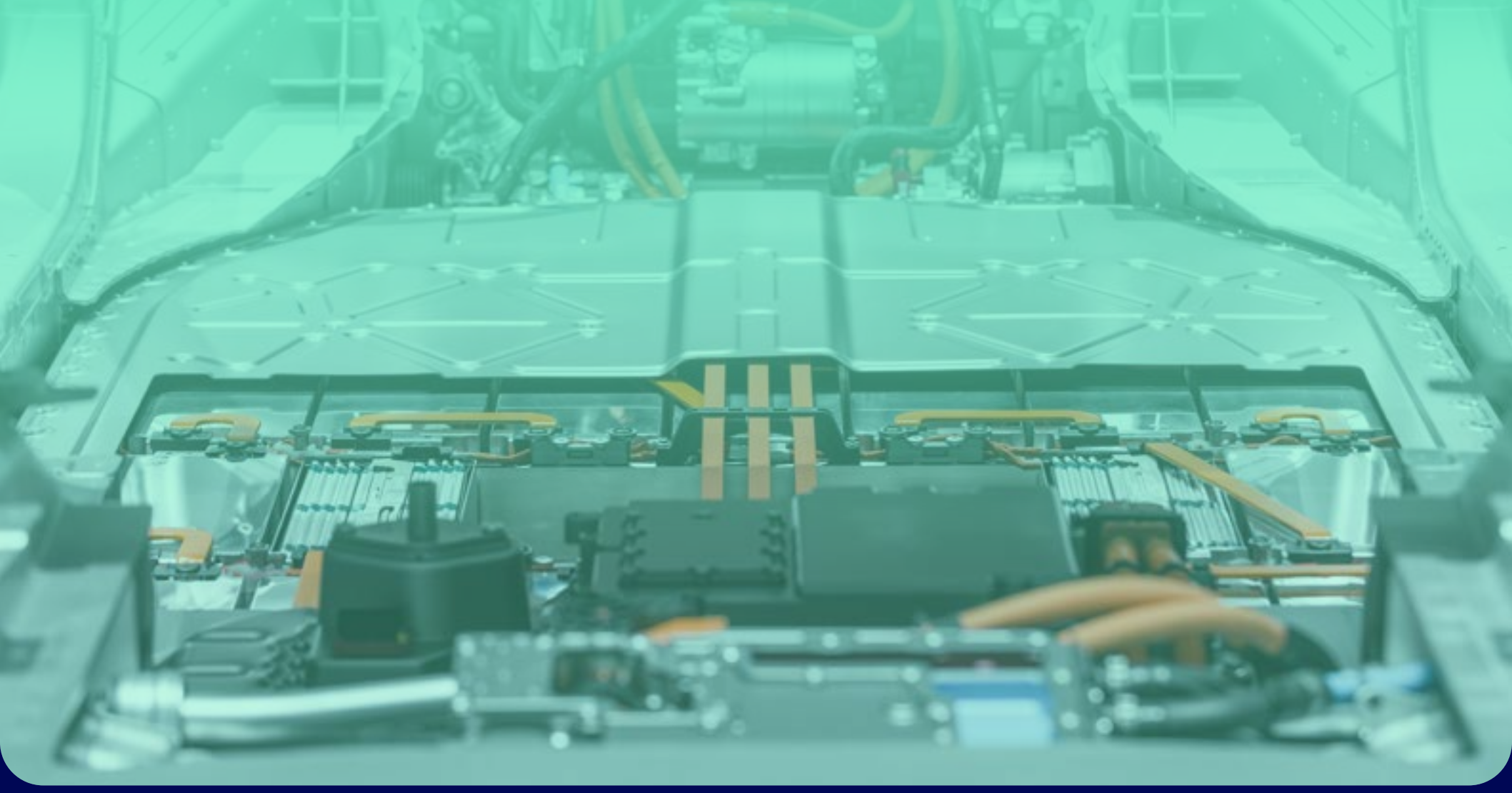
Enabling Sustainability in the Plastics Industry

How a global technology company, ZF Friedrichshafen AG, developed a new efficient production process for high-power electronic components for eMobility.



sens×PERT

ZF

Sustainability and the Plastics Industry

Across the globe, industries face increasing pressure to address their process impact on the rapid advance of climate change, pollution and global warming. To envision a greener future for the planet, it is vitally important for businesses to acknowledge the carbon footprint of their operations and waste production, as well as work with sustainable practices.

Plastic manufacture is one such industry that has been particularly scrutinized for its impact on the world's pollution problems. Producing a large carbon footprint through plastic waste incineration and endangering ecosystems with non-biodegradable material, plastics industries face a challenging battle to become environmentally sustainable and convince society of the ongoing efforts being taken.

The steps to sustainability start within the plastics industry, by minimizing potentially harmful processes and working towards a circular economy. This white paper will address the key factors towards investigating the facilitation of plastics sustainability, and how companies like sensXPERT are applying such practices with an informative use case for sustainable implementation.

At the start of 2023, a new law came into effect for the European Union (E.U.), forcing the largest organizations and the smallest companies, along with all members of their supply chain or regional business, to show how they reduce their carbon footprints and are contributing to the circular economy. Failure to comply or to file the requisite sustainability paperwork will make it nearly impossible for companies doing business in the E.U. to obtain loans from private or public banks, or to qualify for credits.

Additionally, failure of supply chain members to support their OEM and tier supplier customers to obtain their own certification will put them at risk of being replaced by suppliers willing to provide the required reports.

Fortunately, at least in the case of plastics processors, a patented in-mold process control solution with cloud-based machine learning and artificial intelligence algorithms is well positioned to not only help molders optimize cycle time, reduce energy usage and scrap, as well as assure part quality, but it is also an excellent tool for meeting the E.U. taxonomy requirements, as will be discussed.

Sustainable Finance & the E.U. Taxonomy Regulation

With ambitious goals to make Europe climate neutral by 2050, the European Green Deal has been established with aims to improve the health and well-being of its citizens whilst "protecting, conserving, and enhancing natural capital and biodiversity."

Recognizing the need to encourage sustainable activities across the E.U. and to tie investment to climate objectives, the E.U. taxonomy legislation (Regulation 2020/852) came into force on January 1, 2023. This legislation clarifies the definition of sustainable activities and provides science-based transparency tools to guide both businesses and investors in making decisions that support E.U. climate objectives, all while avoiding greenwashing. This is enforced through disclosure obligations on both companies doing business in the E.U. and participants in E.U. financial markets that have been designed to redirect investment toward projects that enhance the health and resilience of businesses, economies, and societies against climate and environmental shocks.

What is the European Green Deal, how does sustainable finance come into play, and in what way does the E.U. taxonomy regulation tie into all of this?

The European Green Deal

Announced back in 2019, The European Green Deal is set to transform the E.U. into a modern, resource-efficient, and competitive economy. These results will involve:

- no net emissions of greenhouse gases by 2050
- economic growth decoupled from resource use
- no person and no place left behind in the transition

The European Green Deal is the new growth strategy aiming to deliver prosperity with a "modern, resource-efficient and competitive economy", with no net emissions of greenhouse gases by mid-century. The deal will be financed by the E.U.'s seven-year budget, as well as one third of the €1.8 trillion investment from NextGenerationEU: a COVID-19 economic recovery plan for E.U. member states.

Its industrial strategy involves harnessing the significant potential in global markets for low-emission, sustainable products, and services in order to achieve climate neutrality by 2050. Key sectors such as plastics manufacture and supply will be provided with affordable, clean technology solutions to help reduce their carbon footprint by this target date.

Key Elements of the European Green Deal

- Climate Neutrality: The E.U. aims to become climate-neutral by 2050.
- Renewable Energy: The E.U. aims to increase the share of renewable energy to at least 32% by 2030.
- Energy Efficiency: The E.U. aims to improve energy efficiency by 32.5% by 2030.
- Sustainable Transport: The E.U. aims to reduce emissions from transport by at least 90% by 2050.
- Biodiversity: The E.U. aims to protect and restore ecosystems and biodiversity.
- Circular Economy: The E.U. aims to create a circular economy where waste is reduced and resources are reused.
- Sustainable Agriculture: The E.U. aims to promote sustainable agriculture and forestry practices.
- Social Justice: The E.U. aims to ensure that the transition to a green economy is just and inclusive, particularly for disadvantaged communities.
- International Cooperation: The E.U. aims to collaborate with international partners to achieve global environmental goals.

Sustainable Finance

A key factor towards implementation of the European Green Deal is sustainable finance. In the E.U.'s policy context, sustainable finance is the consideration of environmental, social and governance (ESG) factors when investing in the financial sector.

The practice aims to support efforts toward economic growth, reducing pressures on the environment, and considering social and governance aspects. Sustainable finance also encompasses transparency when it comes to risks related to ESG factors that may have an impact on the financial system, and the mitigation of such risks through the appropriate governance of financial and corporate actors.

The E.U. strongly supports the transition to a low-carbon, sustainable economy and has been at the forefront of efforts to build a financial system that supports sustainable growth. At the start of 2023, in conjunction with the European Green Deal, access to sustainable finance will be linked to a business's sustainability criteria. For the plastics industry, the challenges begin with the material. Sustainable, lightweight materials that will support the transition into new technologies brings great opportunity for the plastics industry, yet these efforts can be easily compromised by labor shortages and high reject rates due to a lack of production experts.

Additionally, sudden demand for materials such as thermosets and thermoplastics will present a hurdle for traditional plastics manufacturers to report on their sustainability obligations. Holistic optimization becomes vital to innovating with thermosets, as more companies will be required to fully integrate the necessary thermoset tool sensors and machine learning capabilities for Industry 4.0.

Within the framework of the European Green Deal, the European Commission announced a renewed sustainable finance strategy. Publishing its 'strategy for financing the transition to a sustainable economy' on 6 July 2021, The Commission proposed the following actions:

- Extend the E.U. taxonomy framework and sustainable finance standards and labels to recognize transition efforts.
- Stress the importance of inclusion towards sustainability by providing the right tools and incentives to access transition finance.
- Highlight the financial steps needed to become more resilient to the risks posed by climate change and environmental degradation.

These actions present the European Commission's global approach, including work on global convergence on standard setting, such as on taxonomy and disclosures.

E.U. Taxonomy

Until recently, there was no clear framework in place to define or classify terms such as “green” or “sustainable”. The E.U. taxonomy regulation creates a clear framework for the concept of sustainability, exactly defining when a company or enterprise is operating sustainably or environmentally friendly. Operations classified as sustainable economic activities should contribute to the following six environmental objectives:

1. Climate protection
2. Adaptation to climate change
3. Sustainable use and protection of water and marine resources
4. Transition to a circular economy
5. Pollution prevention and control
6. Protection and restoration of biodiversity and ecosystems

As this legislation aims to reward and promote sustainable practices and technologies, businesses within the plastics industry stand to greatly increase their profile and benefit from higher investments when following these core goals. Along with disclosing a sustainability report as referenced in the sustainable finance strategy, companies must adhere to one of the E.U. taxonomy objectives without violating any of the five others.

The classification of an economic activity, which stems from the aforementioned objectives, should follow four criteria:

1. The economic activity contributes to one of the six environmental objectives.
2. The economic activity does ‘no significant harm’ (DNSH) to any of the six environmental objectives.
3. The economic activity meets ‘minimum safeguards’ such as the UN Guiding Principles on Business and Human Rights to not have a negative social impact.
4. The economic activity complies with the technical screening criteria developed by the E.U. Technical Expert Group.

The plastics industry has great potential to meet these objectives through operating efficient manufacturing processes, reducing reject rate, and by reducing overall plastic consumption. To achieve this, the industry requires technology that can provide full transparent monitoring of production processes.

Key Elements of the E.U. Taxonomy Regulation

- Definition of “Sustainable Activities”: The regulation defines a list of economic activities that can be considered environmentally sustainable, referred to as ‘taxonomy’.
- Environmental Objectives: The regulation sets out six environmental objectives: climate change mitigation, climate change adaptation, sustainable use and protection of water and marine resources, transition to a circular economy, pollution prevention and control, and the protection and restoration of biodiversity and ecosystems.
- Transparency: The regulation requires companies to disclose information on their environmental sustainability practices in their annual financial reports.
- Technical Screening Criteria: The regulation sets out technical screening criteria to ensure that only environmentally sustainable activities are included in the taxonomy.
- Sustainable Finance: The regulation aims to support sustainable finance by establishing a framework for sustainable investments and ensuring that financial products are aligned with the taxonomy.

Improving Sustainable Practices

sensXPERT supports manufacturers to achieve sustainable targets through shorter cycle times, lower energy usage, and reduced scrap.

Up to 23% energy savings

Up to 50% of exisiting scrap reduction

Impact on Plastics Processors: Dealing with the Challenge of a Sustainable, yet Cost-effective Production

Before the introduction of the E.U. taxonomy legislation, the plastics industry had already been under heavy scrutiny from the public, governments, and non-governmental organizations (NGOs) to increase its sustainability—not only during material and part manufacture but also at the end of product life. As a consequence, members of the E.U. plastics industry are continually required to disclose information on the sustainability of their processes.

Taxonomy legislation increases reporting requirements and ties the ability to improve sustainability over time to financial market access. The legislation affects capital market-oriented companies as well as small to medium-sized enterprises (SMEs). While SMEs are currently obligated to disclose production reports as a supplier, from 2023 they will also be directly affected without receiving grants and loans. This is because their larger OEM and supplier customers are affected. In order to remain viable members of OEM supply chains, SMEs will need to meet mandated reporting requirements to help ensure their customers and their customers' customers can meet their own reporting requirements.

Companies unwilling or unable to meet these reporting requirements will not only lose access to new loans and credits and could find existing loans terminated but will also find themselves without customers to sell products to. As detailed above, given the challenges the plastics industry currently faces—along with unstable energy costs, supply shortages, and a lack of access to skilled workers—failure to meet taxonomy requirements will severely disadvantage companies.

Challenges in Manufacturing and Processing

Besides sustainability concerns, plastics manufacturers face other significant, more particular challenges, specifically in their plastics production processes. On an expansive level, plastics processors are confronted with general cost and efficiency pressures. For instance, they find it challenging to maintain process stability and identify critical processing parameters that permit better control of final part quality. Additionally, rising material costs add extra pressure on processors to avoid scrap production. Other common challenges that processors face include the following:

- Understanding the influence of processing parameters on material behavior and final part quality due to a lack of transparency during processing.
- Reducing scrap resulting from unacceptable parts produced out of unsuitable processing parameters.
- Determining if long cycle times, which include safety buffers to ensure sufficient curing, could be shortened without significantly increasing scrap.
- Labor shortages are an increasingly difficult challenge that manufacturers have grappled with. More specifically, shortages of workers that are skilled in handling equipment and controls, which adversely impacts efficiency.

Degree of Cure

Degree of cure (DoC) is one measurement of the quality of thermoset processing and helps indicate whether an acceptable part was produced. For most processors, a target DoC is quite individual. Thus, sensXPERT aims to reach a processor's target DoC in the shortest possible time. DoC is also a processing criterion that is used to indicate when a thermoset is sufficiently cured - a.k.a. crosslinks have thoroughly formed between the material's chemical structures and the thermoset has turned rigid and structurally stable - so that parts can be demolded without damage.

Thermoset processors often demold parts before a full cure is reached, as the material is already solid and stable enough to resist damage during ejection, and the curing process can continue outside the mold. This helps processors optimize cycle time, reduce energy usage, and reduce scrap due to under-cured parts.

Limitations in Quality Assurance

To assess final part quality and evaluate process efficiency, companies typically implement quality assurance (QA) inspections. QA inspections can occur before part processing to evaluate raw materials and post-processing to assess the mechanical properties and viability of the parts produced. This ensures and verifies that only viable, in-spec parts get shipped to customers.

In some cases, QA inspections may be unreliable. For instance, quality sampling - deducing the results or conditions of an entire product lot based on a sample - is a conventional QA method. Quality sampling is often performed since testing each part can be too costly and time-consuming. Unfortunately, this means that when a quality assurance engineer discovers an out-of-spec part, many other high-value parts could have also been produced out-of-spec during the time the unacceptable part was demolded and inspected. Thus, all parts would need to be scrapped. This would accrue high labor costs, reduce sustainability due to more material waste, and delay shipment to the end user.

Deviations in Material Behavior

Out-of-spec parts might result on account of deviations in material behavior. Post-processing discovery of batch-to-batch deviations, which changes in internal and external conditions can cause, is a prevalent issue that part manufacturers face. Thermosets, a particular class of polymers well-known for the permanent chemical networks they develop after curing, may be very sensitive to external environmental conditions. For instance, environmental conditions might be changes in facility temperature and humidity. They could also be susceptible to processing conditions like shear and heat exposure. Not only would this affect viscosity, thus the speed of fill, but it could also accelerate or slow cure.

Along with deviations that might occur during the processing of a material, other deviations may occur on account of external conditions prior to the processing. For example, during the transportation of material from a materials supplier to the processing plant, conditions such as weather, temperature in the vehicle, and so on could make a difference in subsequent material behavior. Storage conditions - including duration of storage and the aging of material, temperature, humidity, whether the material was stored indoors or outdoors, etc. - following the transport of materials could impact behavior.

Correspondingly, should a material require the mixture of several components, the mixing ratio, mixing device, and mixing methods might all contribute to the disparity in material behavior. Furthermore, other potential complications could arise from the use of thermosets. The material batch process could be heavily affected if a system contains even the slightest variation in additives and other components.

By detecting deviations in material behavior early on or in real-time during processing, manufacturers could adaptively control their process before producing an out-of-spec part. On that account, understanding material behavior during a production cycle is central to adaptive process control, resulting in reduced scrap and cycle times - hence, improved sustainability and efficiency.

Tackling the Challenges

The challenges above do not come without opportunity. Processors who invest in technology – specifically, technology that allows for adaptive process control – to make their manufacturing operations efficient and more sustainable will find it much easier to meet the taxonomy reporting requirements and ensure they keep their customers. In addition, they will also reduce their costs of goods and services (COGS) via decreased energy consumption, lowered material usage and scrap, improved quality, optimized human resources, shorter cycle times, and improved uptime.

Overall equipment effectiveness (OEE) can also improve, with lower wear on presses and molds and enhanced production capacity (potentially delaying the need to make capital expenditures on new equipment). In the end, this can benefit everyone across the value chain.

sensXPERT: The Solution to More Sustainable Manufacturing

A product of more than 50 years' experience in the plastics manufacturing landscape, sensXPERT is at the forefront of innovation both at NETZSCH and within the rest of the plastics industry.

The new sensXPERT process control solution, sensXPERT Digital Mold, from NETZSCH Process Intelligence GmbH is a highly useful tool for plastics processors to improve their sustainable practices. The sensXPERT solution provides moment-by-moment in-mold material characterization and process data to predict how evolving conditions inside and outside the mold are likely to affect the ultimate performance of parts.

Understanding Material Behavior

As previously touched upon, a vast amount of deviation in the characteristics and behavior of materials due to internal and external conditions is to be expected in plastics production. However, sensXPERT enables greater flexibility in the process by monitoring and adapting to these many and complex variables in real-time.

Therefore, contributing to greater understanding of material behavior and ensuring that manufacturers can implement adaptive process control in their production practices.

sensXPERT's machine learning algorithms can adapt to material behavior deviations, easily missed using traditional methods. Continuous machine learning retraining ensures that the ML models remain accurate, even when there are changes in raw materials or raw material suppliers. This gives manufacturers the freedom to operate within a wider margin of material deviations, and, therefore, within a more flexible supply chain.

The level of transparency that sensXPERT provides can help manufacturers identify and locate deviations more effectively. Additionally, this process transparency can encourage manufacturers to decrease or completely eliminate the safety times - generally in place on account of possible material deviations - that act as a buffer against potential scrap production.

How Does sensXPERT Digital Mold Work?

sensXPERT uses dielectric sensors that can measure the material behavior of a range of materials, including thermosets, thermoplastics, fiber-reinforced polymers, rubber and sands or stones bonded with resin. The combination of in-process dielectric and kinetic data enables the prediction of degree of cure/crystallization, glass transition temperature, or other relevant thermal/mechanical properties of polymers.

Notably, the dielectric sensor is compatible with a variety of manufacturing processes, including (Reaction) Injection Molding, Thermoforming and Compression Molding, Transfer Molding Processes, Vacuum Infusion and Autoclave Curing.

Data streamed from the dielectric sensors are collected by an edge device, which is mounted outside, but close to, the machines in which the molding process takes place. The edge device combines a powerful IPC and a dielectric analyzer in a single unit. Designed for manufacturing environments, the unit allows for cloud connectivity. As such, the device bridges the physical and digital worlds in polymer processing, becoming the single-source-of-truth in the entire production process. Correspondingly, the edge device communicates with the machine, exchanging manufacturing parameters and material properties, while sending and receiving trigger signals.

Not only is the edge device compatible with sensXPERT's in-mold dielectric sensors, but it can also connect to and receive real-time data from third-party pressure and/or temperature sensors.

sensXPERT also offers a Web App that acts as the edge device's interface and empowers manufacturers to effectively adjust their process parameters in real-time. sensXPERT machine learning (ML) models are hosted on the edge device, which are then applied to real-time data collected by the device. These models can accurately predict material behavior to help manufacturers dynamically control their processes and ensure constant part quality. The Web App visualizes these running processes and, using the predictive ML algorithms, provides operators with an optimal point of cure/crystallization so they are able to monitor and adapt active cycles.

The Web App works alongside the sensXPERT Cloud Service. At the most basic level, the Cloud Service validates, stores, and visualizes all historical process data (dielectric and machine) for the user. Third party sensor data can also be stored on the Cloud. The Cloud enables interconnected machines across all manufacturing locations to learn from one another. Using the continuously uploaded data, the ML models that are applied to the edge device are retrained in the Cloud. Furthermore, the historical Cloud data is beneficial in discovering and visualizing trends. Armed with this valuable insight, manufacturers can benefit from process transparency and act decisively before any scrap is produced.

Process Stability

Moreover, the sensXPERT system provides digital component tracking and achieves new levels of understanding and control over the molding process. Not only does this mean a record of process stability for process engineers, but it also means that quality control is conducted in real-time during production. Therefore, QA is tested on each part produced rather than only on a sample.

Accordingly, molders are able to move quality assurance testing from downstream - where it is physically and temporally separate from the molding process - to inside the mold, prior to part ejection. Thus, post-process QA can be reduced to a minimum and the cost per part produced will be reduced.

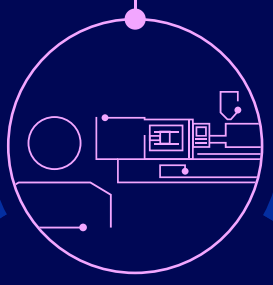
On that account, sensXPERT is able to optimize production processes and remain efficient by enabling adaptive process control. By using this system, companies will also be able to manufacture sustainably through shorter cycle times, lower energy usage, and reduced scrap. sensXPERT ensures that companies can maintain the highest level of transparency necessary for meeting E.U. taxonomy reporting requirements, due to the complete digital thread (traceability) for every product produced using the system.

Several years of field testing with alpha and beta customers has shown that the sensXPERT system can typically improve molding operations by:

- Shortening cycle times by as much as 30%
- Reducing existing scrap by up to 50%
- Generating energy savings of up to 23%

Full visibility and in-mold quality control

Now possible for every single part produced.



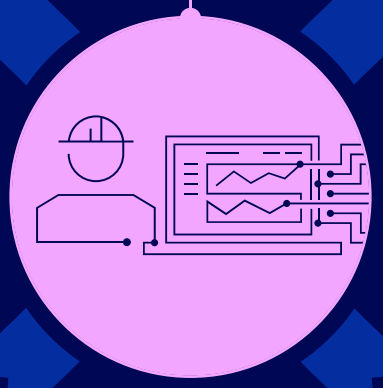
Plastics process control in real-time

Allows the operator to dynamically adapt the process as and when it is needed.

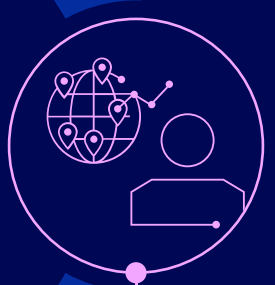
sensXPERT® Cloud

Stores an overview of production history and predictive analytics.

Access real-time transparency & production control on the factory floor



Harness the ubiquity & flexibility of cloud computing



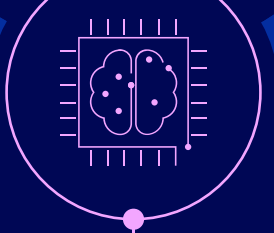
Fully integrated mold sensors

Holistically monitors and characterises materials:

- Degree of cure
- Polymerisation
- Glass transition
- Material deviations
- Viscosity
- Crystalisation
- Temperature

Edge device

Edge device AI core uses machine learning to intelligently adapt data in real-time.

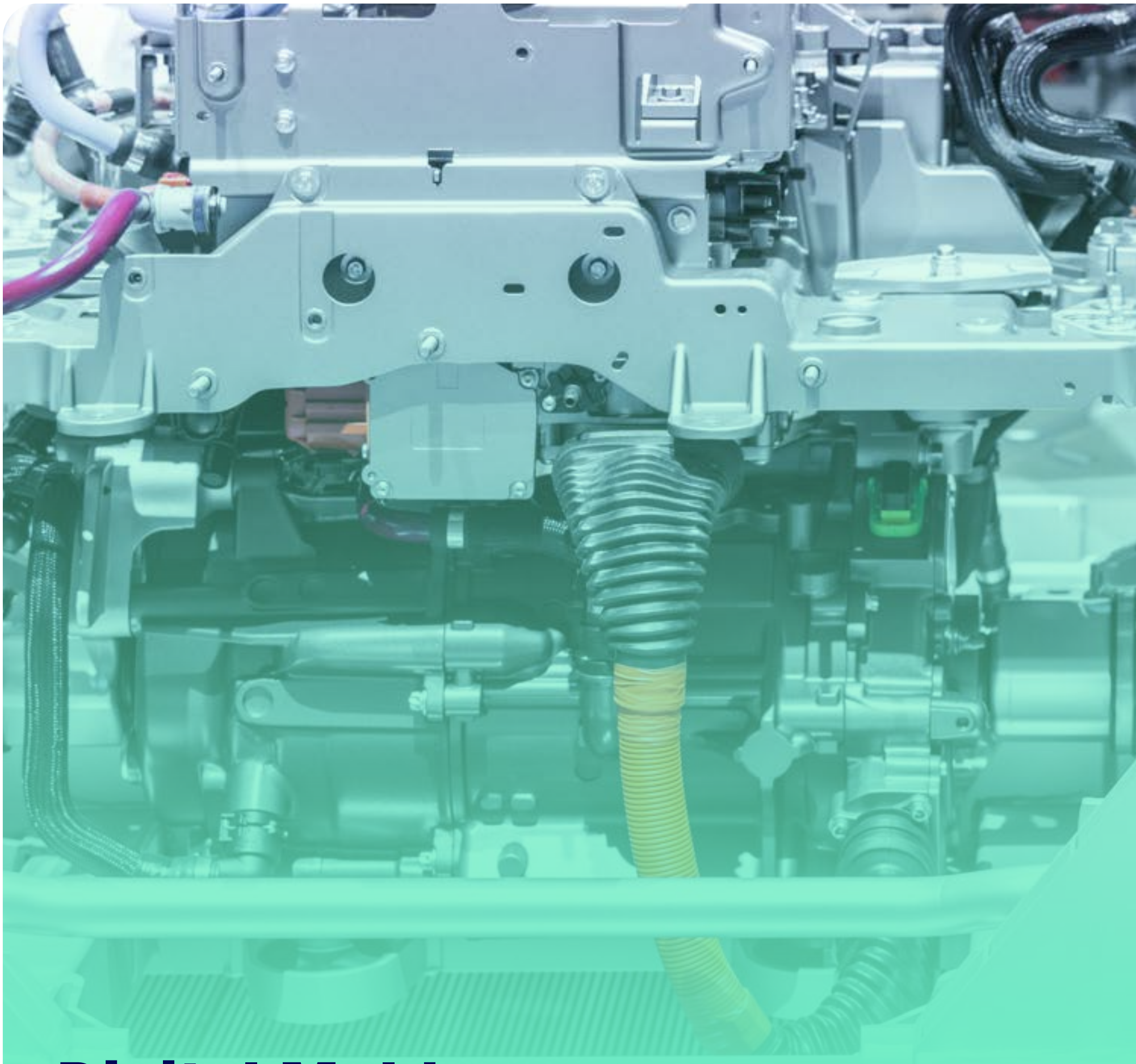


Retrains the AI core

Provides more accurate process forecasts.

Customizable dashboards

Compare efficiency of different production lines from everywhere in the world and from any device.



Digital Mold

Equipment-as-a-Service solution, providing real-time process control with understanding of internal and external mold conditions.

In mold sensXPERT dielectric sensors measure material behavior

Dynamic process control based on machine learning

Case Study: How a Global Technology Company Developed a New Efficient Process and Improved its Sustainability

In 2020, sensXPERT began a collaboration with automotive supplier ZF Friedrichshafen AG.

In its Synergy Group Electronics division, the company produces critical, high-power electronic components used in electric drive (powertrain) systems for eMobility. The process in question involved overmolding high-value electric components with reactive thermoset resins to encapsulate and seal the devices against dust, moisture, chemicals, fluctuating temperatures, and humidity, as well as mechanical shocks in an end-use environment. With greater electrical integrity, products such as electric vehicles become more reliable by extending service life and reducing maintenance costs.

sensXPERT's technology was evaluated on its performance to help reduce cycle time and material waste, lower energy usage, and enrich the automotive supplier's sustainable practices (therefore complying with E.U. taxonomy reporting).

Before the collaboration, ZF's Electronics product line was setting up many new processing lines to encapsulate circuit boards for a new program with a major European automaker. The latest equipment and processing lines were to accommodate a new grade of reactive epoxy, chosen for its low viscosity during encapsulation and improved mold filling.

The sensXPERT process monitoring system presented a unique opportunity to try new approaches in refining processes and reducing investment costs. The system was installed on one of the encapsulation molds to increase understanding of the impact of parameters inside and outside the mold on material behavior. This enabled the ZF team to examine material behavior

consistency and monitor the reliable quality of encapsulated electronic components being produced on the new production line.

Another strategy was to further understand the material behavior and its relationship to changes in the processing environment, both inside and outside the mold. Rather than controlling the process, a molder would set out to control material behavior by selecting a critical property that explained material behavior and indicated the quality of parts produced.

The joint ZF/sensXPERT team ran a series of encapsulation studies with the new resin shot into an instrumented mold mounted in a new transfer press. The mold was instrumented with sensXPERT integrated dielectric sensors and temperature and pressure sensors. Classical process-control guidelines were used to examine the effect of DoC on the encapsulated parts.

Outcomes

After sensXPERT application specialists reviewed the preliminary process data and observed the DoC measurements from the dielectric sensors, they noticed several things. At a target DoC of 90%, all parts cured in less than a few minutes. Yet, comparing the curing times, some parts took significantly less time to achieve the target DoC than others. This potential for time-saving is lost if a fixed curing time with a safety margin for varying material batches and process drift is applied. With sensXPERT dielectric sensor data and predictions from the machine learning models, cycle times were pushed to the limit, as the sensors alerted when the target DoC had been reached.

In line with these observations, the curing time could be reduced by an average of 4%. A fully dynamic adaptation of the curing time bears the potential for saving up to 9% in cycles that exhibit the fastest cure.

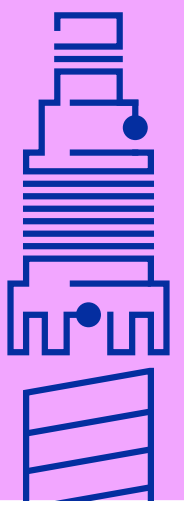
Rico Zeiler, Specialist in Process Engineering at ZF, said the sensXPERT technology allowed more insight into material behavior throughout the molding process. Ultimately, in collaboration with sensXPERT, ZF reinforced sustainability and efficiency in their molding process. sensXPERT has demonstrated the potential for reduced cycle time, lowered energy usage, and decreased COGS to produce parts.

Based on the results of the sensXPERT technology, the ZF Synergy Group Electronics' operations unit has decided to outfit all molds in all presses on its new production line with sensXPERT's process monitoring systems.

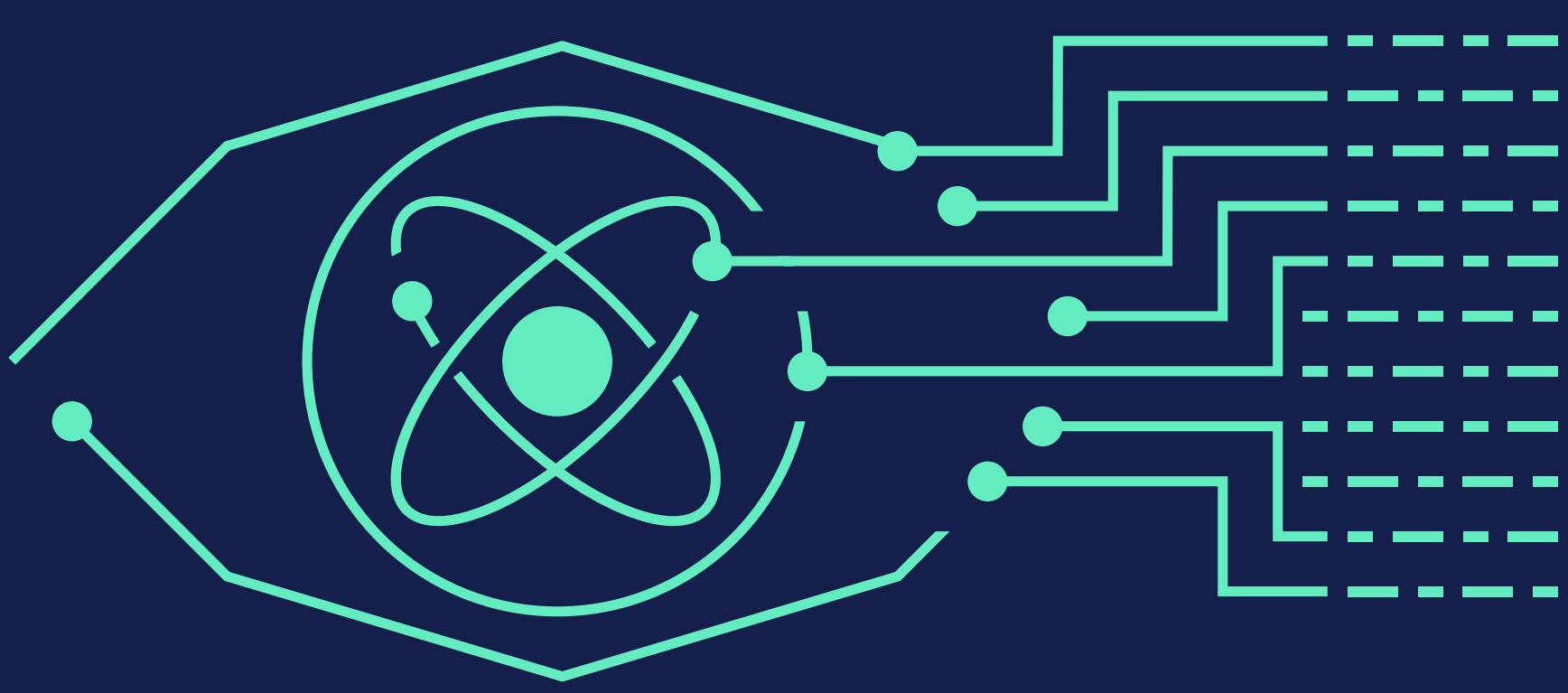
sensXPERT Digital Mold Solution

An Equipment as a Service solution based on material behavior data, providing real-time process control by understanding internal and external mold conditions.

- Dielectric sensors are installed in manufacturing molds to measure real-time material behavior.
- A provided edge-device, connected to the sensors, communicates the material data, as well as third party sensor and machine data to the cloud. Thereafter, machine learning algorithms predict the optimum point for demolding, and technicians are provided with quality data in order to dynamically adapt the manufacturing process.
- The sensXPERT Digital Cloud service can be connected to multiple machines, regardless of geographical location. The Cloud provides total process transparency and data management.



The sensXPERT solution is a highly useful tool that provides moment-by-moment in-mold materials process data to determine the ultimate degree of cure/crystallization of parts.



Conclusion: 5 Steps Towards Sustainable Production

It is no easy feat for the plastics industry to become a sustainable partner for the E.U. Green Deal, and its ambitious climate goals for 2050. It is, however, very possible for companies in the market of plastic manufacture, fabrication, and supply to begin to make a change. Implementation of systems such as the sensXPERT process control solution can better document the plastic industry's use of CO2 in relation to a company's carbon footprint, giving detailed analysis into the production cycle and where sustainable solutions can improve operations.

Investing in such technology will help towards E.U. goals of increasing the share of renewable energy to at least 32% by 2030 and becoming climate-neutral by 2050. The technology helps to identify problems in production before products reach the market, therefore helping businesses keep a detailed record of their processes and aligning the data with the Sustainable Finance report that's needed for the plastics industry to meet E.U. taxonomy requirements. With this in mind, organizations within the plastics industry can follow 5 key steps in ensuring the right path to sustainable production:

1. Ensure thorough and consistent reporting on operations to abide by the Sustainable Finance Strategy and utilize its benefits. The scheme will help towards gaining newer processes and training more people to use them.

2. Implement a process control solution to gain complete process control over material behavior. Catch early production errors and save money on unsustainable scrap and material waste. sensXPERT provides a solution that reduces cycle time, lowers energy usage, and improves COGS to produce parts.

3. Employ holistic optimization for the manufacturing process, using tool sensors and AI software with machine learning capabilities. Industry 4.0 and automation optimization is being heavily employed across multiple sectors to boost efficiency in production.

4. Educate on rising materials such as thermosets and bioresins. Thermoset is growing in popularity and demand, as is the skills shortage for its operation. Monitor temperature and humidity of production utility to avoid volatile errors.

5. Avoid missing out on process digitization and collaboration. Assist untrained workers with collaborative production process tools and discover how different technologies and products can interact to improve process efficiency.

Collaboration along the supply and value chain is essential for the plastics industry achieving the sustainable goals set out by the E.U. sensXPERT technology provides advantages when it comes to real-time data tracking, process improvement, and rapid production optimization. By enabling the reduction of reject rates, energy consumption, and plastic expenditure, sensXPERT provides manufacturers with a sustainable solution that can aid in transparent reporting, as per the requisites of E.U. taxonomy legislation.

Companies interested in learning more are encouraged to contact the team at NETZSCH Process Intelligence GmbH to discuss how sensXPERT technology can save money and help with E.U. taxonomy documentation.

Learn more at www.sensxpert.com or contact the team at www.sensxpert.com/contact

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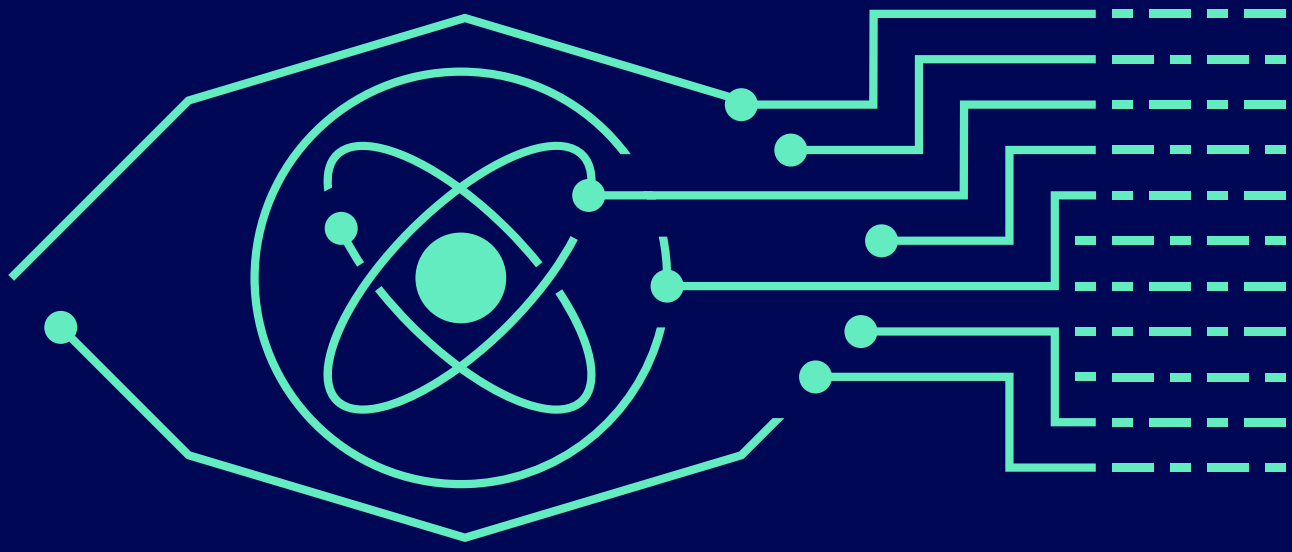

sensXPERT

EXPAND your sense of the possible