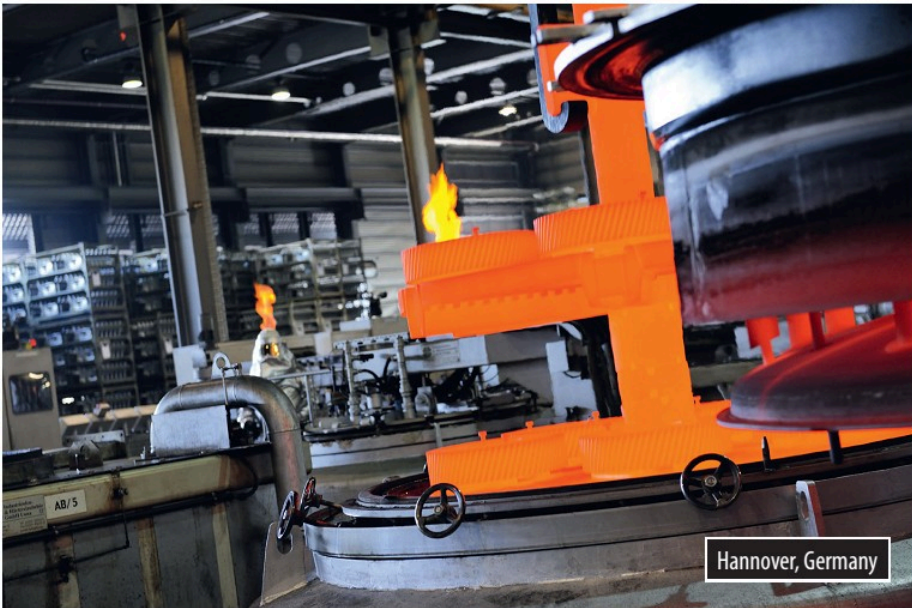
REVENUE:

136 Million Euros (2025)

www.haertecenter.de



Hannover, Germany



A Decentralized Structure with Centralized Excellence

How has the Group evolved in recent years in terms of production sites and organizational structure?

In recent years, we have significantly expanded our production network, now encompassing around 12–13 sites across Germany, Poland, and Austria. This structure allows us to remain close to our customers, providing faster delivery times, greater flexibility, and enhanced operational resilience.

Organizationally, Hanomag follows a decentralized yet integrated model. Each location contributes specialized expertise—whether in carburizing, nitriding, induction hardening, or aluminium heat treatment—while adhering to unified Group standards for quality, environment, and energy management. The foundation of Hanomag Aluminium Solutions GmbH marked an important structural shift toward dedicated specialization, enabling us to serve specific markets with tailored technologies and highly skilled teams.

This approach reflects our commitment to proximity, specialization, and scalability—principles that define our long-term vision.

Guiding Values and a Clear Mission

What are the core values and mission that guide your operations, and what differentiates Hanomag from other companies in the heat treatment industry?





Hanomag's overarching mission is to deliver high-quality, efficient, and sustainable heat treatment solutions that meet the demanding requirements of modern industry.

The company's vision statement emphasizes becoming the market reference in surface technology and component processing for demanding technological fields. This goal is driven by providing efficient and creative solutions for shared success with customers.

- **Quality**
Focus on QUALITY: Customer satisfaction through consistently excellent results.
- **Technological Competence**
TECHNOLOGICAL COMPETENCE as a key success factor: Applying and continually developing our know-how.
- **Sustainability**
Embracing SUSTAINABILITY: Awareness in resource usage and openness to technological advancement.
- **Solution-oriented**
SOLUTION-ORIENTED: Speaking the language of customers and being partners for efficient and economically aligned models.
- **Integrity**
INTEGRITY as the foundation of our actions: Doing what is right and fulfilling commitments – and communicating about it.
- **Team spirit**
Promoting TEAM SPIRIT: Achieving the best results through cross-functional and cross-location collaboration.





Penzberg, Germany

What truly differentiates Hanomag is our comprehensive service offering—from raw material treatment to mechanical processing and coating—combined with our independent position in the market, which grants flexibility and neutrality. Our integration of digital systems throughout production enables transparency, consistency, and long-term reliability.

Technical Breadth Across Materials and Processes

Which specific heat treatment processes does your group offer, and for which materials?

We offer an exceptionally broad portfolio covering both steel and aluminium.

For steel, our services include:

- Case Hardening/Carburizing – producing a hard, wear-resistant surface with a tough core, ideal for gears and shafts.
- Induction Hardening – for selective surface hardening of axles and complex shapes.
- Nitriding (gas or plasma) – for tool steels and alloys requiring high hardness and wear resistance with minimal distortion.
- Quenching and Tempering, Stress Relieving, and several types of Annealing – to achieve optimal strength, toughness, or machinability.

For aluminium, we deliver:

- Solution Heat Treatment and Aging – to enhance mechanical, electrical, and corrosion properties across all aluminium alloys.
- Annealing – to restore formability after cold working.
- High-tech cooling technology – designed to minimize distortion and maximize dimensional accuracy.

This comprehensive process range enables us to serve multiple industrial domains with consistent precision and repeatability.

Integrated Pre- and Post-Processing Capabilities

To what extent do you integrate pre- and post-treatment processes in your facilities?

We provide a fully integrated value-added chain around heat treatment. Our pre-treatment services include shot blasting, surface cleaning, masking, and custom fixturing to control distortion. The post-treatment stage covers straightening, machining, grinding, and both non-destructive (NDT) and destructive testing—hardness, tensile, and metallographic inspections—all in accordance with customer specifications.

We also provide surface finishing, coating, and assembly. This one-stop ap-

proach helps customers reduce logistics complexity, handling steps, and overall lead times, ensuring consistent quality from start to finish.

Digitalization and Process Transparency

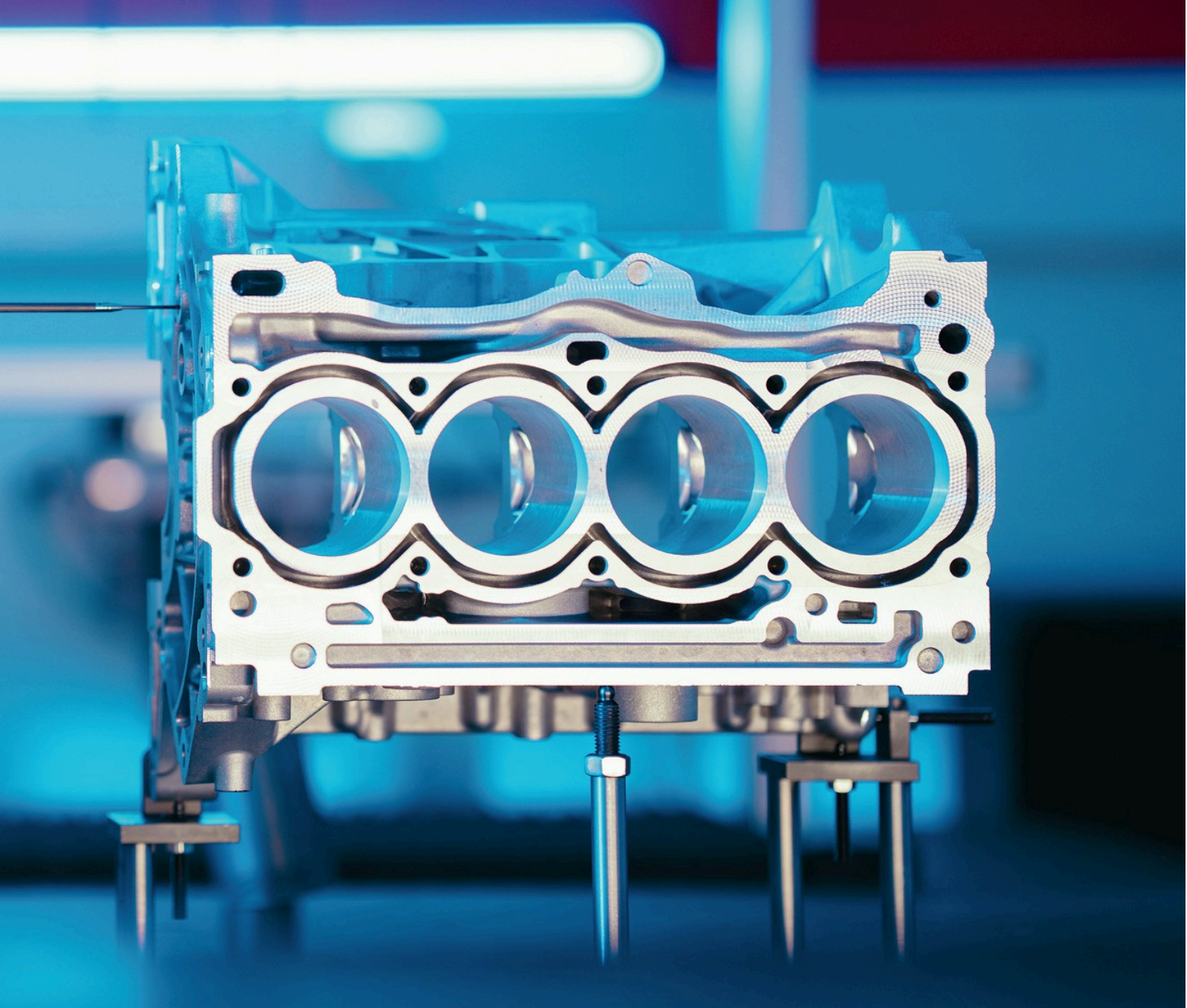
How do you ensure digital process traceability and quality monitoring?

Digitalization is central to our quality philosophy. Each component or batch is tracked through an integrated Manufacturing Execution System (MES). This system logs every furnace parameter—temperature, atmosphere, time—while maintaining barcode or QR-based identification for each part.

All data are automatically stored for audit trails, certification, and statistical analysis. Integration with our ERP ensures seamless planning and reporting, while digital process sheets (ELAM) guide operators step by step to minimize human error. Alarm systems and interlocks maintain compliance and safety. This digital infrastructure supports ISO 9001 and IATF 16949 standards, providing customers full transparency and traceability throughout the production cycle.

Innovation, Energy Efficiency, and Sustainability

Could you share some of the most recent innovations or investments in-



roduced to enhance efficiency, quality, or energy performance?

Innovation is an ongoing process at Hanomag. We have invested heavily in energy-efficient furnaces equipped with regenerative burners and advanced insulation to reduce consumption.

We are testing AI-based process optimization tools that analyze thermal cycles to improve consistency and minimize distortion. Our Digital Twin Technology allows us to simulate heat treatment behavior for complex geometries, ensuring repeatable quality.

We have expanded our plasma nitriding capacity to meet growing demand for high-surface-quality treatments with lower emissions, and we are increasingly integrating green energy sources

and zero-emission quenching media into production. These efforts reflect our strategy of combining technical innovation with environmental responsibility.

Client Sectors and Global Collaboration

What industries and sectors are your main customer base?

Our customer base primarily includes the automotive, industrial machinery, and electrical engineering sectors, with growing activity in renewable energy applications. We serve both OEMs and Tier 1 suppliers, offering tailored solutions for critical components.

Do you cooperate with international OEMs or participate in export projects beyond Germany?

Yes, we work closely with international OEMs and their global supply networks. While we do not export products directly, many of the treated components we process are integrated into assemblies that are exported worldwide. Through this, Hanomag plays an indirect yet crucial role in global value chains.

How do you select your key suppliers and technology partners?

Supplier selection is based on technical competence, innovation potential, reliability, cost-effectiveness, and sustainability. We value long-term relationships, particularly in R&D collaboration, and place strong emphasis on ISO-based quality and environmental compliance. Strategic partnerships are essential for mutual growth and shared innovation.



Taufkirchen an der Pram, Austria

Competitive Advantages in a Changing Industry

In your view, what is the strongest competitive advantage of Hanomag Heat Treatment Group?

Our greatest strength lies in the combination of technical excellence, vertical integration, and customer proximity. We have decades of expertise across steel and aluminium treatment, and our vertically integrated service—from pre-processing to logistics—provides a true turnkey experience. Our digital traceability systems and sustainability programs further enhance our reliability and adaptability. In essence, Ha-

nomag stands out as a technologically advanced, flexible, and environmentally conscious partner.

Challenges and Industry Transformation

What are the main challenges currently facing the heat treatment industry?

The sector faces multiple concurrent pressures. First, rising energy costs affect margins, driving the need for energy-efficient equipment and smarter controls. Second, tightening environmental regulations—including CO₂ emissions, VOC limits, and waste heat recovery—require major investments. Third, the push toward decarbonization means offering

lower-emission processes and renewable energy solutions.

Beyond that, we face labor shortages in metallurgical and process engineering, which we address through in-house training and apprenticeships. Digital transformation also poses challenges, as customers increasingly demand real-time data integration. Finally, supply chain instability calls for diversification and localization. Each challenge also presents an opportunity to innovate, become leaner, and deliver more sustainable value to customers.

Resilience Through Global Turbulence

How did global events in recent years affect your business, and what measures did you take to adapt?

The last few years—marked by the pandemic, geopolitical tensions, and energy crises—tested our resilience. During the COVID-19 pandemic, demand from automotive and industrial sectors declined sharply. We responded with flexible shift models, short-time work, and strict hygiene protocols to protect our people.

Facing supply chain disruptions, we increased buffer stocks, diversified suppliers, and reinforced local partnerships. The energy crisis of 2022 accelerated our investments in furnace modernization, load management, and renewable energy.



Hannover, Germany

In an era of geopolitical instability, we observed a growing trend toward localization and near-shoring—an area where Hanomag's European footprint offers a distinct advantage.

Finally, we leveraged the situation to boost digitalization, enabling remote audits, advanced customer reporting, and upgraded quality systems. These actions allowed us not only to maintain stability but to emerge more agile and future-ready.

Strategic Vision for Growth

What are your medium- and long-term plans regarding new technologies, capacity expansion, sustainability, or international growth?

Our strategic roadmap revolves around technology, capacity, and sustainability. We are expanding AI-driven process control, predictive maintenance, and low-distortion technologies. Industry 4.0 initiatives, including real-time analytics and smart automation, are being implemented across sites.

We plan to increase capacity in high-growth sectors such as aluminium components for e-mobility, and to expand our nitriding and induction hardening capabilities. Sustainability remains central—through electrification of heating

systems, renewable power adoption, and comprehensive heat recovery.

Internationally, we aim to strengthen our European network through strategic partnerships and selective acquisitions, while exploring cooperation with overseas OEMs. Our long-term ambition is to position Hanomag as a climate-friendly, digitally integrated, and customer-centric leader in industrial thermal processing.

Flagship Projects and Achievements

Do you have flagship projects or references you would like to highlight?

Indeed, several projects reflect our innovation and precision:

1. Lightweight Automotive Components – Aluminium Heat Treatment for E-Mobility

For a Tier-1 supplier, we provide fully automated solution heat treatment and artificial aging of aluminium suspension and chassis parts for electric vehicles. The line features robotic handling, real-time furnace control, and integrated hardness testing—all with full IATF 16949 compliance.

2. Plasma Nitriding of Tooling Components

For a global tooling manufacturer, we perform plasma nitriding of H11 and

H13 tool steels for hot forming tools. The process ensures controlled layer thickness, minimal distortion, and a compound-free zone below 10 µm, with integrated pre- and post-cleaning.

3. Gearbox Components – High-Volume Carburizing and Hardening

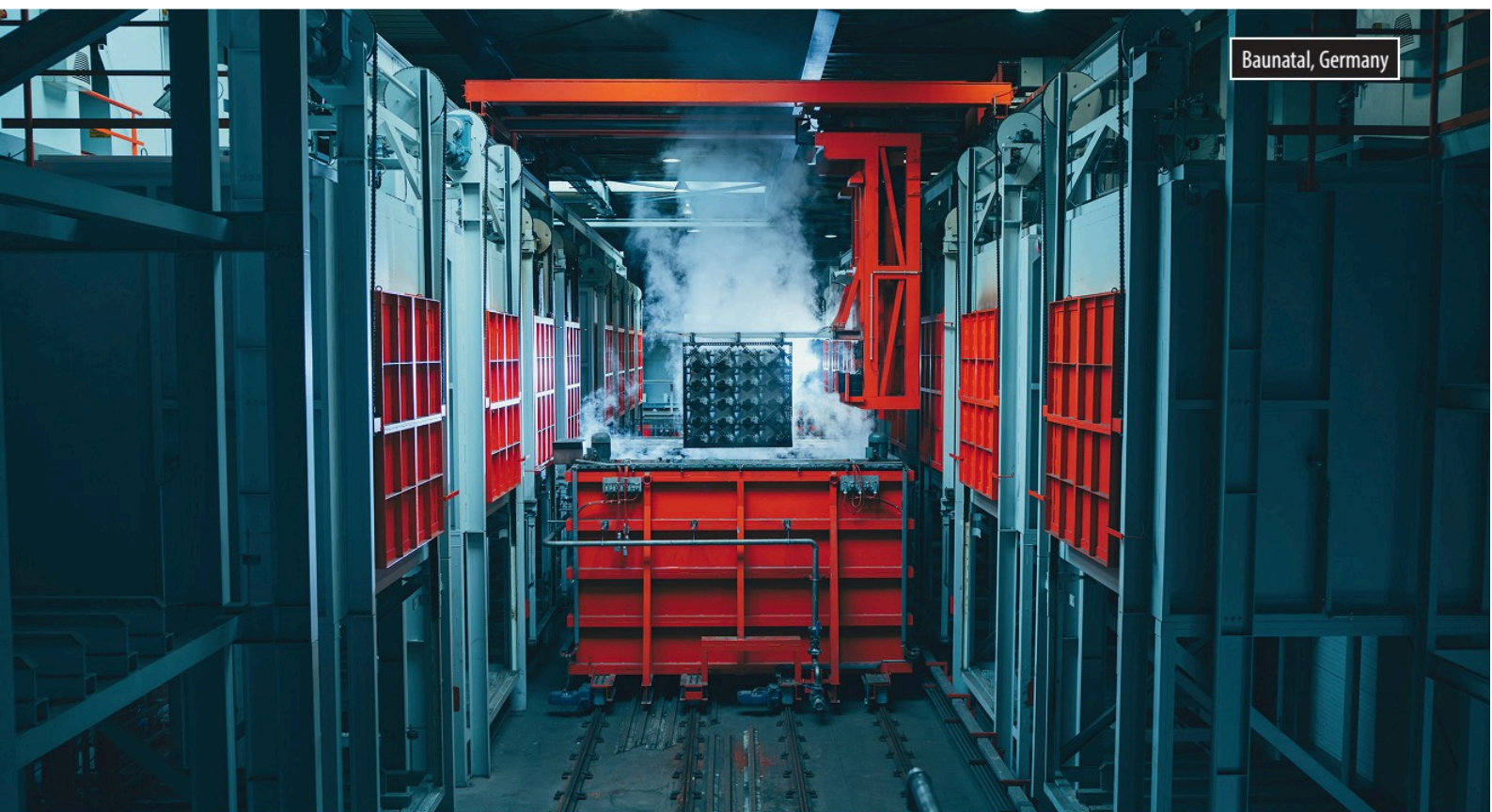
For a leading powertrain OEM, we carry out continuous carburizing and hardening with precise case-depth control. MES-controlled production, integrated straightening, and SPC-based zero-defect policy define this project's success.

Commitment to the Future

Are there any additional points you would like to emphasize for our international readership?

We take pride in representing the values of German engineering excellence and European industrial reliability. While our operations are based in Germany, Poland, and Austria, our reach extends globally through OEM cooperation.

Our philosophy centers on precision, innovation, and sustainability—the three pillars that will guide us as we continue to evolve in the decades ahead. Hanomag is more than a service provider; it is a trusted partner helping industries shape a more efficient and sustainable future.



Reviving Old Equipment With Remanufacturing

By: Ellie Gabel

Rising equipment costs and tighter sustainability targets have made replacement less practical for many manufacturers. Remanufacturing reclaims value and returns assets to near-new performance with lower capital outlay and less downtime. It's becoming a strategic option, and more firms balancing budgets and ESG goals are implementing it.

Key Benefits of Remanufacturing

Remanufacturing offers measurable gains in cost, sustainability, uptime and asset value. Consider the main advantages that make it a top choice for technically sophisticated operations.

Economic Efficiency

Remanufacturing dramatically lowers acquisition costs compared to buying new parts or equipment. Studies find that cost reductions range from 40% to 60% for regenerated components versus newly manufactured equivalents. These savings are instrumental in freeing up capital for other investments and improving margins on spare-part-heavy product lines.

Extended Lifespan and Improved ROI

A remanufactured asset lengthens the life of equipment, converting what would be a sunk cost into additional productive years. That extension raises lifetime return on capital and delays large-capex replacements, improving long-term cash flow.

Cuts Waste at the Source

Manufacturing generates predictable waste streams via raw material extraction, excess packaging and end-of-life disposal. Remanufacturing sidesteps many of those efforts by reusing cores and serviceable components, reducing the need for new raw materials and high-energy processes.

Reduced Lead Times

Remanufacturing often requires less lead time than waiting for new equipment or long supply-chain deliveries, enabling faster returns-to-service and less production disruption. This advantage is especially important as global supply chains become increasingly volatile.

According to McKinsey's analysis, supply chain disruptions significantly impacted 33% of industry players due to material shortages. Rebuilding reduces this risk because product availability may be high.

When Does It Make Sense to Use Remanufacturing?

When remanufacturing is the right choice comes down to three practical lenses — economics, availability and operational fit. Economically, it's most compelling when the rebuilt unit meaningfully lowers the total acquisition cost. When reworked parts cost less than newly produced equivalents, it can tip an ROI calculation in favor of rebuilding for high-value components. Availability is another consideration when lead times are long and supply chains are strained. Remanufacturing can return as-



sets to service faster than waiting for new OEM deliveries. Operations also favor it when legacy systems still meet performance requirements or when it adds incremental value.

Another way to tell is the cost. Rebuilding is the preferred route until repair expenses approach roughly half that of a replacement unit. Past that point, full replacement often becomes more economical. It's also not always the right answer when:

- The asset is functionally obsolete or near true end-of-life, so further service life would be short.
- A replacement delivers materially higher productivity or safety that justifies the extra capital expenditure.
- The manufacturing lead time would cause intolerable production losses — unplanned downtime remains high for many. The average large facility loses about 27 hours per month to unplanned outages, so lengthy out-of-service time can quickly erase the financial advantages.

Examples of Remanufactured Equipment

Remanufacturing spans several assets and use cases:

- Heavy machinery: Major structural and powertrain components are swapped or rebuilt to restore machines to like-new capacity.
- Automotive and industrial powertrains: Cores are reworked, worn surfaces are machined, seals and bearings are replaced, and systems are fully tested so reworked units deliver warranty-backed performance.
- Robotics and automation systems: High-value controllers and gearboxes can be refurbished or remanufactured, offering a lower-cost path to preserve automation investment while upgrading controls.



- Energy and fluid-handling equipment: Rotating equipment and associated subsystems are common candidates. Remanufacturing avoids energy-intensive production and shortens lead times compared to sourcing new original equipment manufacturer (OEM) units.

How to Implement the Remanufacturing Process

Here are the stages that make remanufacturing practical and repeatable.

1. Evaluate Opportunity

Start by screening assets through an economic and operational lens. How much life can be added, and what will the rough rebuild cost be compared with replacement? Use the pragmatic threshold for when costs get too close to replacement and prioritize candidates that clearly improve cash flow and reduce supply risk.

2. Decide on Delivery Approach

Determine whether remanufacturing will be handled primarily in-house or outsourced. The right choice depends on internal capabilities, cycle-time targets and the need for specialized services. Weigh capacity, cost and control to come to a decision.

3. Protect and Prepare Cores

Put controls in place so cores arrive in usable condition and can be returned to service. This includes tracking identity and condition, limiting damage during transport, and following basic cleanliness and handling practices. These steps reduce downstream surprises and make any subsequent work far more predictable.

4. Restore and Validate

Use the appropriate combination of repair, replacement and improvement to bring units back to specification. Regardless of who performs the work, validation should be evidence-based. Document what was done, run representative checks so the team can trust the unit's performance and provide a clear acceptance record before it returns to service.

5. Learn, Measure and Expand

Implement remanufacturing in small increments, capture lessons about bottlenecks or failures, and refine practices before expanding. Continuous learning turns a one-off rebuild into a scalable capability that improves over time.

A Smarter Way Forward

Remanufacturing offers numerous benefits that can give companies a competitive advantage. However, several factors must be taken into account before implementation. If it provides financial and operational value, manufacturers can use it as a practical lever for resilience and value recovery.



Closing the Loop: How NDT Data Can Optimize Your Manufacturing Process

By: Ellie Gabel

More manufacturing leaders have become interested in closed-loop systems. These involve the real-time analysis of continuous feedback loops associated with production. Decision-makers can use those insights to find improvement areas and track metrics.

Nondestructive testing aligns with this approach because it allows people to maintain tight quality control without making products unsellable due to damage. Learn how NDT data can contribute to production data and highlight optimization opportunities.

Improve Flexibility and Efficiency When Testing Large Parts

Running nondestructive tests on massive components is time-consuming but necessary, especially when people use the examined items in tightly regulated industries. A collaborative research project tackled many associated difficulties, developing a robotic platform that boosts agility and shortens process workflows while enabling quality.

Parties from the French Institute for Technological Research and numerous industrial partners created a roboticized platform for the completed FANTOM project. It assists people in performing NDT activities on composite structures used in the aeronautics industry.

Those involved believe their work will drive innovation in non-destructive testing and reduce the need for lengthy and costly methods. The robot is also flexible enough to integrate into existing systems to boost efficiency.

This mobile robotic system autonomously inspects parts and includes many advanced end effectors to handle specific inspections. It also integrates artificial intelligence to inspect abnormalities. The accompanying operator interface allows supervision and data collection, helping workers monitor processes in progress.

Large parts offer many opportunities to collect and use test-related information for process improvements. Bringing robots into workflows supports manufacturers through labor shortages that otherwise make meeting NDT goals challenging.

Find Tiny Flaws in Expensive Items Faster

NDT takes much less time than destructive measures, so it minimizes downtime. Testers can even examine components while they remain in use. Despite the efficiency benefits, those interested in improving testing processes look for possibilities to achieve the same or better results in shorter periods. Parties become especially motivated to enhance options for high-value or in-demand products. Representatives from AI server manufacturers know that defects can appear in the system assembly phase. Many use NDT for internal

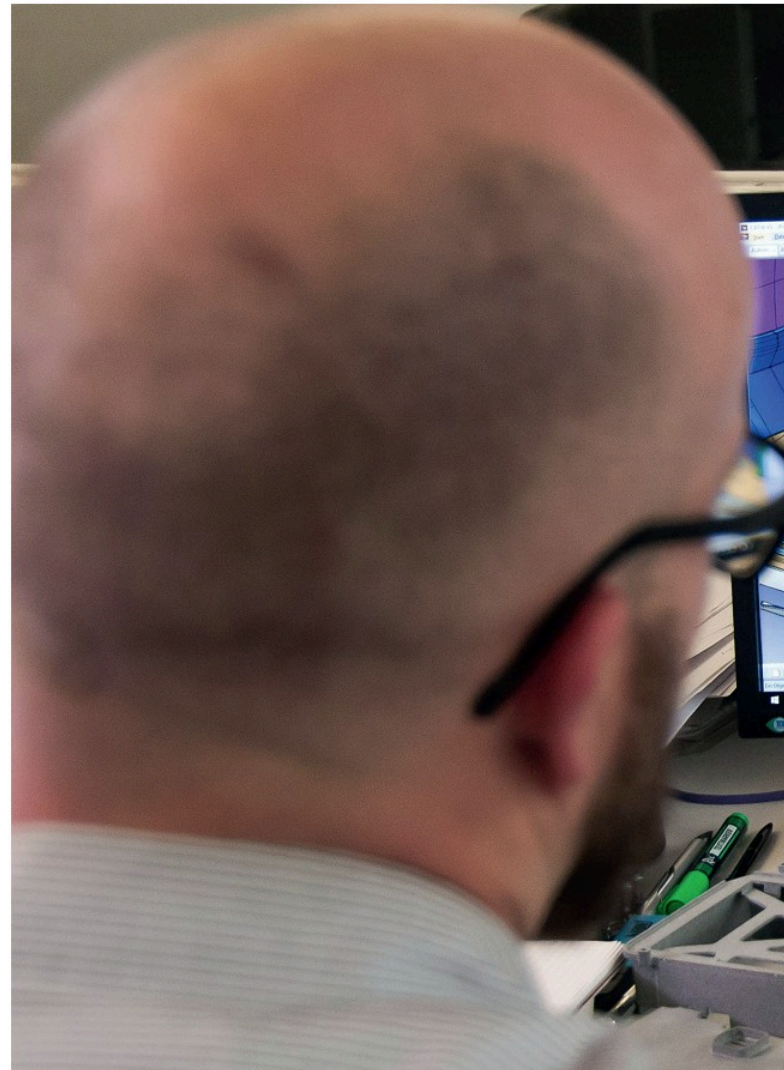
processes, plus partner with suppliers to ensure they uphold the required standards. The abundance of data generated during quality checks can shape company decisions and elevate customer satisfaction.

One manufacturer uses 3D X-ray scanners, which have increased yields by 20% because they need only a day or two to confirm root causes of issues. In one case, a foreign supplier dispute about a leaking component required the producer to conduct CT scans to learn more. Those examinations revealed microfissures. That example shows how executives can leverage NDT data, proving whether problems emerged within the factory or later.

Leaders get the best results when they choose specific aims. Those aspirations can influence internal activities by keeping employees motivated and accountable.

Use NDT Tools With High-Resolution Image Capabilities

Some NDT products have built-in features that capture





valuable image data and provide more context when analyzing it. A manufacturer of measurement instruments benefited from a computed radiography scanner to check pressure-retaining welds.

Although the business previously used analog film for radiographic testing, leaders looked for alternatives. Each weld diameter spans 3-914 millimeters and has a wall thickness of 0.2-38.4 millimeters, requiring a versatile solution. The executives found a portable, digital scanner that generated images with better contrast sensitivity than the old methods. This improvement allowed testers to see greater material thickness variances and accelerate their processes because scanning image plates takes less time than conventional processing.

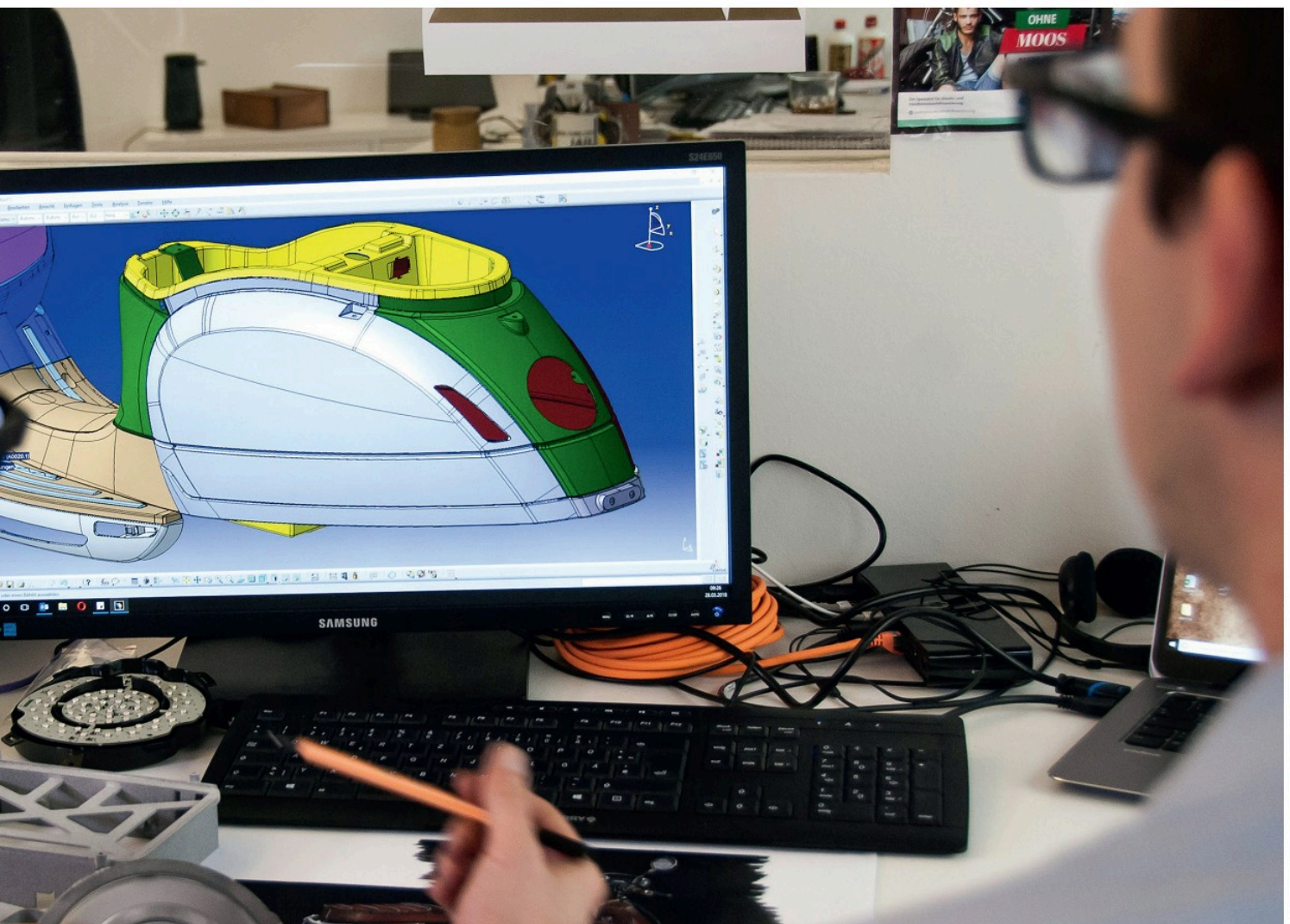
The scanner has integrated image filters, and people can adjust the brightness and contrast for more precise evaluations. A magnifying feature zooms in on specific regions. That capability lets users measure a weld's joint penetration, ensuring

the amount meets design specifications and does not damage the sensitive electronics underneath.

An NDT tool capturing valuable data opens process improvements for forward-thinking manufacturers. Most workers need time to adjust to new workflows, but information-backed decisions can increase executives' confidence in enforcing standards.

NDT Data Provides Necessary Insights

Some manufacturers only make changes after experiencing significant challenges. Analyzing NDT data allows them to become more proactive and determine whether existing processes catch deficiencies well enough. Because people can examine products without damaging them, these methods support sustainability and protect the bottom line by reducing preventable waste. Investing in a dedicated analysis platform is a practical early step to increase visibility, enhance problem-solving and create or control a closed-loop system.



4 Edge Quality Failures That Cause Premature Fuel Injector Failure in High-Pressure Systems

By: Emily Newton

Fuel injectors are linchpins in high-pressure fuel systems where they deliver precisely metered fuel at extreme pressures and tight tolerances. However, the smallest edge-quality defects can upset spray patterns, increase wear and push injectors to fail long before their expected service life. Those premature failures lead to unplanned downtime and higher repair costs and it can be due to several factors.

How Edge Imperfections Compromise Injector Performance

In fuel injectors, "edge quality" refers to the microscopic condition of critical mating and sealing surfaces. Think tiny burrs, rollovers, sharp corners and the overall surface finish. At the component scale, these flaws look insignificant. Yet, at the operating scale, they change how parts contact, seal and transfer load. Even small deviations in edge geometry alter flow paths and contact stresses in ways that accelerate wear.

High-pressure fuel systems operate in an extreme mechanical and thermal regime. Injection pressures can exceed 30,000 psi and temperatures inside the combustion environment push materials toward their limits. Common metals like aluminum typically lose appreciable strength at around 400° Fahrenheit, so injector parts rely on engineered alloys and tight tolerances to survive. When materials are pushed near their performance edge, any imperfection becomes a weak point.

Microscopic edge defects act as stress concentrators. Under repeated pressure pulses, those concentrators focus cyclic loads, promoting fatigue crack initiation and progressive fracture. They also disturb spray atomization and local flow, increasing erosion and the risk of cavitation at valve seats and nozzles. In short, poor edge quality shortens service life by compounding small mechanical, thermal and fluid dynamic effects.

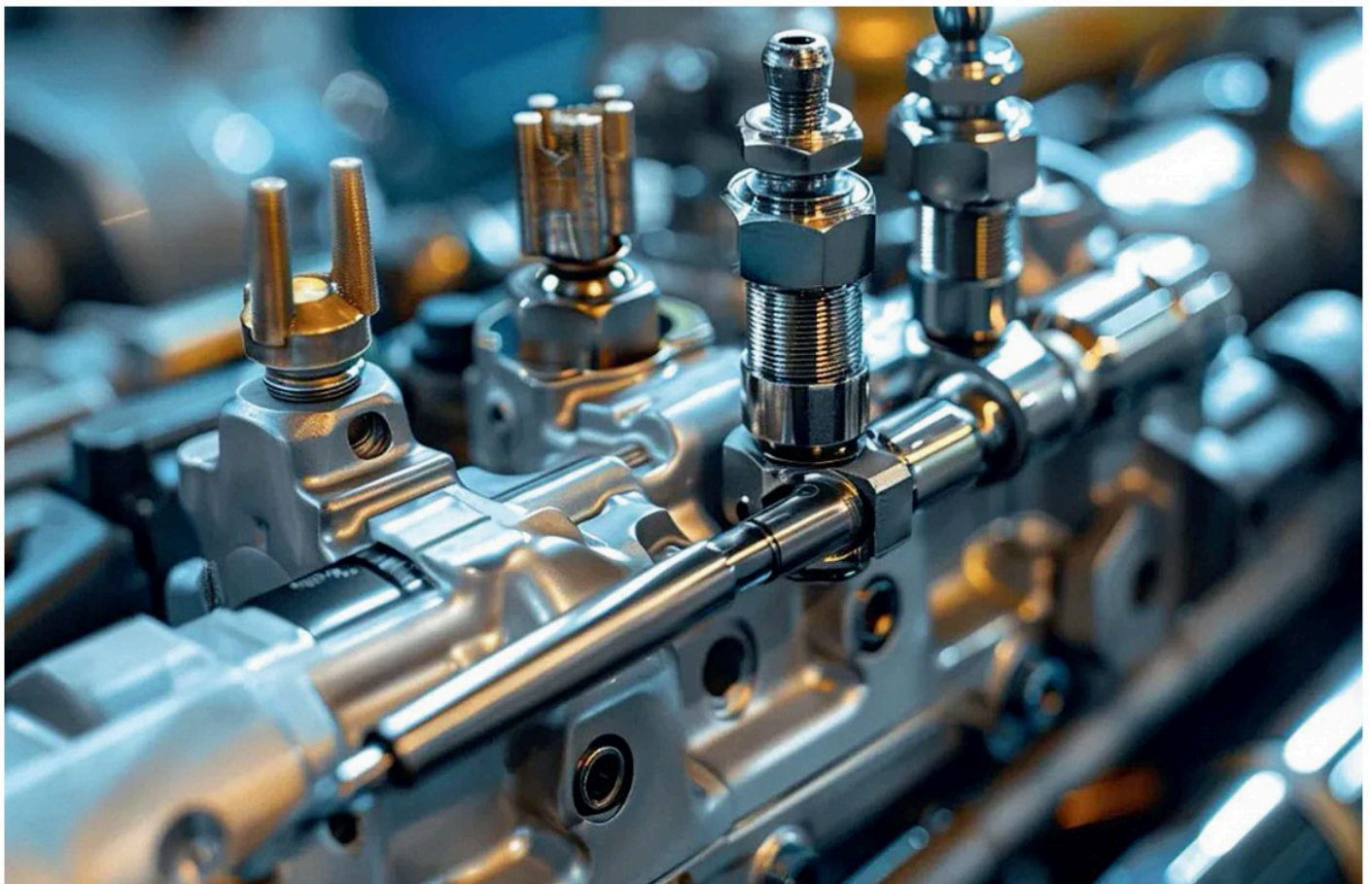
Common Edge Quality Failures and Their Devastating Effects

The following edge-quality failures are the most common instances the industry sector sees in high-pressure injectors.

1. Micro-Burrs and Rollover

Micro-burrs and rollovers form when cutting, turning or grinding, which leaves material folded or torn at an edge instead of being cleanly removed. On an injector, that tiny lip looks harmless. Yet, in service, it can shear off or act like an abrasive flap against mating surfaces. That changes the nozzle orifice shape, disturbs spray patterns and introduces hard particles into the high-pressure fuel stream where they abrade valve seats and fine passages.

These local abrasions quickly lead to corrosion, blocked orifices, fluctuating injection timing and stress risers. Because





the root cause is manufacturing, the fix is typically process-level, ranging from improved tool setups to controlled cutting parameters.

2. Inconsistent Surface Finish

Patchy roughness, tooling marks or uneven polish change how fuel flows across injector surfaces and through orifices. Rough spots increase local friction and disturb the thin fuel film and spray, producing larger droplets or an uneven spray cone that reduces atomization. In turn, this encourages incomplete combustion and the formation of carbon deposits.

A 2024 study supports this link between roughness and wear. Researchers found that higher surface roughness reduces fluid-film thickness on engine components, which raises friction and accelerates wear under high-load conditions. Applied to injectors, the same mechanism makes rough or uneven finishes more likely to promote coking and seal failure. That is why tighter surface finish control pays off in terms of durability and performance.

3. Sharp Edges and Stress Risers

Sharp corners and unfinished edges act as stress risers — small geometric discontinuities that drastically amplify local stress. Under the repeated high-pressure pulses of an injector, those amplified stresses become the natural sites for micro-crack initiation.

A crack that starts at a sharp edge near a nozzle seat or pintle can grow with each cycle until a critical fracture occurs, resulting in a sudden loss of sealing or erratic injection. Once initiated, crack growth accelerates under the same service conditions that cause it, including pressure cycling and local corrosion.

4. Variable Edge Radii

Small differences in the radius at an injector's edges may seem trivial, but they change how fuel approaches and passes through orifices. One study observed that increasing the inlet orifice radius lowers the local resistance coefficient and raises the flow coefficient, meaning even modest radius changes alter local pressure losses and flow rates. That shifts velocity profiles, increases the chance of turbulence and changes how mass is distributed across the spray cone.

Those flow changes are important in service, as an uneven one produces an imbalance in injection between holes or ports. It also increases the risk of cavitation and reduces atomization consistency.

Proactive Strategies for Preventing Edge-Related Failures

Preventing edge-related failures means attacking the problem at three points — find defects early, stop creating them and limit their impact in service. Implement them in the following steps.



Advanced Inspection and Metrology

Use targeted measurement early and often to keep microscopic defects from reaching assemblies. Techniques — such as scanning electron microscopy (SEM) for micro-burrs and automated optical inspection for rapid visual checks — enable you to quantify burr height, radius and roughness to specification. Integrating those checks into the incoming part acceptance and final assembly gates converts invisible geometry issues into clear pass or fail criteria.

Precision Manufacturing Processes

Prevent defects in parts by selecting processes that yield clean edges and consistent radii. Precision grinding, controlled EDM, abrasive-flow machining, electrochemical machining and laser polishing all produce superior edge quality versus rough cutting. Pair those methods with disciplined tool-wear monitoring and targeted deburring to minimize particle generation and ensure repeatable sealing and spray performance.

Operational Best Practices

Field practices reduce wear and catch early warning signs before failure occurs. Start with high-quality fuel, including staged and filtered fuel, and appropriate additives to minimize abrasive and chemical damage. Then, follow with routine diagnostics, such as injector balance tests and pressure and flow checks. Together, proactive inspection, precision processing and disciplined maintenance lower the chance that a small edge defect becomes an expensive unplanned failure.

Maintaining Reliability and Safety with Injectors

Edge defects may be tiny, but they accelerate wear and lead to premature injector failure. Improving edge quality through better finishing, consistent radii and targeted inspection prevents many downstream defects. Additionally, good operational habits further limit damage in service. Together, those simple measures reduce downtime and help injectors reach their intended service life.

Custom Converting: Meeting Complex Manufacturing Requirements

By: Ellie Gabel



Converting industry companies specialize in modifying or combining raw goods to make thin layers that become textiles, films, paper, and other flexible materials. Because these businesses often fill customization requests for clients who need partially or fully finished products, their executives have deployed many strategies to remain competitive and adaptable.

Prioritizing Automation Investments

Many decision-makers follow the lead of their peers in other sectors and realize the importance of strategically adopting automated equipment to accelerate workflows, reduce errors, and address labor shortages. These systems can also raise overall output, helping converters meet new needs or accept large contracts.

In one case, representatives aimed to reduce headcount for a process that separates and retrieves stacked foam layers from production lines with vacuum suction, preparing them for cutting into the desired shapes. Leaders targeted this goal by purchasing several unstacking machines and approximately 25 conveyors. Although these steps formerly required 20 workers, just four now work the heavily automated line.

Finding the most appropriate ways to automate time-consuming steps supports custom conversion because it minimizes variability caused by fatigue or distractions. Retraining opportunities that expand employee skills also equip entities to address internal gaps while keeping production levels high.

Improving Company Processes to Enhance Quality

Converting brands showcase dependability and trustworthiness by emphasizing continuous improvement. The business size, products created and average volume influence the steps taken to achieve the desired results. However, leaders should focus on measurable actions connected to overarching goals.

For example, lowering defect rates requires taking correc-

tive and preventive actions tailored to the identified shortcomings. However, executives without well-defined quality standards should develop a framework according to customer requirements, current regulations and industry norms. Regular inspections and tests indicate how closely the enterprise meets its ideals.

Conducting them at various process stages enables identifying root causes as early as possible. Positioning improved quality as an ongoing goal also increases personal accountability and motivation by encouraging workers to consider how to uphold continuous improvement while addressing clients' complex orders and growing their skills.

Educating Workers to Keep Knowledge Current

Education often dominates a new hire's first few weeks, ensuring they understand a converting company's mission, safety rules and administrative processes. Such training supports these individuals throughout their time with employers, equipping them to stay abreast and implement internal and wider industry changes and best practices. The content may also prepare them for new customer requests reflecting emerging trends.

Many converting industry leaders foresee a rising demand for recyclable and compostable packaging that aligns with upcoming European Union requirements. Paper-based and mono-material offerings featuring barrier technologies to protect the contents will help brands become more sustainable by using suitable, updated designs.

When training content covers developments such as this one, staff will have the knowledge to stay relevant in an evolving industry. However, educational coordinators should account for how many employees lack desks or other designated locations to work through modules or chapters.

One converting business tackled that challenge by launching an online learning platform specific to its industry. Learners can take detailed machine overview courses or those about tissue and print offerings. Because this on-demand solution allows entities to create customized content, the topics remain applicable to those addressing new order types and increasing volumes.

Showing Adaptability to Succeed

These examples illustrate how converting companies can tweak methods, offerings and processes to excel in a challenging industry. That responsiveness makes them well-equipped to fulfill customer needs as they evolve.

Executives should remain open to investing in new equipment, expanding training opportunities and instituting workflow improvements while assessing how to improve. Employee and customer feedback can reveal focus areas that drive lasting and meaningful impacts.



A New Identity, the Same Passion for Science and Innovation



Peter Browning
President GBU Specialty Polymers at Syensqo

Making its debut at K 2025 under a new name, Syensqo marks a bold new chapter in its journey as a global leader in specialty polymers and advanced engineering materials. In this exclusive interview, Peter Browning, President of the Specialty Polymers business, discusses the strategic importance of the company's rebranding, the fast-growing technologies driving transformation across industries such as automotive, electronics, healthcare, and hydrogen mobility, and Syensqo's unwavering commitment to sustainability and circularity. Through continuous innovation and close collaboration with customers, Syensqo is redefining what performance and responsibility mean in the world of high-performance materials.

Interview with Peter Browning, President of Syensqo's Specialty Polymers business.

Syensqo is making its debut at K 2025 under a new name. How significant is this moment for the company and its future positioning?

This year marked an important milestone for Syensqo as we made our debut at K 2025 under our new identity. It was exciting to be back at the world's leading trade fair for plastics and rubber, this time with a renewed vision and energy that truly reflected who we are today — an innovation-driven company focused on solving some of the world's toughest material challenges.

We've always been a science- and innovation-led organization, and that hasn't changed — in fact, we're doubling down on that mission. At K 2025, we showed how our advanced materials deliver exceptional performance in the most demanding conditions, and how they enable breakthrough technologies across key industries.

We showed practical examples of this — from materials that improve the efficiency of e-motors and power systems, to ultra-pure polymer chemistry supporting next-generation semiconductors, to high-performance solutions for medical devices that push the limits of safety and reliability. These are areas where the world needs new answers, and where Syensqo is at the leading edge.

So for us, this debut wasn't just about a new name — it was about showing what Syensqo stands for: performance, innovation, and a deep commitment to advancing humanity through science.

Your specialty polymers portfolio addresses a wide range of applications, from e-motors and compressors to healthcare and semiconductors. Which areas are currently the fastest-growing, and why?

Indeed our portfolio is designed to help our customers solve the toughest challenges across multiple markets.

In the Electronics space, we're seeing strong growth with our new NFS (fluorosurfactant free using our proprietary non-fluorosurfactant technology) Tecnoflon® portfolio for semiconductor applications. This market-first product portfolio is designed to deliver superior performance under extreme process conditions — like high temperatures and plasma exposure — that are essential for advanced chip designs powering AI and high-performance computing. Our latest introduction, unveiled at K 2025, features a high-temperature-curing NFS grade that delivers the performance needed for these leading edge chips while also addressing a key industry priority: eliminating fluorosurfactants from the semiconductor supply chain.

In our Life Solutions area, we're seeing strong growth for our sulfone materials in advanced filtration — from hemodialysis to water treatment — driven by the superior in-use performance of

FACT BOX



BIOGRAPHY:

Peter Browning

President GBU Specialty Polymers at Syensqo

Peter has held different leadership positions within Solvay, now Syensqo with a strong track record, consistently driving growth and profitability. He previously served as President of the Peroxides global business unit deploying H2O2 megaplant licensing whilst engaging in strategic restructuring in Europe and Asia. As President of the Aroma Performance global business unit, Peter successfully refocused the business on natural ingredients to turn around the division's economic performance. As General Manager of Engineering Plastics, he led the business to successive record profit years leveraging innovation and geographical expansion before playing a pivotal role in the division's sale to BASF at a highly attractive valuation. He holds a degree in Chemical Engineering from Aston University and an MBA from London Business School.

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both Udel® PSU and Veradel® PESU. At the same time, there's clear momentum toward our new ECHO grades, as customers increasingly seek circular, lower-carbon solutions without compromising on quality. A great example is our partnership with Nitto, where our Udel® PSU ECHO, made with certified non-fossil feedstock, is replacing traditional fossil-based polysulfone in water treatment membranes — combining high performance with real progress toward circularity.

As the automotive electrical vehicle industry transitions to high voltage (800V+) architectures, the need for materials that can deliver thermal resistance, superior dielectric strength, and long-term reliability has never been greater. Our KetaSpire® PEEK materials for magnet wire and slot liners not only enable these performance gains, but also drive improved system efficiency and lower overall costs. By pushing the limits of what's possible in e-motor design, Syensqo is helping OEMs and Tier suppliers accelerate the

shift to more compact, efficient, and powerful electric drivetrains.

Syensqo recently won top honors at the Altair Enlighten Awards with Horse Powertrain. Could you tell us more about this achievement and its importance for lightweighting and sustainability?

We're thrilled to have received the 2025 Altair Enlighten Award with Horse Powertrain — it's a great example how we work closely with our customers to help them bring their novel ideas to life with our innovative solutions. The winning innovation leverages Syensqo's Amodel® PPA to deliver a breakthrough in hybrid drivetrain efficiency. Horse Powertrain's adoption of this advanced thermoplastic enabled a novel e-motor cooling design, resulting in a remarkable 47% weight reduction and 36% cost savings compared to traditional metal solutions. The metal-to-plastic conversion also allows for part integration and streamlined high-volume assembly through injection molding, laser welding, and snap

fits. Improving our customers manufacturing process and ultimately lowering the carbon footprint across the entire process. For us at Syensqo, it's proof that advanced materials can help the automotive industry move toward a lighter, smarter, and more sustainable future.

Recycling and circularity are becoming increasingly critical. How is Syensqo advancing its innovative recycling technology for sulfone polymers?

At Syensqo, we see recycling and circularity as absolutely essential, not optional. That's why we've developed a proprietary chemical recycling process for our sulfone polymers such as our Udel® PSU, Radel® PPSU, and Veradel® PESU. This technology can depolymerize post-industrial and post-consumer waste back into purified monomers, which are then reused indefinitely to produce new high-performance materials — without any loss of quality or performance. By closing the loop in this way, we're reducing waste, lowering carbon footprint, and helping customers boost recycled

content in demanding applications, from healthcare to aerospace. It's a major step toward true circularity in high-performance polymers.

In addition to our work with sulfone polymers, Syensqo is also advancing circularity in polyolefins. Our next-generation polymer stabilizers are designed to maintain performance and durability in both virgin and recycled materials, allowing manufacturers to increase the share of recycled content without compromising quality. By supporting circularity in both high-performance polymers and commodity plastics, we're helping to make sustainability achievable across the entire plastics value chain.

Hydrogen technologies and hydrogen-powered mobility are among the most discussed topics at K 2025. What role does Syensqo play in enabling this transition?

At Syensqo, we play a key role in enabling the transition to hydrogen-powered mobility by providing the ad-

vanced materials and expertise that make hydrogen technologies efficient, reliable, and developed for next-generation applications.

We offer a broad portfolio of specialty materials, including ionomers and other high-performance polymers that are essential across every stage of hydrogen producing and consuming systems. Used in membranes, electrode binders, gaskets, diaphragms, cell frames, and end plates, as well as in critical areas such as thermal management and air systems, our materials improve efficiency, durability, and safety while ensuring reliable performance across diverse applications.

In April 2025, we expanded this portfolio with the launch of HYRA™, our dedicated range of hydrogen-grade polymers engineered for exceptional performance in hydrogen environments. The first HYRA materials — based on Radel® PPSU and Udel® PSU — combine strong chemical resistance, low ion leaching, and long-term mechanical stability, en-

suring consistent operation under demanding conditions.

Our vision comes to life through Climate Impulse, a pioneering mission to fly non-stop around the world powered entirely by green hydrogen. As the project's main technology partner, Syensqo provides the advanced materials — from lightweight composites and adhesives to insulation solutions — that enable safe hydrogen storage and efficient energy use. This collaboration exemplifies how science and partnership can push the boundaries of clean aviation and accelerate progress toward a carbon-neutral future.

Beyond product innovation, how does Syensqo approach sustainability in its operations and supply chain?

At Syensqo, sustainability is part of how we create value and grow our business. It strengthens our performance, drives innovation, and makes us more resilient. We see it as a source of competitiveness — a way to deliver solutions





that are better for our customers, for society, and for the planet.

We are advancing toward carbon neutrality across our operations by 2040, with validated 2030 targets to reduce our greenhouse gas emissions by 42% in our own activities and by 25% across key areas of our value chain, compared to the 2021 baseline. Today, three-quarters of our sites already run on renewable electricity, and we have achieved half of our 2030 emissions-reduction goal.

In addition, by 2030, we aim to achieve a 20% average reduction in freshwater withdrawal compared with the 2021 baseline at sites exposed to water availability challenges.

Finally, more than 80% of our innovation pipeline focuses on sustainable solutions, and 16% of our sales already contribute to circularity — a share we aim to grow significantly by 2030. From advanced materials for electric vehicles and green hydrogen to bio-based and recyclable polymers, our technologies

are helping entire industries transition to more sustainable models.

Sustainability at Syensqo also means responsibility — operating safely, respecting people, and partnering with communities and suppliers to create lasting value.

Looking at the coming years, what are Syensqo’s strategic priorities to strengthen its position as a leader in specialty polymers globally?

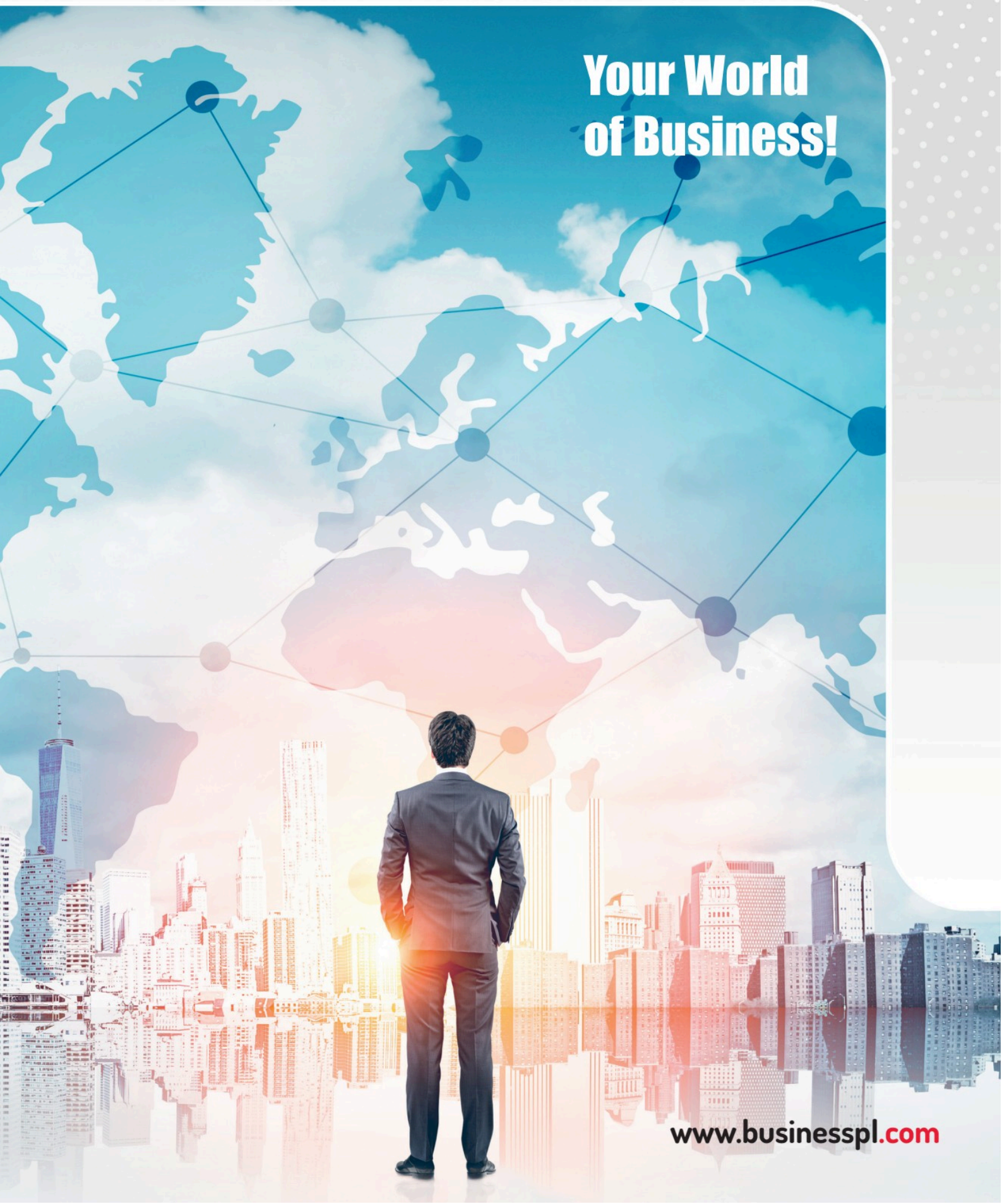
At Syensqo, our focus over the next few years remains on helping the world transition to cleaner energy, smarter mobility, better living, and a more digital economy. With battery costs dropping sharply and EV adoption accelerating, our advanced polymers are playing a greater role in making cars lighter, safer, and more efficient. At the same time, the explosion of computing power driven by AI and data centers is creating new demands for our materials in thermal management, electronics, and cooling — all critical to keeping digital

infrastructure running more sustainably and efficiently. How do we make that happen? By innovating — and co-innovating. With a customer-driven mindset and a strong scientific foundation, we align our expertise with the evolving needs of industries and society. Through our global Customer Innovation Centers, we work hand in hand with customers, partners, and stakeholders to co-create market-leading solutions that truly make a difference.

We’re also making sure our growth is balanced and responsible. That means building a strong regional presence in Europe, North America, and Asia to stay close to our customers and ensure resilient supply chains, while continuing to invest in bio-based and recyclable materials that advance circularity. Innovation, sustainability, and customer collaboration remain at the heart of everything we do. By combining these strengths, we’re positioning Syensqo not just as a leader in specialty polymers, but as a partner in sustainable growth.

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